Projection of U.S. Apparel Demand And Consumer Profiles Based On Demographic Changes For The Period 1991 – 2010

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PROJECT CODE: S92C7 (to be merged with A92C6)

I. Relevance to NTC Goals

During the last year, a new system called "TABIS" was designed by acquiring the necessary hardware, software, public and private data and by interfacing them together for an easy access, analysis and graphical representation.

This project is aimed at 1) creating a system for forecasting U.S. apparel demands by specific categories to the year 2010 and 2) providing the forecast data for the same based on the available public and private databases. The system (called "Textile and Apparel Business Information System" — TABIS) is the first of its kind in a public sector and has been designed to help the small and medium size U.S. apparel manufacturers with little or no means for developing or purchasing a sophisticated forecasting system for their marketing needs. We know of no other system, public or private, which is comprehensive enough to fill the existing need in apparel marketing and strategic decision making.

The research components include 1) system design based on many large datasets, 2) utilization of all similar but non-identical data sources for forecasting, 3) mathematical, statistical and heuristic modeling under dynamic indicators (population, fashion, economy) and 4) short-term prediction of consumer behaviors in apparel purchasing. These components are both academically challenging and practically rewarding in view of the enormous need currently unfilled. In terms of the declared NTC goals, therefore, this project is ideal for providing trained personnel, and new forecasting and marketing technologies for apparel and textile industries, and strengthening research in the areas of demand activated manufacturing with a direct linkage to consumers.

II. Design of "Textile and Apparel Business Information System" (TABIS)

A. System Hardware

We have acquired a DECstation 5000/25 with a 1 Gb hard drive (this drive can hold the same amount of data as 1000 high density 3.5" floppy diskettes). This disk facilitates working with large datasets in their entirety as opposed to working with a sub-set of the datasets. The computer and disk are attached to the ethernet network and can be accessed by all members of our research team from any of the workstations on campus. We named our database as "Textile and Apparel Business Information System" (TABIS).

B. Data Acquisition

We have acquired the following data sets from the public and private sources:

- ***NPD Consumer Purchasing Trends:***
  - Panel data on total, jeans, tailored, slacks, underwear, and panties for 1986 – 1992.
- ***Market Research Corporation of America (MRCA) Consumer Purchasing Trends:***
  - Panel data on total, jeans, sweats, men's suits, men's dress and sport shirts, women's slacks, and boys knit and woven shirts for **1988 – 1992.**
- ***American Textile Manufacturers Institute (ATMI):***
  - All monthly data from Textile Highlights for the past 10 years in QuattroPro spreadsheet format.
- ***NPA Data Services, Inc.:***
  - ***By*** state & county, FIPS, and code for 1970, 80, 85, 90, 92, 95, 2000, 2010 values for population, income/household, employment, etc.
- U.S. ***Dept. of Commerce, Bureau of the Census:***
  - Projections of the US and State Populations by Age, Sex, and Race: 1986-2010.
  - Annual Projections US Population by Age, Sex and Race: 1988-2080.3 1 different projection series.
  - -County Business Patterns, 1986, 1988 and 1990. This data contains county totals for employees and number of establishments by Standard Industrial Classifications (SIC). Of particular interest are SIC 2200 (textiles) and SIC 2300 (apparel).
  - Monthly Retail Sales and Inventories (total dept store and apparel specialty retail sales-men and women).
  - National monthly sales estimates, Jan 1967 – Dec 1991.
  - Geographic Area monthly sales estimates, Jan 1987 – Dec 1991.
  - Kind-of-Business sales, Jan 1978 – Dec 1991 End-of-Month inventory & inventory/sales ratios, Dec 1980 – Dec 199 1.

    MA22 & MA23 U.S. Domestic Production Information. These tables are broken into several pieces and stored in WordPerfect format.

- ***U.S. Dept. of Commerce, Bureau of Economic Analysis:***
  - National Income and Product Account (NIPA) Gross Domestic Product and Related Series.
  - Personal Consumption Expenditures (PCE), Annual & Quarterly 1959-1990.
- ***Sales & Marketing Management Magazine:***
  - Regional and State Summaries of Merchandise Line Sales by Men & Boys, Women & Girls, Dept, and All Stores — Annual 1975–84, 87–90.
- ***American Apparel Manufacturers Association (AAMA):***
  - Population Basics Metropolitan Area Data.
  - Retail Sales Basics Metropolitan Area Data.
  - AAMA Topline Report, Annual 1984-1991 Men, Women, Boys, Girls by 30 line items.
- U.S. ***Dept. of Labor, Bureau of Labor Statistics (BLS):***
  - US Consumer Expenditure Data grouped by age, income, area, etc (69 groupings) 10 line items for Apparel include men, boys, women, girls, children.
  - Employment, Hours & Earnings, monthly & annual, -1939-1991 by SIC.
  - Consumer Price Index (Survey = WP, CU, CW).

C. System Interface

The raw data received have been converted to ASCII format and stored on the 1 Gb disk. The ASCII files are then read into SAS datasets and accessed with SAS's version of the Standard Query Language (SAS/SQL). SQL allows the user to easily specify and select any subset of the data. Interface programs were written to prompt the user for the desired data description and then to automatically write the SAS/SQL program to select the data subset. The subset can then be analyzed using SAS's statistical and graphical procedures, or written to an ASCII file and imported into other data analysis software. Since the interface program's code-generator writes and executes the SAS code for the users, one can access the data without actually learning the SAS computer language.

D. System Enhancement Research

The TABIS database has undergone several rounds of speed enhancement to provide the user with the quickest possible response time. The main speed-up comes from reading the ASCII into SAS datasets ahead of time; some of the larger datasets require over 15 minutes to read into a dataset, but once this is done the data can be accessed in seconds. The second main speed enhancement comes from indexing the larger datasets. Indexing is a database technique which is analogous to an index in the back of a book which assists the reader in finding which page a particular word is on instead of looking through the entire book. The third main enhancement was achieved by rewriting some of the SQL queries in a more efficient way.

Four new datasets are now accessible through TABIS. This addition brings the number of interface programs up to eleven. They are: NPD Panel Survey Data on Apparel Consumption, MRCA Panel Survey Data on Apparel Consumption, U.S. County Business Pattern, and the Monthly Retail Sales & Inventories.

The main TABIS menu has also been divided into three sections. The first is a basic ASCII interface to assist the user in selecting any piece of data from any dataset; the ASCII-based menu and output can be accessed remotely via PCs connected to a modem, or workstations on the Internet network.

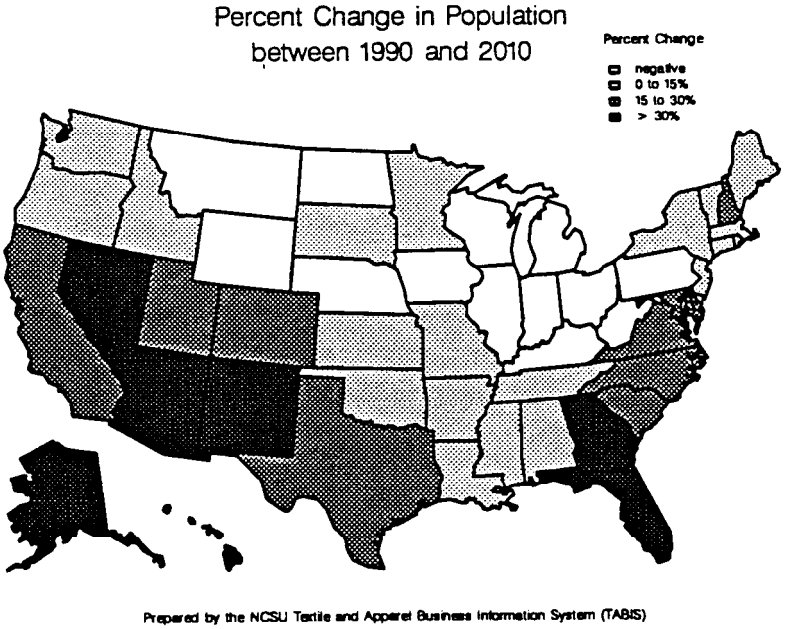
E. Research on Computer Graphics

In addition to the ASCII-based menu, the next two parts produce on-screen X-window graphics and require the user to be directly logged into a workstation at NCSU. One graphical portion produces slide-show "animations" of graphs of the data displayed over time so the user can study trends and changes that are occurring over time. For example, the increasing age of the "baby boomer bulge" is easily seen in animations of the population projections.

The other graphical portion performs "data visualization" by creating maps and/or graphs of the data the user selects. Several example outputs are included in this report.

Several graphs and maps were produced to help visualize the large quantities of data. One example is the County Business Patterns (CBP) data on the number of employees and establishments per county for each industry. This data is much easier to comprehend after TABIS provides county names to go with numerical FIPS county codes. Even more helpful is the ability to graph this data on a U.S. map. Two examples are included on the facing page for apparel employment and establishments. Similar examples for textile employment and establishments are included on the following page.

It is interesting to compare the CBP textile and apparel employment maps with other data. By comparing the CBP maps to a map of the NPA population projections (below) one can discern that most states with a large number of textile and apparel employees are also projected to have population increases. Pennsylvania is one exception to this general observation.



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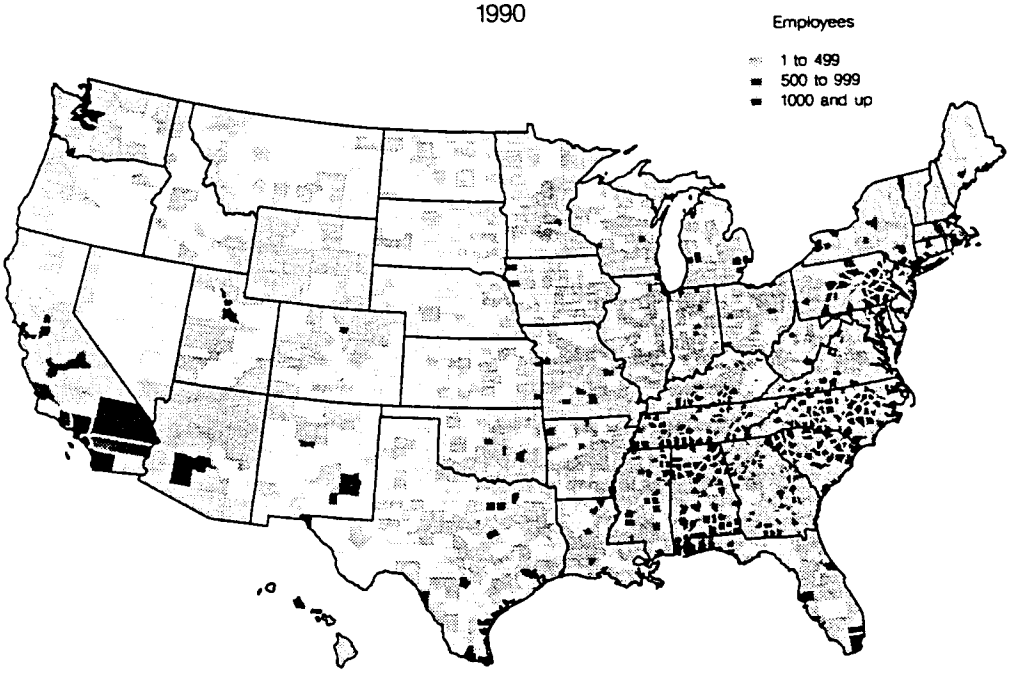
US Apparel Employees by County

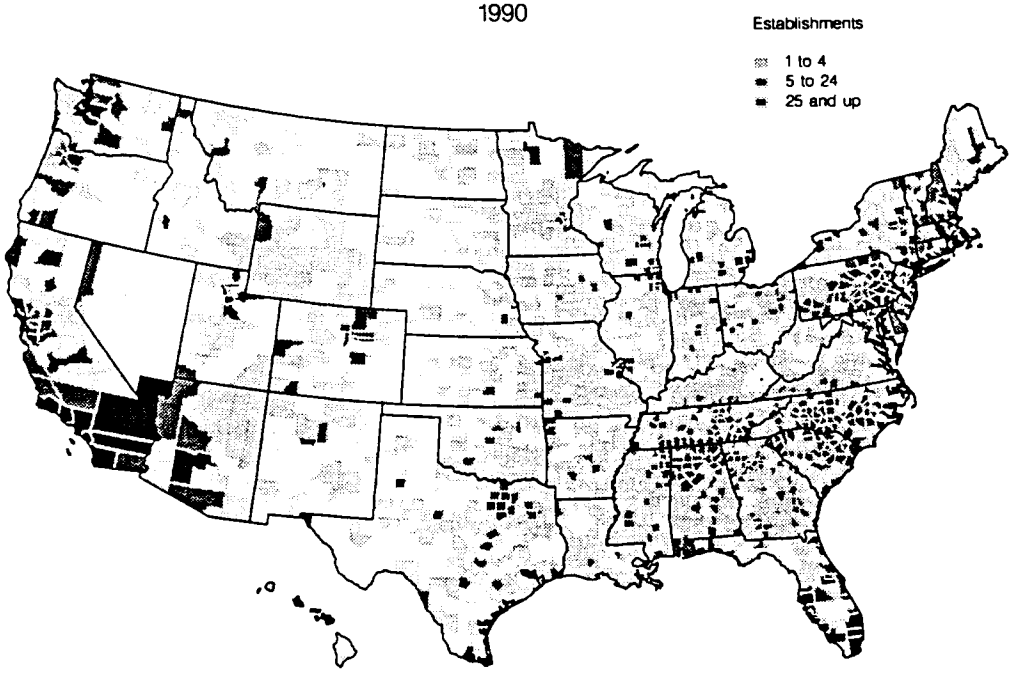
1990



Prepared by the NCSU Textile and Apparel Business Information System (TABIS)

US Apparel Establishments by County

1990



Prepared by the NCSU Textile and Apparel Business Information System (TABIS)

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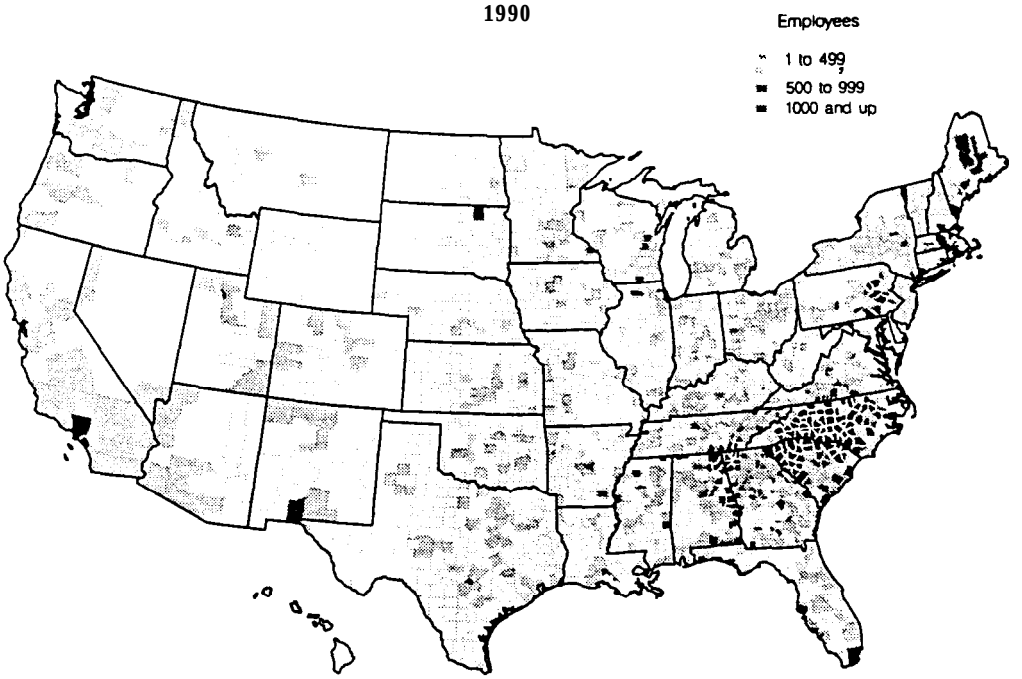
US Textile Employees by County

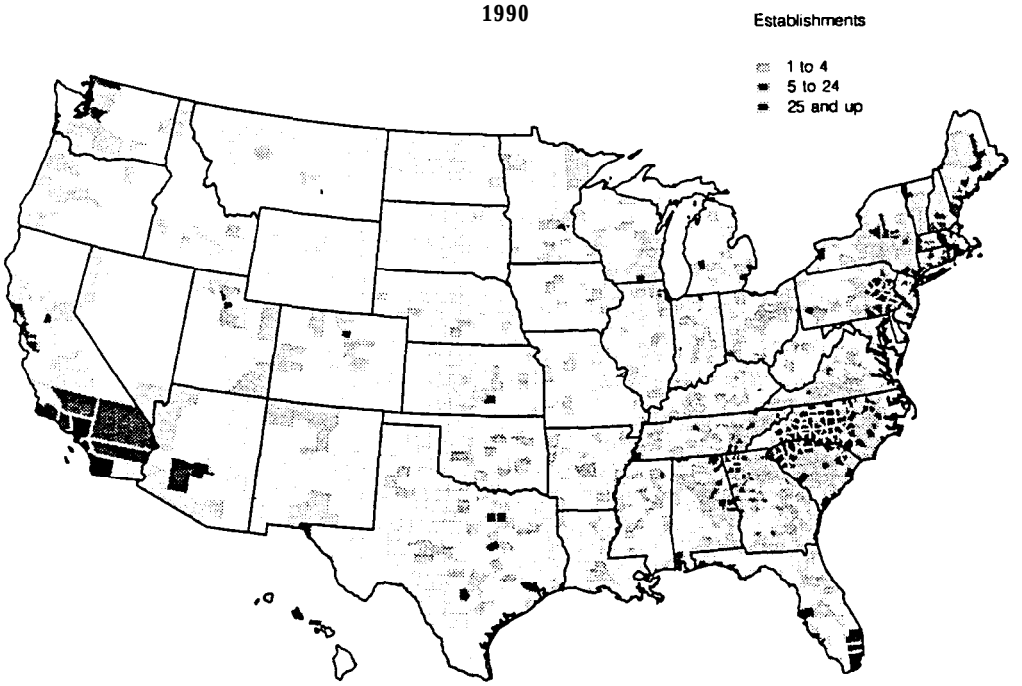
1990



Prepared by the NCSU Textile and Apparel Business Information System (TABIS)

US Textile Establishments by County

1990



Prepared by the NCSU Textile and Apparel Business Information System (TABIS)

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III. Statistical Analysis and Demand Modeling

The first statistical analysis activity was centered on the apparel data from the Bureau of Labor Statistics' Consumer Expenditure dataset. This data consist of expenditures by various groups (age, household makeup, occupation, income, race, geographic location, etc.) on men, boys, women, girls, and children's apparel for the years 1986 to 1990. This data were then written to an ASCII file and imported into a spreadsheet. In the spreadsheet, equations were set up to show the data as a percentage of the total consumer expenditure for each of the groups. The size of the final spreadsheet was 154 by 68 (i.e. 10,472 cells).

A similar analysis was performed on the U.S. Department of Commerce, Bureau of Economic Analysis' National Income and Product Account (NIPA) data. This data shows the total expenditures on women/girls/infants and men/boys apparel for the years 1959 to 1990. The data are in both real and current dollars. Spreadsheets were created to show this data as a percentage of total, apparel, services, and non-durable expenditures. The size of each spreadsheet was 27 by 37 (i.e. 945 cells).

A. Apparel Demand Modeling

With the arrival of the NPD and MRCA Panel Survey Data on Apparel Consumption, the group's efforts were centered on developing a simple forecasting model as a start. Our first attempt has focused on making demand projections for jeans by age group. The projections were based on the U.S. Census population projections. An average jeans per person was calculated for the years with actual consumption data, and projections were made by multiplying the average jeans per person by the population projection for each age group.

J_i = jean purchases for year i

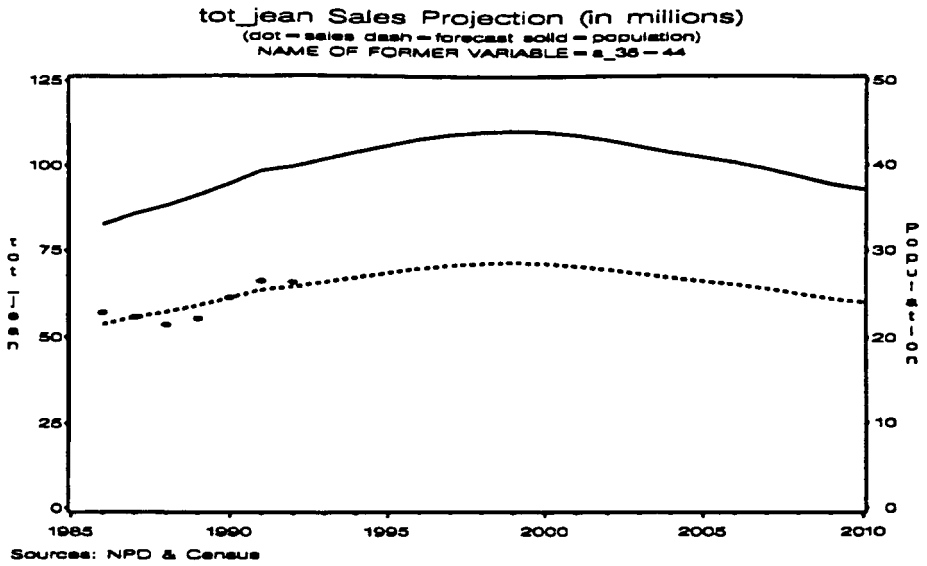
P_i = Bureau of Census population projection for year i

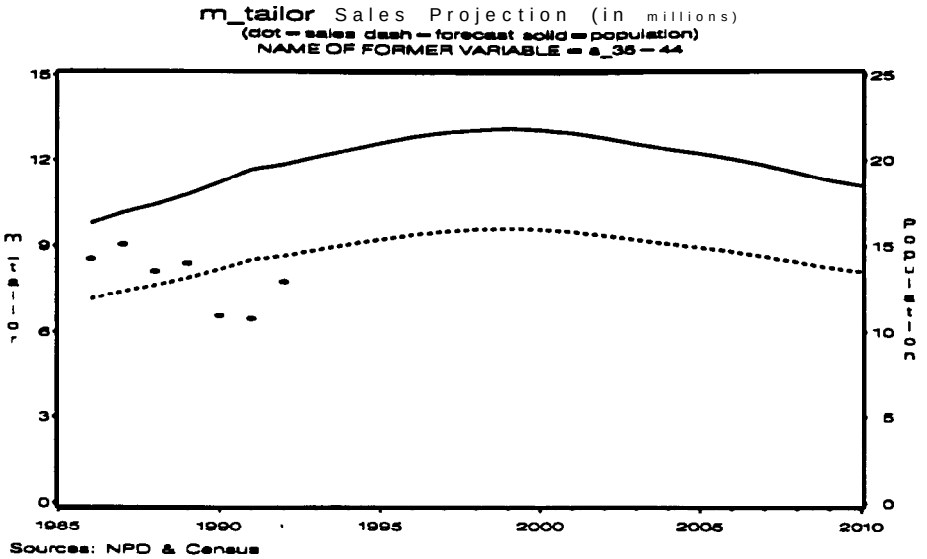
$JP_i = J_i/P_i$ = jeans per person for year i

$A = \text{sum}(JP_i)/\text{count}(JP_i)$ = average of all JP

$F_i = A \times P_i$ = forecast jeans purchased for year i

Several SAS programs were written so that such projections can be made for any of the apparel categories with available data. Two examples are included on the facing page for 35–44 age group. The first example is for total jeans. The jeans data follows a fairly straight line, and fits our simple model well. The second example is for men's tailored clothing — this data seems to follow a cycle around projection line from our simple model.





Efforts are currently underway to obtain additional data for other household characteristics from NPD and MRCA for the same age groups and garment lines so the data and projections can be compared and validated.

B. Design of Analysis to Combine Statistical and Heuristic Models

Under development has been a theory for combining a statistical model and a heuristic model based on qualitative information. This work is essential for reflecting the changes in fashion, human perception, economic climate and others on a more structured analytic formula. In our future collaboration with Auburn group (A92C7), the work would be essential in combining the results to date from both projects.

IV. Industrial Participation/Collaboration

During the last 12 months, we visited the following organizations and obtained assistance and pledges from these allied industries to actively participate in our future endeavor.

- NPD (Port Washington, NY) — Consumer panel survey data on apparel (1986 – 1992) were obtained from them, free of charge, for our research. They pledged continuous assistance to us.
- MRCA (Stamford, CT) — Consumer panel survey data on apparel (1988 – 1992) were extracted from their main data source for our research, free of charge. They will also support us with technical assistance.
- Levi Strauss (San Francisco), Burlington Industries Market Research Group (NY), DuPont Co. (Wilmington, DL) — We obtained numerous data on apparel consumption and market trends from these companies. They pledged, some in written forms, to provide technical support for our research work.
- ATMI (Washington, DC) — They agreed to let us access their "Textile Hi•Lights" database for research purposes, with a pledge to support our efforts.
- AAMA (Arlington, VA) — In addition to the invaluable expertise of Carl Priestland, AAMA has provided much assistance to our research efforts.

V. Technical Presentations/Publications

A. Prepared and presented a paper to the 4th Annual Academic Apparel Research Conference on February 8, 1993. The paper was titled "Creation of an Apparel/Textile Business Information System and Forecasting of U.S. Apparel Demand for 1991 – 2010" (by R.E. Allison, M.W. Suh, C.H. Priestland and M. Davidian). The paper was printed in the proceedings of the conference.

B. A paper entitled "U.S. Apparel Demand Forecasting for 1991 – 2010" was presented by M.W. Suh to the 3rd NCSU College of Textiles – Bremen (Germany) Univ. Joint Research Symposium on September 12 – 13, 1993 in Raleigh, NC.

VI. Resource Management

A. Equipment-A DECstation and a 1 Gb disk space were purchased by a State-appropriated fund (non-NTC) for this research. In addition, NCSU College of Textiles is an IBM "CIM in Higher Education" site and has been an ideal location for conducting this NTC research. Various communication networks under the environment directly benefited the data storage/retrieval/communication activities of our research project.

B. Personnel -Three P.I.s with distinct capabilities (M.W. Suh — Statistical Modeling Analysis, Textile Management/Eng., C.H. Priestland — Apparel Economics/Marketing, Information/Data Management, M. Davidian — Statistical Modeling/Analysis) pulled expertise together in all aspects of project management. C.H. Priestland, Chief Economist of AAMA and an Adjunct Professor at NCSU, provided his practical expertise in the systems design and in industrial contacts. We fully

utilized the industrial consultants, free of charge, for our system design, data acquisition and interpretation of projected demands. The names are not listed here for brevity.

The project has progressed much beyond our expectation with the able assistance of Mr. Robert Allison (Ph.D. student in Textile Technology Management). Another excellent graduate student Ms. Ekaterina Popdimitrova (Ph.D. student in Textile Technology Management) was added in 1993 to expedite the research. In addition, two other graduate students, S. Kwon (Ph.D. – Statistics) and J. Ahn (M.S. – Information Science), contributed to the project on a part-time basis.

C. Collaboration with Auburn Group — As we began our forecasting activities, we immediately felt a need for incorporating such qualitative elements as fashion (color, style), economy and consumer psychology. We began communicating with an Auburn group (A29C6 – E.L. Brannon, L.J. Anderson, P. Ulrich) to see if we can benefit each other. The situation, as we analyzed, was perfect to match the two together for a future collaboration and expansion. Finally, we agreed to merge the two research projects together as soon as possible, pending an approval from the operating board.

D. Communication Networking — Currently, we are accessing our data to any PC or workstation within NCSU. The database can also be accessed to any location in U.S. via modem or E-mail. The proprietary data, however, must be guarded before this could happen. We have already been working at separate workstations within NCSU without having to come to the main location.

E. ATMI "Textile Hi-Lights" and Import/Export Databases -We have a direct access to these ATMI systems although we will incorporate the "Textile Hi-Lights" PC/QuattroPro spread-sheet database into our system immediately.

VII. Budget and 3rd Year Goals

We have merged with an Auburn Group, A92C6, (Brannon, Anderson, Ulrich). See the "A92C6 — Third Year Proposal" for details.