Use of Body Scan Data to Design Sizing Systems Based on Target Markets

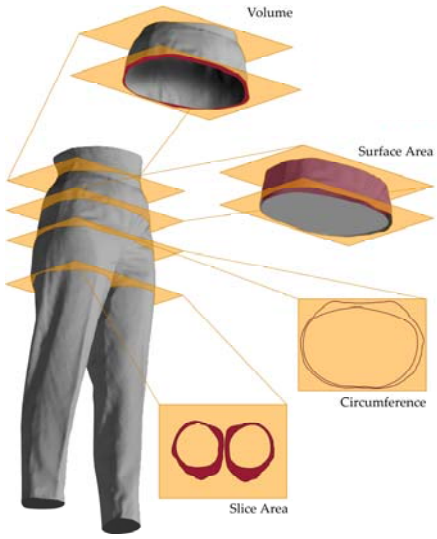
Susan Ashdown, leader; Suzanne Loker (Cornell)
Carol Adelson (Fashion Institute of Technology)

The three-dimensional body scanner is a promising new research technology that will contribute to revolutionary changes in the conception, design, manufacture, marketing and distribution of apparel. Currently, the quantification of fit is complex and ambiguous; and objective methods, such as comparison of one-dimensional measurements, are inadequate. Body scanning provides multi-dimensional data that have the potential to provide new insights into sizing and grading systems to improve fit. Our ultimate goal is to develop a prototype mathematical process to use body scan data to improve sizing systems for a specific target market population of an apparel firm.

We are providing insights into body/apparel relationships with the ultimate goal of developing a tool for apparel companies to improve their sizing systems.

Using body and pant scan data, we are evaluating how size range, measurement specifications and grading rules can be improved to better accommodate a target market. We used a Tecmath VITUS/smart 3-D body scanner with eight cameras and four eye-safe laser light sources to capture approximately 300,000 spatial data points per scan for each of 203 female subjects.[1] Subjects were scanned twice, once in minimal clothing and a second time in the best-fitting size of Liz Claiborne test pants. Scans were cropped above the waistband and at mid thigh, and planes were set at critical fit areas (see Figure). We then used Innovmetric's Polyworks software to merge, align and clean the scan data; as well as provide 3-D visualizations. Polyworks allowed manual extraction of circumference, slice area, surface area and volume data as well as 3-D visualizations to describe body and apparel relationships in ways never before possible.

We conducted a variety of statistical analyses to characterize specific problems of pant fit in the target population. Cluster analysis of body scans identified five clusters distinguished by general size and suggested that some of the non-traditional measurements such as abdomen to hip surface area may be helpful in improving the existing system. A panel of experts then used the 3-D visualizations of each pant scan to rank fit as "acceptable," "marginal" or "unacceptable" on a global basis (rating overall fit from front and back views) and then for localized areas (rating 13 specific body locations). These ratings helped identify problem areas or misfits based on size and categorize the sample by fit for further analysis. Ease values[2] in linear, area and volume measurements proved to be a valuable measure to identify and characterize misfit. We also analyzed ease values to show misfit trends based on body proportions.



Circumference, Slice Area, Surface Area, and Volume Measurements Captured Using Planes

To determine the state of fit for the existing sizing system used at retail, we calculated the mean visual fit ratings to measure closeness to acceptable, marginal or unacceptable fit. From a front view, the majority of the women in the Misses style target market fell a little above a marginal rating.[3] From the back view, the majority of the target market fell closer to marginal.[4] While a true test of the existing sizing system would be difficult, we can take these figures as indicators that there is a substantive need and ample opportunity to improve this sizing system.

We also found patterns of surface area misfit at the waist and abdomen areas that statistically differentiated between acceptable and unacceptable and between marginal and unacceptable fit ratings. Statistically significant patterns of surface area misfit between specific fit ratings and pant sizes emerged at abdomen to hip sections. Moreover, we found that target market body proportions were different than those of fit model and size grades, confirming that the current sizing system is not fitting the full range of the target market well. Subjects with the lowest and highest hip to waist ratios were less likely to find acceptable fit than subjects with hip/waist ratios in the middle of the range. We are further analyzing the data to consider crotch length, thigh measurements and slice areas as indications of body shape variation as well as statistical cluster analyses to determine ideal size groupings.

To develop a prototype mathematical process to improve the existing sizing system, our first step was to de-

1 selected to fit our industry partner's target market (Liz Claiborne) of 34-55 year old women in Misses 4-16 and Women's 14-24 sizes.

2 ease values are the additional amounts of fabric needed in a garment beyond the body measurement for good fit.

3 scale: -1 = unacceptable, 0 = marginal, 1 = acceptable; mean = 0.29, standard deviation = 0.65

4 mean = 0.05, standard deviation = 0.53

termine how relevant body measurements correspond to our visual ratings of good fit. We are now using the distributions of those measurements to modify the current pants grading matrix and are generating a model using multinomial logistic regressions. We collected additional data on changes in body size that occur with movement, by scanning 49 subjects in standing and seated positions. We will analyze these data for insights into appropriate ease values to provide comfortable pant fit, and incorporate them into the prototype mathematical process. Our goal is to find the minimum number of measurements that will be able to accurately describe "fit" variance and to apply these results to improve the sizing and grading systems currently used in industry.

Contributors: **Graduate Students**: *Eui Choi, Lindsay Lyman-Clarke, Jian-Guo Cao, Jinghong Gao, Lucy Dunne, Kirk Mayer, Yun Jeong Oh, Adriana Petrova, Nami Tanaka, Jeong-Ju Yoo*; **Undergraduate Students**: *Luisa Avila, Arnab Bose, Stephanie Chan, Fred Fang, Amy Kinateder, Erica Lastufka, Kira Luxon, Janaki Parthasarathy, Ewunike Patterson, Jaclyn Popeil, Erica Richter, Tara Taft, Frankie Tsang, Natalie Walsh, Orren Wexler* **Others**: Project Manager: *Katherine Schoenfelder*; Faculty: *Dexter Kozen, Van Dyk Lewis.*

Industry Interactions: 4 [Liz Claiborne, Inc.; Saint Laurie Merchant Tailors, Edyth Gazzulo, JC Penney , Z-weave, Browzwear, Perfect Fit, Leslie Fay, Brett Stern, D3 software, Nike, [TC]²]; **Other Interactions**: Non-NTC Academic: 8 [Ithica College, Univ. of DE, Michigan St, Oklahoma St, London College of Fashion]; Government: 1 [NASA]

Project Web Address:

http://www.human.cornell.edu/units/txa/research/ntc/S01-CR01-A3.pdf

http://www.human.cornell.edu/txa/extension/appind/bodyscan

For Further Information:

1. 3-D body scanner: http://www.explore.cornell.edu/bodyscanner (2003).
2. 3-D body scanner Discovery Channel Canada [Television, S. Bentley (Producer). Toronto (2003)].
3. S. P. Ashdown, A. Petrova, S. Loker and L. Cowie, *Development of protocols for objective fit analysis using body scan data.*, International Journal of Clothing Science and Technology (2004).
4. J. F. Azoulay, *Body scans and consumer demands move into the future together* AATCC Review (Feb 2004).
5. M. Leslie, *Net watch: High-tech haberdashery*. Science, 301, 899 (Aug 15, 2003).
6. S. Loker, L. Cowie, S. P. Ashdown, V. D. Lewis, *Female Consumer's Reactions to Body Scanning*, Clothing and Textiles Research Journal, 22(3):p? (2004).
7. A. Petrova, unpublished **Master's thesis**, Cornell, *Analysis of Body Scan Data for Best Fit of Pants* (2003).

Susan P. Ashdown, an Associate Professor in Textiles and Apparel at Cornell, joined the faculty in 1991. Susan earned a Ph.D. in apparel from the Univ. of Minnesota in 1991, a M.A. in textiles: apparel design from Cornell in 1989, and a B.A. in theater arts from Grinnell in 1971. Her research interests include anthropometrics; apparel sizing, fit and the perception of fit and 3D body scanning.
S01-AC27, S01-CR01*, S04-CR01*
spa4@cornell.edu
(607)-255-1929
http://www.human.cornell.edu/faculty/facultybio.cfm?netid=spa4&facs=1

Carol Adelson, an Associate Professor at New York City's Fashion Institute of Technology (FIT) and Chairperson of the Fashion Design Dept., joined the faculty in 1966. Carol earned an A.A.S. in fashion design in 1956 from FIT and a B.A. in liberal arts in 1973 and an M.S. in education & media in 1977, both from City Univ. of New York. Her research interests include sportswear design and pattern making.
S01-CR01
(212)-217-3318

Suzanne Loker, the J. Thomas Clark Professor of Entrepreneurship and Personal Enterprise in Textiles and Apparel at Cornell, joined the faculty in 1998 from positions at Univ. of Idaho, Univ. of Vermont, Kansas State and Washington State. She earned a Ph.D. from Kansas State in Educational Psychology in 1981, an M.A. from Syracuse in Clothing Design in 1973, and a B.S. from the Univ. of Wisconsin in Apparel Design in 1970. Suzanne's research interests include management of information and production technology, mass customization and home-based work in the apparel industry.
S01-CR01
sl135@cornell.edu
(607)-255-6204
http://www.people.cornell.edu/pages/sl135
http://www.apparelindustry.cornell.edu