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   There is a growing emphasis on multi-functional smart sportswear, since it enhances the wearers’ performance and protects their bodies from extreme conditions during activities. Promoting this new type of product can generate a niche market in the sportswear industry, which has been rapidly growing since the late 1990s. This research focuses on developing smart multi-functional sportswear for the overweight, called a diet-facilitating suit, using smart textile materials that monitor the change of waist circumference, body temperature, and the amount of exercise, giving feedback to the wearer.
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THE SOAPBOX: A Non-Classic Approach to Spun Yarn Warp Sizing

By John (Jake) C. Lark

Interest and investment in developing new chemical additives for use in spun yarn warp sizing has suffered a significant period of neglect over the past several years. The industry has suffered a near complete loss of support from the producers of the primary film forming components normally used in current warp size formulations. Technical support from both starch and polyalcohol producers has been passed to dry blend formulators. Warp sizing chemical suppliers are now expected to provide much of the technical service and expertise on the machines used to process their products. Industry interest and participation had dropped to the point where there was no justification for continuation of the AATCC RA-73 Warp Sizing Committee.

Prior to the introduction of the concept of a “no-iron” fabric based on polyester/cotton blended yarn, starch was the primary basis of the size formulation. Starch sizes had little to no adhesion to polyester component of the yarn and the weaving process soon left the protective size and sized fiber on the floor. Weaving efficiencies also joined the size on the floor.

The crisis was soon alleviated with the introduction of the high molecular weight synthetic PVA polymer. Starch was introduced as a component to weaken the size film and reduce cost. Since this development, investigations have been concentrated on adjusting film strength and adhesion of the size film to the surface of the yarn bundle. With the exception of water-based polyacrylic and polyester resins introduced to promote adhesion, little of note has been accomplished in the field and weaving performance appears to have reached a plateau.

A Non-Classical Approach

One of the most common expressions in weaving has been a desire for “better yarn.” There have been numerous attempts over the years to produce better yarn properties by applying a chemical to fiber during the spinning process.

The most infamous example of these attempts was in the application of water-based colloidal silica dispersions to cotton in the early 1950s. Colloidal silica was sprayed on cotton fiber during the opening process to provide a frictionizing interaction between fibers in the final yarn bundle. This actually worked, and the yarn produced demonstrated significantly improved yarn properties and performance in the weave room.

What was not initially recognized was the fact that as water was removed from the colloidal silica dispersion in drying, the small silica particles agglomerated to sand particles. This resulted in severe abrasion to both the metal and ceramic components that came into contact with the treated cotton. Machine part replacement was the business model of the day. Subsequent trials with organic resins on fiber demonstrated significant initial improvements in yarn properties, but resin build-up on spinning machinery eliminated this approach to producing improved yarn.

Yarn formation is a dry process that has been shown to successfully resist attempts to modify the fiber before yarn formation. Warp sizing is the initial aqueous-based process performed on the yarn. Trials to take advantage of this process have been conducted to introduce organic, non-abrasive nanotechnology additives to modify fiber cohesion properties. In this process, it is the hard sized yarn that is the beneficiary of improved fiber cohesion.

Mill results have provided the following comparisons in rigorously controlled evaluations. In trials, hard yarn was collected from:

1. a classic PVA/starch-based size formulation
2. a non-classic PVA/starch formulation that contained a modifying additive. The new technology added solids representing 1-1.5% of total size solids.

The following results were obtained from these mill evaluations:

1. Tensile and elongation analysis demonstrated a lower coefficient of variation in the non-classically treated hard yarn.
2. More than 20% of the low end values of both tensile and elongation of the treated yarns were absent in comparison to the (control) classically-sized warp yarn.
3. The improvements gained in higher fiber cohesion in the sized yarn bundle were reflected in reduced warp and filling stops in weaving.
4. Fiber shedding in the treated warps was significantly reduced in both slashing and weaving.
5. Abrasion resistance of the treated warps demonstrated significant improvement.

Conclusion

Fiber cohesion within a hard sized yarn is improved with the addition of low levels of an organic nanoparticle species applied in the warp sizing process. This effectively provides higher quality yarn, which is reflected in significant improvements in weaving performance.

Author
John (Jake) C. Lark, former Chair, AATCC RA-73 Warp Size Committee
Columbus, GA, USA; johnlark@bellsouth.net
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New Members Joining in April and May 2014…

By Sandy Thomas

Delaware Valley Section, USA
Senior: Peter Szanto, DuPont Co.
Students: Yi Deng, Elizabeth Gilligan, Jenna Knouse, and Thanh Nguyen, Drexel University

Gulf Coast Section, USA
Senior: John Allen, Maples Industries Inc.
Senior: Gary Baran, Maples Industries, Inc.
Senior: Dale Blankenship, Maples Industries Inc.
Senior: Sandra Guin, quality control lead, Maples Industries Inc.
Senior: Tina Wu, department manager, TUV Rheinland of North America Softlines.
Student: Mahendran Balasubramanian, Oklahoma University.

Hudson Mohawk Section, USA
Student: Kari Beth Smiraglia, Syracuse University.

Midwest Section, USA
Senior: Angela Atkinson, Lubrizol Advanced Materials, Inc.
Senior: Christophe Bulliard, Sensient Imaging Technologies.
Senior: Matt Dudas, global market segment manager, Lubrizol Advanced Materials Inc.
Senior: Walt Koteff, Sensient Imaging Technologies.
Senior: Michael Labella, account manager, Sensient Imaging Technologies.
Students: Kate Bruce, Michaela Byers, Abigail Elston, Hanna Hoch, Emma Lubben, Madison Mishak, Mia Pierson, Sarah Ramsey, Alyssa Rosman, Elizabeth Scarpino, Ashley Schonberg, Mackenzie Thacker, Stephanie Tupper, and Peggy Wang, Iowa State University.
Students: Mercedes Garcia-Reyes, Kimberly Gottschalk, Jackee Johnson, Arianna Levin, Brennan Randel, and Kathryn Zoschke, Kansas State University.
Students: Dimitri Cason, Han Chen, Sean Smith, and Olivia Zachmann, Michigan State University.
Students: Mary Eifert, Brittany Grayson, Kara Henry, Lauren Hulen, Shelby Jasper, Meredith Morrow, and Tonya Pesch, Stephens College.
Students: Samantha Frederick, Victoria Guthart, and Emily Pei, University of Northern Iowa.

New England Section, USA
Senior: Lauren Alex, Avery Dennison.

Northwest Section, USA
Senior: Debra C. Green, fabric development manager, Brooks Sports Inc.
Senior: Barbara McGrath, apparel testing lab manager, Nike Inc.
Associate: Lyndie Goodwin, quality assurance coordinator, Pendleton Woolen Mills.
Associate: Marilyn Ryan, Hitex Corp.
Student: Eileen Celentano, Oregon State University.

Pacific Section, USA (inactive)
Senior: John Carver, mechanical engineer, Athos Co.
Senior: Saji George, technical support chemist, Pickering Laboratories.
Senior: Mike Gottschalk, marketing manager, Pickering Laboratories.
Student: Stephanie Alcantar, California State University-Los Angeles.
Student: Nicholas Malensek, Colorado State University.
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Piedmont Section, USA
Senior: Angela Alexander, product development/testing manager, Gildan Inc.
Senior: Neel Calhoun, Lubrizol Advanced Materials Inc.
Senior: Craig White, global manager of business development, Huntsman Textile Effects.
Senior: Christopher Wilson, dyeing manager, Gildan Inc.
Associate: Lloyd Frick, vice president–biology, PurThread Technologies Inc.
Associate: Johnny Shell, vice president–technical services, Specialty Graphic Imaging Association.
Students: Floria Hance-Morant, Kristen Richards, Taylor Rutledge, Hollie Thomas, and Rachel Wilson, University of North Carolina at Greensboro.

Southeast Section, USA (inactive)
Associate: Christina Groover, FDA and quality administrator, Encompass Group LLC.

Student Chapters
Central Michigan University, USA: Crystal Hutson, Nicole Mueting, Andrea Powers, Karla Schulze, Allyson Varra, and Dora Wilcox.
North Carolina State University, USA: Ryan Clance, Jihye Lim, and Allen Tate.
University of Delaware, USA: Zoe Cohen, Emily Kopcik, Kathryn Lindsay, Tara Martinak, Kortney Peterson, Lyndsay Ryan, and Abigail Siegal.
University of Rhode Island, USA: Samantha Allen, Caroline Anderson, Ashley Bart, Kayla Baviello, Tara Depietri, Calli Giardiello, Erin Gosson, Leah Gross, Taylor Hall, Lily Hampton, Shauna Harlow, Julie Hunter, Adam Kolb, Georgia Maroni, Bryce McGillivray, Page McKnight, Christine McMahon, Hallie Reardon, Michael Rose, and Annarose Zelano.
University of Nebraska, Lincoln, USA: Olivia Borer, Brandy Focken, Brandon Perchal, Kilee Richards, Sarah Wanek.

Independent Members–Worldwide
Senior: Md. Mostafizul Alam, analytical chemist, TUV Rheinland Bangladesh Pvt., Bangladesh.
Senior: Carlos Borda Moreyra, auditor–textile quality, Textile del Valle S.A., Peru.
Senior: Karla Canari Flores, laboratory testing, Precotex SAC, Peru.
Senior: Belinda Carp, sales and marketing director, Textiles Intelligence, United Kingdom.
Senior: Kun-Lin Cheng, Taiwan Textile Research Institute (TTRI), Taiwan.
Senior: Pranab Dasgupta, assistant manager, Regency Garments Ltd., Bangladesh.
Senior: Trinh Du, lab technician, CSA Group, Canada.
Senior: Katherine Espinoza Quispe, laboratory quality analyst, WT Sourcing Peru SAC, Peru.
Senior: Hemantha R. Fernando, production manager, Li and Fung Sourcing (Bangladesh), Sri Lanka.
Senior: **Julie Gauthier**, lab technician, CSA Group, Canada.

Senior: **Sarita Garcia Haylla**, quality control analyst, WT Sourcing Peru SAC, Peru.

Senior: **Carlos Gonzales Salazar**, quality auditor, Cofaco Industries SAC, Peru.

Senior: **Tanjina Binte Hafiz**, fabric technologist, Centro Tex Ltd., Bangladesh.

Senior: **SM Amdadul Hague**, lab technician, Concorde Garments Ltd., Bangladesh.


Senior: **A. T. M. Hasanuzzaman**, dyeing lab manager, AKH Knitting and Dyeing Ltd., Bangladesh.

Senior: **Abul Hassnat**, wet process lab in-charge, Woodbridge Industries LLC, Bangladesh.


Senior: **Anuruddha Indatissa**, technical manager, Li and Fung Sourcing (Bangladesh), Bangladesh.

Senior: **Syed Atif Iqbal**, quality control lab manager, Naveena Exports Pvt. Ltd., Pakistan.

Senior: **Md. Mojahidul Islam**, assistant lab technician, Mahdeen Sweaters Ltd., Bangladesh.


Senior: **Muhammad Kashif Khan**, quality control lab manager, Naveena Exports Pvt. Ltd., Pakistan.

Senior: **Indra Kurniawan**, textile testing researcher, Center for Textile–Indonesia, Indonesia.

Senior: **Jay Naidu**, global marketing director, Huntsman Textile Effects, Singapore.

Senior: **Cynthia Parinango Rivera**, quality auditor, Cofaco Industries SAC, Peru.

Senior: **Shankar Parthasarathy**, technical manager, Li and Fung Sourcing (Bangladesh), Bangladesh.


Senior: **Marjan Rahman**, quality assurance coordinator, H&M Hennes & Mauritz AB, Bangladesh.

Senior: **Suryani Ratnaari**, textile testing researcher, Center for Textile–Indonesia, Indonesia.

Senior: **Sanjay Ray**, chemistry technologist, CSA Group, Canada.

Senior: **Rizwan Razi**, senior quality assurance manager, Li and Fung Sourcing (Bangladesh), Bangladesh.

Senior: **Flor Rojas Ordonez**, chief of quality testing, Confecciones Textimax, Peru.

Senior: **Mintu Roy**, assistant manager, SGS Bangladesh Ltd., Bangladesh.


Senior: **Shartaz R. Saad**, senior lab officer, Rahim Textile Mills Ltd., Bangladesh.

Senior: **Sukanta Kumar Sarker**, manager, Regency Garments Ltd., Bangladesh.

Senior: **Gladys Sernaue Huaranga**, textile quality analyst, WT Sourcing Peru SAC, Peru.

Senior: **Ricardo Serrano Huaqui**, quality testing assistant, Confecciones Textimax, Peru.

Senior: **Shri Shridevan**, CSA Group, Canada.

Senior: **Zofia Sobczyk**, CSA Group, Canada.

Senior: **Heidi Sopia Grijalva**, textile quality analyst, WT Sourcing Peru SAC, Peru.

Senior: **Eber E. Soto Cruz**, quality assistant, Cofaco Industries SAC, Peru.

Senior: **Kazi Rita Subarna**, assistant lab manager, Rahim Textile Mills Ltd., Bangladesh.

Senior: **Prasad M. Sudhaheewage**, technical manager, Li and Fung Sourcing (Bangladesh), Bangladesh.

Senior: **Momtaz Tanvir**, additional superintendent of police (logistics), Bangladesh Police, Bangladesh.

Senior: **Constantina Togias**, chemist, CSA Group, Canada.

Senior: **Emerson Vera Alejos**, laboratory testing, Precotex SAC, Peru.

Senior: **Mohammad Abdul Wahed**, C&A Textiles, Bangladesh.


Senior: **Mavy Zuniga Cardenas**, project coordinator, Cofaco Industries SAC, Peru.

Associate: **Shaban Raslan**, dye lab, Giza Spinning and Weaving Co., Egypt.

Student: **Sung Hyun Bae**, Chung-Ang University, South Korea.
New Corporate Members

CSA Group

Located in Toronto, Canada, the CSA Group is an independent, not-for-profit, member-based association dedicated to advancing safety, sustainability, and social well-being. The company is an internationally-accredited standards development, testing, and certification organization, and also provides consumer product evaluation, education, and training services. CSA’s expertise includes: industrial equipment, plumbing, construction, electro-medical and healthcare, appliances, gas, alternative energy, lighting, and sustainability. The CSA mark appears on billions of products around the world. CSA marks are widely accepted and recognized by many government and code officials, regulatory, and regulation bodies like the SCC and OSHA, leading retailers and authorities having jurisdiction (AHJ).

The company was established in 1919 as the Canadian Engineering Standards Association (CESA). Today, CSA Group provides services to businesses, industries, and consumers worldwide, including new technologies such as electric vehicles, alternative fuels, nano materials, wind and solar energy, and fuel cells.

Esquire Knit Composite Ltd.

Esquire Knit Composite Ltd. is a privately-owned, knit garment manufacturer located in Dhaka, Bangladesh. The company offers yarn and fabric dyeing, knitting, cutting, sewing, laundry, embroidery, and printing services. Esquire serves customers in Europe and the USA, including brands such as Esprit, Marks & Spencer, C&A, Zara, Celio, and Jordache. Its products include ladies’ dresses and tops, embellished polo and T-shirts, sweatshirts, and children’s wear.

Esquire Knit Composite Ltd. was established in 1996, including the industrial knowledge of its sister companies: Esquire Dyeing Industries, Esquire Knitwear Ltd., and Fashion Paradise & Synthia Multi Fiber Ltd.

Maples Industries Inc.

Maples Industries is a manufacturer of area and bath rugs, widely distributed through major retailers such as Wal-Mart, Target, Kohl’s, Costco, and Bed Bath and Beyond. Located in Scottsboro, AL, USA, the company is privately-owned and was incorporated in 1966 by John and Wade Maples.

Pickering Laboratories Inc.

Pickering Laboratories manufactures artificial body fluids for use in product testing. The lab makes artificial perspiration, urine, and saliva as well as solutions conforming to official protocols of AATCC, ISO, ASTM, and custom formulations. Along with analytical chemistry products, product test solutions are developed to assist laboratories performing industry-supported testing. Located in Mountain View, CA, USA, Pickering Laboratories sells in 150 countries in North and South America, Europe, the Middle East, Africa, Asia, the Pacific Rim, and the Caribbean, and has 87 distributors around the world.

In 1984, Michael Pickering invented a reagent to analyze amino acids for analytical chemistry. Over the years, additional products were developed for the analytical market serving environmental, clinical, food safety, and biotech industries.
AATCC Technical Center Celebrates 50th Anniversary

AATCC members, staff, and friends gathered on the front lawn of the Technical Center to celebrate the building’s 50th anniversary at Research Triangle Park in North Carolina, USA. AATCC moved to North Carolina in 1964 from the Association's first home on the campus of the Lowell Textile College in Lowell, Massachusetts, USA. This May, the Association celebrated with an open house and buffet on the lawn during the Spring Committee Meetings.
AATCC Committee Meeting Highlights

ECR: Executive Committee on Research
TCR: Technical Committee on Research
TM: AATCC Test Method
EP: AATCC Evaluation Procedure
M: Monograph
P&B: Precision and Bias Statement

Executive Committee on Research
ECR Subcommittee C2-S1, International Test Methods Committee, reported that Bob Lattie, current chair, will be retiring at the end of the year and a replacement is needed to take over his duties within AATCC and the US TAG. There was the option to have more than one person representing the several factions.

Spanish Translation of Test Methods: FLAQT (confederation of Latin American dye and chemical associations) have been given 10 test methods to translate into Spanish by the end of the year. They will sell them on their website and will also make them available for sale on the AATCC website. As part of the agreement, both organizations will also exchange memberships and link to each other’s website. There is also a need for Spanish/Portuguese webinars.

Sales of Chinese Translations of the Technical Manual: There had not been any reported sales up until now but we have been advised by email in February stating that 78 Technical Manuals were sold in 2012 and 2013.

AATCC Proficiency Testing Programs: The six proficiency testing programs are maintaining their successful level of participation for the entire year.

International Training Programs: There are 70 training programs slated for 2014 in Visual Color Assessment, AATCC with ASTM, and Color and Appearance. They will be in 11 cities in six countries. Usual attendance is between 2-8 people.

Meeting on Staining Propensity of Polyester/Spandex: Kanti Jasani chaired this meeting, which discussed the possibility of reactivating a committee for this purpose. It was decided that the issue was so broad that it might be beneficial to conduct a symposium to solicit feedback from industry. The eventual result might be a new test method, as current test methods do not predict performance under certain conditions.

Colour Index: The presidents of the China Dyestuff Industry Association (CDIA) and the SDC signed a Collaboration Agreement in April which formalizes the CDIA’s involvement in assisting their members to submit products for registration in the CI. New products are now coming through to the CI as demonstrated by the recent announcement by Huntsman concerning their registration of new products. There has been extensive programming developments to the database to make it more user friendly and improve its security, as well as cleaning up the current information.

AATCC Buyers Guide: The Buyer’s Guide (BG) historically has been a list of suppliers for equipment related to the test methods, which most recently has been provided online. Our new server will not be able to host the software. The BG software can be hosted on the software vendor’s server, but it will cost money to do so, and to maintain in the future. It was voted on and approved to maintain access to the Buyer’s Guide for two years while a task force (to be formed) looks at alternative solutions.
2015 TCR Service Award Nominations Sought

Deadline: October 1, 2014

Angela Massengill of Cotton Incorporated, chair of TCR, announced that nominations are now being sought for the 2015 TCR Service Award. If you know of a deserving senior individual member of AATCC, please submit the nomination by October 1, 2014. Access award criteria and nomination form at: www.aatcc.org/general/awards/TCR.htm.

Technical Committee on Research

Certificates of Service

Peter J. Hauser of North Carolina State University (NCSU), AATCC President, presented the Certificates of Service to the outgoing members of the Administrative committees: Rembert J. Truesdale, III for outgoing chairs of the Harold C. Chapin Award Committee and the Young Entrepreneur Award Committee; Philip Brown of Clemson University, outgoing chair of the Olney Medal Award Committee; and Robina Hogan of Omni Tech International, At-Large Member of the AATCC Materials Interest Group. Outgoing chairs of the Research Committees are: Heidi Carvalho of Rothtec Engraving, chair, RA104, Garment Wet Processing Technology; Lisa A. Earnshaw of James Heal, chair, RA60, Colorfastness to Washing Test Methods; Ellen Roaldi of Bureau Veritas CPS, chair, RA 23, Colorfastness to Water Test Methods; and Michele Wallace of Cotton Incorporated, chair, RA 100, Global Sustainability Technology. Retiring members of the Executive Committee on Research are: Susan Gassett of Natick Soldier RDE Center; and Jodi Geis of Manufacturing Solutions Center.

Exploratory Meeting on Polyester/Spandex Blend (RR92)

Kanti Jasani of Performance & Technical Textile Consulting announced that the inactive AATCC RR 92, Interaction of Dyes and Finishes Test Methods, needs to be reactivated as there is a need/issue to develop a test method for predicting colorfastness with the polyester/spandex blend. It appears there is a need to have a test method that can help industry predict the level of colorfastness results/issues. A committee was formed with Martin J. Bide (URI), Adi Chehna (Textile Tech Services), Mike Cheek (Huntsman), John Crocker (SDL Atlas), Tom Landrum (Polo Ralph Lauren), Sravanth Kanukuntla (SGS), Andy Lien (GreenEarth), Nelson Houser (M. Dohmen USA), and Kanti Jasani. Developing a test method will require a comprehensive study of all complexities and a symposium/workshop will be a good way to start the process.

RA23, Colorfastness to Water

TM 104 was submitted to TCR for reaffirmation with no changes and was approved to appear in the 2015 Technical Manual. From its previous committee letter ballot and TCR ballot to include the caution statement on polyester/spandex blends, suggestions for other changes to TMs 15, 106 and 107 were generated. These proposed changes were submitted to both CLB and the last TCR ballot and received negatives, which need to be addressed prior to publication. The results of the interlab for TM 107 regarding circulating versus non-circulating ovens were discussed. Krishna Parachuru of Georgia Tech, chair of the RA 102, will re-evaluate the data based on 0.5 step tolerance between operators. Definitions of oven types to be included in TMs 15, 106 and 107 will be reviewed again at the next meeting. Jodi Geis of Manufacturing Solutions Center, and chair of RA23, will contact AATCC to obtain results from proficiency data for possible use in establishing a P&B for the methods.

RA24, Fiber Analysis

A new inverted staircase of Table I for TM 20A was submitted to TCR ballot as well as the no-fluorinated solvent update. Both were approved to be published in the 2015 Technical Manual. A report on the latest proficiency trials reflected very good performance with polyester/cotton and wool/rayon blends, with greater variability associated with the silk/cotton blends and high variability assist with the wool/cashmere blends. Blends for the next proficiency testing rounds are anticipated to be ramie/cotton and a modacrylic blend.
RA31, Antimicrobial Activity
The proposed new odor method needs a P&B. Several labs have agreed to do testing to get data for a P&B which include Microban, WuXi Apptec, Thomson Research, Vartest, and NanoHorizons. The proposed revision of TM 100 to add a change to population and add buffered saline was submitted to committee ballot and received several comments. In discussing results, it was brought up that the TM needs to be completely revised with all variables. A subcommittee has been formed to review four sections (original, steady state, 5% nutrient broth, 12%). The committee is working on a revision of TM 30.

RA33, Colorfastness to Atmospheric Contaminants
The committee recommends a change to TM 23 concerning the removal of the note on wire screen due to safety issues. The committee feels this may increase the time to achieve the “standard of fade” color needed; but control parameters should not be changed. The chair will contact AATCC to see if this can be done editorially. The GFC1, Lot 21, along with its standard of fade, is now available from Testfabrics. The change from Disperse Blue 3 to Disperse Violet 1 was needed to provide an increased “change in color” upon completion of GF cycle.

RA36, Color Measurement
The proposed draft for reactivation with a new title for TM 148, Light Blocking Effect of Textiles: Photodetector Method, was submitted to TCR Ballot and approved with a few editorial changes for publication in the 2015 Technical Manual. A proposed new method on “Light Blocking Effect of Textiles: Spectrophotometer Method” was submitted to TCR Ballot and with a few minor changes will be published in the 2015 Technical Manual. Renzo Shamey of NCSU, chair of RA36, gave a presentation on “Analysis of Variability in Perceptual Assessments of Color.” Reports on level specification for EP 9 illumination were given, and a subcommittee was formed to develop experimental procedure. The Committee needs to develop a survey pertaining to light sources used in industry and retail.

RA38, Colorfastness to Crocking
A task group has been formed to thoroughly review TM 8. This task group will include Lisa Earnshaw of James Heal, Abe Hafeez of Testfabrics, John Crocker of SDL Atlas, Tammi Rollins of CTL, and Matt Marshall of UL.

RA42, Dimensional Change
The recent TCR ballot for revisions of TM 135 resulted in one negative, which indicated that the conditions stated in the table did not match the monograph. The negative was withdrawn and the TM will move forward as proposed. This subject has been brought up previously; RA99 will be surveying opinion on whether methods should be self-sufficient, with all information provided in the method, or whether methods should reference the updated monographs on the AATCC website. Regarding the revision of TM 179 and fabric selection for P&B, Adi Chehna of Textile Tech Services, chair of RA42, is still waiting for response from Krishna Parachuru, chair of RA102, for the appropriate amount of samples, specimens, laboratories, technicians, etc. for a good P&B. Shawn Meeks of Testfabrics will see if AHAM can provide fabrics and garments in case more samples are needed, in addition to those from Cotton Incorporated. Chehna and Norma Keyes of Keyes Consulting are finalizing a first draft for the proposed new Side Seam Twist in Woven and Knit Garments, which will be sent to a committee ballot. Keyes is to work with LouAnn Spirito from SGS to gather P&B data, since SGS is performing this method already. Susan Gassett of Natick Soldier RDE Center said that Natick is doing a study to compare commercially available machines to the wash wheel and expects to have results by the November meeting.

RA43, Professional Textile Care
The three AATCC TMs that RA43 is responsible for (TM8 86, 132, and 158) are subject to review due to the US regulatory ban on the chemical perchloroethylene. At the November meeting, a presentation will be given by GreenEarth, which will present a replacement for perchloroethylene.

RA45, Finish Analysis
The committee is continuing to craft a proposed new TM for the “Determination of Formaldehyde: Water Extraction,” to determine free and hydrolyzed formaldehyde. The committee has data from four operators and three labs, which will be used to provide data for the P&B. When the P&B is complete, the draft will be submitted for committee letter ballot. It is anticipated that the TM will be published in the 2016 Technical Manual. Updates to TM 112 were made, which make the method more useable in today’s labs. Comments received from the TCR ballot for reaffirmation will be addressed in the TM update.
RA49, Insect Resistance
The proposed new TM to extract free insecticide from textile surfaces has undergone two committee ballots and still need changes. An additional committee ballot, with changes suggested from both ballots, will be sent out in June 2014 in hopes of making the fall TCR ballot. A presentation of the TM has been made and confirms the interest and the use of this TM.

RA50, Lightfastness and Weathering
The committee letter ballot for proposed revisions to TMs 111, 169, and 186 received several negatives, one being the fact that ASTM D1776 is out for revision within ASTM D13. Smriti Kumar of Q-Lab, chair of RA50, will contact the negative voters asking that they withdraw their negatives. The Blue Wool Subcommittee reported AATCC had success with a new blue wool that will replace L2 and L4. It will be one blue wool with two end points. Dyeings will be done week of May 12th, and will be approximately five years’ worth (850 yds.). The dyed samples will be sent to James Heal, Q-Lab, and Atlas Material Testing Technology with testing expected to be complete within 30 days. There is currently approximately eight months’ supply of L2 and L4 available. Richard Slomko of Atlas Material Testing Technology, and secretary of RA50, reported that ISO 105-B01, Colourfastness to Light: Daylight, will be sent out for FDIS ballot due April 7, 2015. ISO 105-B02, Colourfastness to Artificial Light: Xenon Arc Fading Lamp, is in FDIS and a ballot will close in May 2014. Due to differing opinions between the US experts, the US will abstain. TM 125 has an error in Section 8.3 that states 100 ± 5%. The committee has suggested that it be kept, but an example added, stating “Original 10 grams, Weighted 20 ± 1 gram.”

RA56, Stain Resistance
A committee ballot for proposed reaffirmation of TM 130 will be submitted. There was a discussion on an interlab grading study for the new rating scale. If eight total samples between two labs are ≤ 1.0 apart, it is likely they are the same. For two samples/two labs the value is ~1.9 or less. Attribute cause is undetermined at this point. Video training and calibration specimens are proposed to cover this item. A proficiency testing program on grading (not performance), using the new scale and using fixed stained specimens, has been proposed. This will be reviewed with AATCC to develop a plan.

RA57, Floor Covering
This committee met April 16, 2014 at the Carpet and Rug Institute in Dalton, Georgia, USA, and their minutes are hereby made a part of this report. Alan Buttenhoff of Shaw Industries, chair of RA57, discussed the current draft of the proposed TM on “Carpet: Liquid Penetration by Spillage.” The committee recommended several changes, which the chair will incorporate and submit to a committee ballot. The proposed reaffirmation of TMs 138 and 171 were approved and will be in the 2015 Technical Manual. Review of the Red 40 Stain Scale has been completed and the new improved scales are available for purchase. An article was drafted and published in AATCC News, describing the availability. The proposed TCR ballot for reaffirmation of TM 121 received a negative requesting that a reference to the appropriate EP be referenced and the instructions for rating be removed from the TM procedure. Those present and attending by phone thought that the TM needs to keep the process, as it is in the TM and not just a smaller part of a larger piece of work. The chair will discuss this with the negative voter for resolution. Richard Turner of Mohawk Industries made a presentation on TM 138 on the effect of the change to the vinyl tiles used in the TM. Analytical testing was included that highlighted the difference in composition. Testing of the same material using both the new and old tiles were reviewed, which demonstrated significantly different test results. A request was made that the committee should investigate if the current quality control aid is appropriate for use.

RA59, Fibrous Test Materials
There is not any available viable source for the Acetate Adjacent Fabric. Bob Lattie with SDL Atlas will ask this to be put on the ISO Agenda for TC 38 only (ISO 105-FO7). Shawn Meeks of Testfabrics reported that Japan is working on a control fabric for ozone testing (WG3). Testfabrics is also working on this and it is currently available.

RA60, Colorfastness to Washing
A comparison of TM 61 versus TM 188 was performed. The conclusion was there was a good correlation for shade change, but poor correlation for staining. The question was whether a single 45 minute test equals five home launderings in TM 61—for shade change: yes; for staining: no. A proposal to add a cold water option in TM 61 was
discussed. A task group of Suzanne Holmes with AATCC, Susan Gassett with Natick Soldier RDE Center, and Jodi Geis of Manufacturing Solutions Center are to analyze the data and consider the results. The TM 61 task group on revision of the TM reported that Sections 1-6 have been revised and presented to the committee. These were discussed and editorial changes suggested. The proposed new two bleach TMs will be submitted to committee ballot.

RA61, Appearance Retention
A proposed revision of TMs 88B, 88C, 124, and 143 was submitted to TCR letter ballot to add a statement in the P&B regarding the 4 lb. versus the 8 lb. load and received two negatives. One was resolved but the other negative may require an editorial change. This change will be discussed further to ensure it is truly "editorial” in nature. TM 66 was submitted to TCR ballot for reaffirmation and was approved to be reaffirmed with no changes at this time; however, the committee is working on a revision of this method. Ning Pan, of University of California-Davis, spoke on "Fabric Wrinkle Recovery Test.” Ken Greeson of Cotton Incorporated, chair of RA61, presented “Re-evaluation of AATCC TM 66 on Dynamic Measurement of Wrinkle Recovery” on behalf of Tan Junfeng, Wang Lei, and Liu Jignli of the College of Textiles and Clothing, Jiangnan University, China.

RA63, Water Resistance, Absorbency, and Wetting Agent Evaluation
It was reported that the lab portion of the Committee RA75 correlation study has been completed. The proposed new Vapor Permeability Test from REI went out for round robins and has a P&B. This proposed TM will be sent to committee ballot soon. Revision of TM 200 was discussed. The TM will be edited based on suggestions from the subcommittee and will be sent to committee ballot. Six TM were submitted to TCR for reaffirmation with no changes and were approved for publication in the 2015 Technical Manual: TMs 17, 22, 70, 79, 200, and 201. The proposed revision of TM 127 was approved by TCR ballot with a few minor changes and will go forward for publication in the 2015 Technical Manual. The manufacturers of the nozzles in TMs 35 and 42 has indicated that they cannot meet the stated tolerance of .005; they can only get .002. The committee will ask for the original engineering specifications of the nozzle to identify if this is an existing issue that was not previously called out by the manufacturer or if this is a result of a new process change for the manufacturer.

RA75, Evaluation of Materials and Products for End Use Performance
The Field Correlation Test Study subcommittee reported on the status of the moisture management Lab-Field correlation. The subcommittee experienced some setbacks with securing a cut and sew manufacturer for the garments. There are now two reliable cut and sew manufactures that are close in proximity to the REI office in Washington State. Formal statistical analysis via AATCC for lab test results is not complete. The next steps would be manufacturing of the garments and the field test plan. The subcommittee will reconvene to finalize the field test plan and survey questions.

RA80, Printing Technology
Kerry King of Spoonflower gave a presentation on "Production Digital Printing." The committee reviewed current thinking and actions around textile printing education initiatives, especially a webinar and session at SGIA in the fall.

RA87, Applied Dyeing and Characterization of Dyes
TM 184 was approved by TCR for reaffirmation with no changes to be published in the 2015 Technical Manual. TM 146 was discussed. The small changes suggested at the last meeting cannot be considered as editorial so the committee is re-evaluating the need for a change. Nelson Houser of M. Dohmen USA will survey the four major dye suppliers to see if there is a consensus to revise the TM or to leave it unchanged. A discussion ensued regarding the need for a new TM for water soluble dyes. The committee is looking to consolidate into one TM the solubility of all water soluble dyes with effect of additives such as metal ions or salts as various options within the test. The committee will try to have a first draft by the next meeting. RA87 will need to work with the new committee being reactivated (RR92) to work on a symposium on wet processing of polyester/spandex blends. Another Dyeing Symposium was also discussed. A steering committee of Nelson Houser of M. Dohmen USA, Mike Cheek of Huntsman, Bryan Dill of Archroma, and Bert Truesdale of TenCate Protective Fabrics was formed to work on this symposium.
RA88, Home Laundering Technology
The subcommittee met prior to the full committee meeting and reported the following: All models on the AATCC website have the AATCC key-dance cycle except for the international models. By fall 2014, international models should have the cycle. Two machines have been tested at Whirlpool to confirm cycles have been implemented. The 2013 M6 conditions are in place on the Normal cycle only. The goal is to increase number of cycles to be incorporated on future machines. Parameters fixed in AATCC cycle: water based on 8 lb. load size (sensing disabled), agitation in one direction, time, extraction and two rinses. Temperature can vary based on user input. The following are action items: verify profile meets AATCC requirements; resetting of machine/service mode; obtain Whirlpool approval for AATCC to develop a video to instruct on accessing AATCC cycle; develop clear and simple instructions on accessing the mode; and translate to other languages for international testing. Mir Qudus of Whirlpool, chair of RA88, provided an update on synchronization of FTC regulations and the AATCC M6. The recommendation was submitted to Mr. Frisby of the US Federal Trade Commission (FTC). The US Consumer Product Safety Commission (CPSC) is to provide assistance to AATCC to have FTC refer to AATCC M6 for temperature recommendations. AATCC is to update the monograph to reflect FTC requirements. A survey to measure the demand of key-dance machines will be updated to reflect new demands, including children's sleepwear testing and the demand for other cycles than the Normal cycle. Lou Protonentis, AATCC technical director, gave an update on the AATCC liquid HE detergent. Testing will begin soon to assess its performance in stain removal. Discussion initiated around a standard 8 lb. test load. The goal is to standardize load and loading procedure similar to existing industry standard procedures. A motion, by Paul Johnson of 3M Co., to drop the descriptors (cold, warm, hot, extra hot) in favor of referring only to I-IV designations, will be discussed at the next meeting. New temperature designations will only be applied to lab testing, not having consumer relevance. Machine validation procedure to be developed by the committee. Committee members involved with providing input on validation procedure include Protonentis, Qudus, Gary Childers and Elizabeth Eggert, both with Procter & Gamble, and Brian Shiels of PB Performance Products.

RA89, Hand Evaluation
Ning Pan, of the University of California-Davis, made a presentation on drape evaluation using the PhabrOmeter. Discussion progressed for possibly revising TM 202 to include drape testing. TM 202 was reaffirmed by TCR ballot under the three year review process and will be published with no changes for the 2015 Technical Manual. Seshadri Ramkumar of Texas Tech, chair of RA89, proposed developing a TM for evaluating the friction of fabrics. Although evaluation of friction of heavy materials such as carpets is needed, the scope of the initial work will be on a TM for apparel fabrics. Currently there is a resurgence of interest in hand evaluation of textile materials.

RA99, Technical Manual Editorial Review Committee
The committee will prepare a survey to be sent to members of committees that use information in all monographs to determine if AATCC TMs can merely reference the Monograph (instead of embedding tables from the Monograph in the TM). A brand survey conducted by AATCC revealed a need for a simplified version of our TMs. RA102 is working on a “boiler plate” section for our test methods that would advise users on how to arrive at the number of specimens that need to be tested. Currently, many of our test methods refer users to the ASTM standards that have now been discontinued. The Note of Caution regarding polyester/spandex type fabrics that was added to the appropriate AATCC methods in the 2014 Technical Manual has now also been added to ASTM’s Fabric Performance Specifications as appropriate.

RA100, Global Sustainability Technology
Samuel Moore of Hohenstein Institute gave a presentation on “The OekoTex Sustainable Textile Production (STeP) Certification Program.” This program complements the OekoTex 100 and replaces the older OekoTex 1000, which was the original factory certification program.

RA102, Statistics Advisory
The committee is working on data analysis for Committees RA56, RA63, and RA75. Krishna Parachuru of Georgia Tech, chair of RA102, gave a presentation on “Experimental Design—Concepts and Principles.”
RA104, Garment Wet Processing Technology
Harrie Schoots of Celanese acted as chair in the absence of the chair and secretary. Len Farías of Cotton Incorporated gave a presentation on "Novel Approaches to Achieve Garment Washing Effects in Cotton Fabrics," which was well received.

RA106, UV Protective Textiles
TM 183 was submitted to TCR for reaffirmation with no changes and was approved for the 2015 Technical Manual. There was a discussion of three documents (one from AATCC and two from ASTM) to see how they all relate to one another. The three UV standards can be broken down as AATCC TM 183 as a measurement method, ASTM D6544 method on how to prepare the textile prior to measuring, and ASTM D6603 on how to classify and label based on the test results from AATCC TM 183. Steve Simonson of ITG, chair of RA106, relayed to the committee that ASTM D6603 is now a standard specification rather than a standard guide. Norma Keyes of Keyes Consulting made a motion, which passed, that the committee restart its efforts to put together a document which would contain these three standards. It would include an introduction with a simple explanation of how to use these three standards to make a UPF claim. AATCC would make the document available for sale. Teresa West of Williamson Dickie Mfg., Ellen Roaldi of Bureau Veritas, and Adam Varley of Vartest Labs volunteered to work with Keyes on this project. There was further discussion to include a section comparing the US standard to ISO and the Australian standards. There was also a discussion of developing UV reference fabric(s) for TM 183. The fabrics must have a UPF >15. Varley volunteered to work with Abe Hafeez of Testfabrics on this project.

To see videos from these most recent committee meetings, visit the AATCC YouTube page: www.youtube/user/theAATCC/playlists and click on the "AATCC Spring Committee Meetings" playlist.

AATCC International Training Programs

Peru
The AATCC international training program at Certintex in Lima, Peru, graduated a new class this May. Elsa Nava, General Manager, was the instructor. Congratulations to the attendees: Katherine M. Espinoza Quispe, Sarita P. Garcia Huaylla, Gladys N. Sernaqué Huaranga, Heidi Sopla Grijalva, Carlos D. Borda Moreyra, Juan A. Joya Crisóstomo, Eber E. Soto Cruz, Cynthia A. Parinango Rivera, Mavy M. Zuñiga Cardenas, Carlos A. Gonzales Salazar, Emerson E. Vera Alejos, Karla R. Cañari Flores, Flor O. Rojas Ordoñez, and Ricardo C. Serrano Huaki.

China
SGS-CSTC Standards Technical Services Co. Ltd. hosted two AATCC International Training programs in China this spring with trainer Judy Qiu. The class in April in Shanghai graduated Caiping Xiao, HongYing Wang, Lillian Cao, Lilli Li, and Seline Xu. The class in May in Qingdao graduated Kevin Xing, Junqing Yang, Nina Huang, and Vivian Wang. Congratulations to the successful attendees!
Papers are currently being solicited for subject areas listed below for the 2015 AATCC International Conference. This conference will be held March 24-26, 2015 at the Hilton DeSoto in Savannah, GA, USA. Interested individuals should complete the abstract submission form* and provide an abstract of 125 words or less to: pickett@aatcc.org.

**Advances in Dyeing**
**Biodegradable/Sustainable Fibers**
**CAD/CAM and Design Technologies**
**Coatings and Laminates**
**Color Science, Trends, Communication and Management**
**Consumer Issues/Product Quality**
**Digital Asset Management**
**Digital Textile Printing**
**Design to Production Workflows**
**Dyeing/Finishing Troubleshooting**
**Electronic/Optoelectronic Fibrous Materials**
**Electrospinning**
**Environmental/Safety Issues**
**Fiber Surface Modifications**
**Filtration**
**Flammability**
**Geotextiles**
**Image and Data Management**
**Improving ROI on Technology, Personnel and Expenditures**
**Innovative Technologies**
**Liquid Crystal Fiber Spinning**
**Mass Customization**
**Medical/biomedical Textiles**

**Microdenier/Microfilament Fiber Spinning**
**Nanofibers and their Spinning**
**Nanotechnologies**
**Nonconventional Cellulosic/Protein Fibers**
**Nonwovens**
**Novel Dye/Pigment Chemical Syntheses**
**Novel Fibers/Chemical Materials**
**Performance Finishes**
**Printing Innovations**
**Product Life Management**
**Protective Textiles**
**Sourcing**
**Supply Chain Management**
**Sustainability in Wet Processing**
**Technical/Garment Design Issues**
**Technical Textiles & Sports Materials**
**Textile Care Developments**
**Textile Design Technology**
**Textile Testing**
**Virtual Fit and Body Scanning**
**Visual Store Merchandising**
**Yarn and Fabric Preparation**

Abstracts for oral presentations must be received at the AATCC Technical Center on, or before, July 21, 2014. Abstracts received after this date will automatically be placed on a waiting list. AATCC reserves the right to accept, place on a waiting list, or reject any paper for any reason.

Authors of accepted oral presentation papers will be notified. In accepting an invitation to present a paper at the conference, a speaker agrees to provide AATCC with a final abstract of their paper by October 17, 2014 and the full text by February 2, 2015. Papers presented at the conference become the property of AATCC and cannot be published elsewhere without the express, written permission of AATCC. Speakers receive complimentary registration for the conference.

Abstracts for poster presentations should clearly state the problem, solution, and results of the research work. Poster abstracts will be accepted until November 7, 2014 and should be submitted to Peggy J. Pickett at pickett@aatcc.org. Poster presenters pay a reduced conference fee.

The program will also feature the traditional Herman and Myrtle Goldstein Student Paper Competition and the Olney Medal Address.

Abstract submission form is available online at www.aatcc.org/ic.
Color Management Workshop

Registration: August 11
Workshop: August 26-27
AATCC Technical Center
Research Triangle Park, NC, USA

Color plays an important role in a consumer’s decision to purchase a particular product. To get the color envisioned by the designer and demanded by the consumer, color communication throughout the supply chain is imperative—especially in textiles items, which contain many components.

Attend AATCC’s Color Management Workshop, held August 26-27 at the Association’s Technical Center in Research Triangle Park, NC, USA, and hear world-renowned color experts discuss:

• color principles and the effect of lighting
• factors to consider when developing your color palette
• how color choices affect cost, fashion, durability, and dyeing reproducibility
• how to implement a digital color program with your supplier
• managing color on multiple textile substrates
• how to control shade from concept to production
• and much more!

Participants will have an opportunity to have their color questions answered during the presentations and breakout sessions. Breakout sessions will focus on illumination and observer issues; sample analysis and measurement technique; creativity with trends and virtual development; color matching; production evaluation and control; and how to do the right color right.

This workshop is designed for merchandisers, retailers, manufacturers, product developers, color approval managers, specifiers, and designers.

Individuals registering on or before August 11 pay US$705 for individual and corporate AATCC members (US$1049 for non-members) and will include luncheons, breaks, and a copy of all available papers. After August 11, the registration fee increases to US$755 for AATCC members and US$1099 for non-members. Refunds will be honored if cancellations are received on or before August 11, 2014. No refunds will be given after August 11. A US$75 cancellation fee will be charged. Attendance is limited, so early registration is encouraged.

Functional and Nano Finishes for Industrial Textiles

October 14
IFAI Specialty Fabrics Expo
Minneapolis, MN, USA

AATCC will sponsor a session titled Functional and Nano Finishes for Industrial Textiles at the IFAI Specialty Fabrics Expo 2014 on October 14 in Minneapolis, MN, USA.

This session will focus on functional and performance enhancement of textile products for high performance and industrial applications. New treatments and chemistries that involve nanoparticles, nanofinishes, and combinatorial finishes that can add value to textiles will be highlighted. The presentations are aimed at providing new product applications and improved end-use performance.

Digital Textile Printing—Technology, Processing, and Testing

October 22-24
Specialty Graphic Imaging Association (SGIA) Expo
Las Vegas, NV, USA

Join us at the Specialty Graphic Imaging Association (SGIA) Expo being held October 22-24 in Las Vegas, NV, USA and attend AATCC’s digital printing session. This session titled, Digital Textile Printing—Technology, Processing, and Testing will be presented by Kerry M. King of Spoonflower Inc.
King’s presentation will provide insights into emerging production technologies for digital textile printing. She will also include a general discussion of ink chemistry options for textiles, including colorfastness properties and processing requirements for each. Relevant test methods in reference to textile product applications (e.g. apparel, home decoration, and more specialized products) will also be identified.

While at the show, please plan to visit AATCC’s booth, #2795, and chat with the staff about the Association’s test methods and quality control aids, educational offerings, membership benefits, and activities.

Section News
AATCC local section meetings give everyone the opportunity to “visit AATCC.” You do not need to live or work in the hosting session. Bring a friend or colleague to see what AATCC technical and networking programs are about. Invite them to join AATCC!

Northwest Section
The AATCC Northwest Section will hold a meeting **July 10**, in Seattle, WA, USA.

The meeting and luncheon will be held at Henry’s Tavern at 12:30pm, followed by a tour of Filson at 2:30pm. The program will include information about Filson’s history and a tour of their manufacturing facility.

**Mark Your Calendar**
Make plans now for upcoming events and opportunities. For details, visit [www.aatcc.org](http://www.aatcc.org).

**July 10**
Northwest Section Meeting
[www.aatcc.org/members/sections/documents/NW_Section_July_2014meeting.pdf](http://www.aatcc.org/members/sections/documents/NW_Section_July_2014meeting.pdf)

**July 21**
Abstracts due for Oral Presentations at AATCC International Conference 2015
[www.aatcc.org/ic](http://www.aatcc.org/ic)

**August 11**
Color Management Workshop
[www.aatcc.org/events/workshops/color.htm](http://www.aatcc.org/events/workshops/color.htm)

**October 14**
Functional and Nano Finishes for Industrial Textiles
IFAI Specialty Fabrics Expo
[www.aatcc.org/events](http://www.aatcc.org/events)

**October 22-24**
Digital Textile Printing—Technology, Processing, and Testing
Specialty Graphic Imaging Association (SGIA) Expo
[www.sgiaexpo.com](http://www.sgiaexpo.com)

**November 7**
Abstracts for Poster presentations for AATCC International Conference 2015 due.
[www.aatcc.org/ic](http://www.aatcc.org/ic)

**March 24-26, 2015**
AATCC International Conference
Savannah, GA, USA
[www.aatcc.org/ic](http://www.aatcc.org/ic)

**Ongoing**
AATCC Webinar Series
[www.aatcc.org/events/online/webinars.htm](http://www.aatcc.org/events/online/webinars.htm)

UV Calibration Reference Fabric Program
[www.aatcc.org/testing/improve/uv.htm](http://www.aatcc.org/testing/improve/uv.htm)

Global Test Method Training
[www.aatcc.org/events/workshops/global.htm](http://www.aatcc.org/events/workshops/global.htm)

Proficiency Testing Programs
[www.aatcc.org/testing/improve/proficiency.htm](http://www.aatcc.org/testing/improve/proficiency.htm)

Textile Fundamentals Online Training
[www.aatcc.org/events/online/fundamentals.htm](http://www.aatcc.org/events/online/fundamentals.htm)
AATCC received 88 entries from various colleges and universities for its tenth annual design competition. This year’s theme, **Boardwalk**, asked students to showcase their talent in textile design by creating a swimwear collection for 18-30 year old women. Color palettes could be chosen from the *PantoneView Colour Planner Summer 2014*.

Awards included a first place cash award of US$1,000 along with a copy of Pantone’s Cotton Passport and a US$100 Spoonflower gift certificate; a US$750 award and a US$100 Spoonflower gift certificate for second place; and two US$100 awards for honorable mentions and US$50 Spoonflower gift certificates.

- **1st Place:** *Whittled Sands* by Emma Sidoriak, University of Delaware
- **2nd Place:** *Architectonic Armory* by Mercedes Garcia-Reyes, Kansas State University
- **Honorable Mentions:**
  - *Bali Tides* by Jordynn Beckman, University of Wisconsin-Stout
  - *Native Pride* by Elizabeth Gilligan, Drexel University

"The best and worst part about doing the Competition was that I was working on it in the midst of finishing up my senior year," says first place winner Emma Sidoriak, University of Delaware. "I used the Competition as an outlet for my creative juices that were otherwise pent up because of the stress and anxiety of a hectic semester. I really enjoyed myself working on this project." The Concept 2 Consumer® Design Competition was not Sidoriak’s first experience of AATCC. "I helped to found a new club on campus, a UD student chapter of AATCC, of which I was President; this was a great leadership experience." Sidoriak says that AATCC membership is important to her future career. "I think being an AATCC member will be beneficial in the future because the AATCC network sheds light on others in the industry with various backgrounds, yet similar values to my own when it comes to the importance of textiles and responsibility."

"I enjoyed researching the current swimwear trends as well as the color trends for the season," notes second place winner Mercedes Garcia-Reyes, Kansas State University. She says she also learned to have more confidence in her CAD and design skills. "I never expected to place in the competition, and just did it for my class and for fun, so it really did take me by surprise when I found out that I had won second place out of so many entries."

"I enjoyed the competition because I got to design swimwear for a fun, fashionable target market and it was a chance to be creative," says honorable mention winner Jordynn Beckman, University of Wisconsin-Stout. “I learned that working hard, [and] taking the time to research trends and the target market was very important.” The other honorable mention winner, Elizabeth Gilligan of Drexel University, notes that AATCC membership “is essential to any student or young designer. Not only does it provide news about upcoming events, but it serves as a reliable platform for jobs, networking, and scholarship opportunities.”

AATCC would like to thank the competition judges:

- Carrie Yates, Manager, Product Development at Cotton Incorporated
- Erica Christianson, Nike Swim Designer at Perry Ellis International
- Jessica Wright, Print & Pattern Developer at Nike
- Julie Lotz, Senior Design Manager at Spanx
- Stephanie McCarrey, Designer at Spanx
- Tracy Marciano, Senior Swim Designer for Nike at Perry Ellis International
1st Place
Whittled Sands by Emma Sidoriak, University of Delaware

2nd Place
Architectonic Armory by Mercedes Garcia-Reyes, Kansas State University

Honorable Mention
Bali Tides by Jordynn Beckman, University of Wisconsin-Stout

Honorable Mention
Native Pride by Elizabeth Gilligan, Drexel University
**Outstanding Graduate**

Congratulations to the AATCC Outstanding College Graduate of the Year, Amber Harkonen of the Fashion Institute of Technology (FIT). She received a cash prize of US$1,000 and a plaque recognizing her achievements at the FIT Alumni Dinner, where Amanda Johnston (AATCC FIT Student Chapter President 2013-2014) presented these awards from AATCC. Harkonen was also congratulated by the 2013 AATCC College Graduate of the Year, FIT’s Amanda Soule.

![Amanda Johnston, Amber Harkonen, and the AATCC 2013 Outstanding College Graduate of the Year, FIT’s Amanda Soule. Photo courtesy of FIT.](image)

**Call for Research Proposals**

Applications due: **September 30, 2014**

The AATCC Foundation Student Research Support Program is supported by AATCC Foundation Inc. to encourage student research in textile chemistry and related fields important to the textile sciences. Its purpose is to support and facilitate textile research conducted by undergraduate and graduate students enrolled in textile programs at US colleges or universities. Recipients are selected by the AATCC Foundation Student Research Review Board and are recommended for funding to AATCC Foundation Inc. Awards can range from US$500 to US$4,000, depending on the project’s significance to the textile industry.

**Download application and guidelines:**

[www.aatcc.org/foundation/grants/research.htm](http://www.aatcc.org/foundation/grants/research.htm)

**Submit grant applications to Yiqi Yang,**

Chair, AATCC Foundation Student Research Support Program; yyang2@unlnotes.unl.edu

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**Call for Student Competition Papers**

Entries Due: **December 1, 2014**;

Papers Due: **February 2, 2015**

Student papers are being sought for the 2015 Herman & Myrtle Goldstein Student Paper Competition. This competition will be held March 24-26, 2015 during the AATCC International Conference in Savannah, GA, USA.

The intent of the competition is to encourage independent or group student research. A project and appropriate results may be submitted by any student (or group of students) who is a member of AATCC. Undergraduate entries must involve work completed
as an undergraduate and will have a weighting factor assigned to them.

Oral presentation of the student papers is a feature of each AATCC International Conference. A panel of judges will screen the submitted papers to select the top 8 papers for the competition. Competition papers will be evaluated by a panel of judges and at the Conference, and will be evaluated on both the written manuscript and the oral presentation.

Cash prizes for the competition winners include US$1,000 first place, US$750 second place, US$500 third place, US$250 fourth place, and US$100 for honorable mentions (students presenting in the competition at the Conference, but not placing in one of the top four categories). Winning papers may be published in the Association's magazine, AATCC Review or submitted to the Association's peer reviewed journal, AATCC Journal of Research.

Official entry form: [www.aatcc.org/students/awards/2015_HMGSPC_entry_form.pdf](http://www.aatcc.org/students/awards/2015_HMGSPC_entry_form.pdf)

Criteria for judging the written and oral presentations available from: rshamey@ncsu.edu or pickettp@aatcc.org


Submit official entry form: December 1, 2014; nicholk@aatcc.org

Submit final papers: February 2, 2015; nicholk@aatcc.org

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### AATCC Test Method Online Training Videos

AATCC test method online training videos are designed to explain and demonstrate the more commonly used AATCC Test Methods and Evaluation Procedures.

**FEATURES & BENEFITS**

- Step-by-step visual instruction
- Demonstration of correct techniques
- Text and audio narration
- Learn at your own pace from anywhere
- View & pay for only the modules you need
- No travel expense

Inquiries please contact Garry Atkinson
+1.919.549.3544 | atkinsong@aatcc.org

[http://www.aatcc.org/events/online/test_method_training.htm](http://www.aatcc.org/events/online/test_method_training.htm)
Cool Beans

By Corrie Pelc
When harvested, soybeans are mainly processed for their oil used in cooking or for biodiesel production, according to the North Carolina Soybean Producers Association Inc. (NCSPA). The high-protein fiber that remains after the oil is extracted—also known as meal—is normally fed to livestock. The NCSPA says about 11 lbs of crude oil and 47 lbs of soybean meal is produced from a 60 lb bushel of soybeans.

The large amount of soybeans that are harvested and processed each year obviously leaves quite a lot of soy protein for the taking. So, what to do with the leftovers? One company has already developed a soy fiber they are producing commercially. The United Soybean Board (USB) is now funding a number of fiber research projects looking at using soy protein to produce soy-based fibers. Here’s a look at how soy fibers are growing in the textile industry.

According to the American Soybean Association, 268 million metric tons of soybeans were produced globally. Brazil was the largest producer of soybeans in 2012, producing 83.5 million metric tons, followed by the United States (US) at 82.1 million metric tons.

For such a little thing, soybeans are big business.
Soy fiber is now being produced commercially by ABrand (Beijing) Technology Co. Ltd., (formerly China Harvest) for use in a variety of applications. According to Jackson Wang, sales manager at ABrand, the company produces soy fibers in conjunction with Swicofil Switzerland at a current capacity of 20,000 tons per year of staple fiber. The fiber produced—what ABrand refers to as soybean protein fiber (SPF)—is a mix of soybean protein and polyvinyl alcohol (PVA). Wang says the two materials are dissolved and mixed together, and then put through a series of processes that include wet spinning and acetalizing to produce the finished fiber product.

Wang says there are a variety of applications where ABrand's SPF is being used, from undergarments to carpeting to nonwovens. He says SPF offers a number of advantages for these types of uses, including an excellent drape and comfort, ability to be dyed with acid or reactive dyes, and non-shrinking. Additionally, these benefits have also played well when SPF is blended with other fibers, such as cashmere, mercerized wool, silk, combed cotton, and elastic fiber.

Wang says ABrand expects the market for soy fibers to grow, thanks to a large source of soy protein to be used, as well as its environmentally-friendly properties. “(We) hope the application of soybean fiber can be wider—(we) hope the production can (become) more economical, and the fiber can (attain) a more attractive price,” he adds.

Sprouting Research
Research to create additional soy protein fibers is in full swing. The projects, funded by the USB and overseen by Robina Hogan, commercialization manager, fibers, for both Omni Tech International Inc. and the USB, range from creating soy fibers through melt spun and dry spinning processes, to creating nanofibers using soy protein. Hogan explains that all the projects are still in the development stages, “None of these are technically in the commercial mode at this point.”

Soy Fiber Resins
One project is at Clemson University, conducted by Amod A. Ogale, Dow professor of chemical engineering and director of the school’s Center for Advanced Engineering Fibers and Films (CAEFF). Ogale and his team worked with soy flour to successfully produce a continuous melt-extrusion process from a soy-PE resin, with fibers as thin as 40 micrometers. “The soy-PE fiber strength and stiffness compared well with the base polyethylene resin, so the fiber properties are suitable for limited-use applications with their advantage being lower cost relative to base resin,” he explains.

Ogale says the research and fiber development at Clemson is primarily for the fibers to be used in “limited-use” applications, such as disposable nonwovens. He says they are currently scaling up their research for pilot studies.

At Triad Polymers LLC, a chemistry that blends a soy protein isolate with polyethylene developed by Marvin Technical Associates is currently being evaluated for scaling up to commercial quantities. “We are investigating a novel two-step process to prepare a masterbatch suitable for commercial fiber and nonwoven applications in PE resin,” says Peter Pförtner, vice president of Triad Polymers. Pförtner also says the company has been approached by another company promoting biopolymers to produce soy compounds for extrusion/injection molding applications.

At Cornell University, Anil N. Netravali, professor of fiber science in the department of Fiber Science and Apparel Design, and his team have been working
on crosslinking soy protein and using it as a resin in "green" composites by reinforcing it with cellulosic fibers. "We have also come up with a method to crosslink soy protein without using external crosslinkers," he adds.

**Soy Nanofibers**
Additionally, Netravali’s group has also successfully electrospun soy protein to create nanofibers. "Because the soy protein contains amino acids that contain positive or negative charges, these nanofibers attract particles that have positive or negative charges," he says. Netravali is looking at using the nanofibers in air filtration applications, as well as possibly tissue engineering. "We have shown that just one gram of soy protein nanofibers can filter 100% of Gram-negative airborne bacteria. These nanofibers should also be able to capture airborne viruses," says Netravali.

Producing soy nanofibers has also been the focus of a research project between Alexander Yarin, professor in the department of Mechanical and Industrial Engineering at the University of Illinois at Chicago, and Behnam Pourdeyhimi, associate dean for industry research and extension of the College of Textiles at North Caroline State University and executive director of The Nonwovens Institute. Yarin says they have developed a solution blowing process that uses a bipolymer blend that is pushed through nozzles at a very high speed—almost 300 meters per second. "As a result, the thickness of the fiber decreases dramatically and becomes almost like a fractal," Yarin explains. "When you have eight nozzles like that, you can very rapidly produce a significant piece of material like 20 cm by 20 cm. This is much faster than (an electrospun) nonwoven."

Yarin says they are currently patenting their process and working on commercializing it. They are focusing on the wipes category, as well as filter membranes, biomedical applications, and geotextiles. "We have in mind some applications in agriculture for protecting plants—bringing green materials back to the field for protecting plants," he adds.

Michael Jaffe, professor in the department of Biomedical Engineering at the New Jersey Institute of Technology, and his team have been working on two different areas of soy fibers. The first is a melt spinning-type process that uses a blend of soy protein and polyvinyl alcohol that produces a fiber made of about 20% soy, resulting in a fiber for nonwoven

**Soy Fiber—The Early Years**
Today is not the first time soybeans are being looked at to make fibers. Soy fibers can be traced all the way back to the 1930s, with American industrialist Henry Ford, who decided to begin using natural products as a substitute for costly petroleum-based materials. “He focused on soy, and he actually developed the soy PVA blend technology,” says Robina Hogan, commercialization manager, fibers for both Omni Tech International Inc. and the United Soybean Board, “Since then, soy chemistry started going into a lot of thermostats and thermosets,” she explains. However, Hogan says that once World War II ended, Ford’s work with soy came to an end, as the factories he was using to produce soy fibers were needed to make other vitally-needed things in the post-war economy.
applications such as diapers and feminine hygiene products. Jaffe says they have teamed up with the Nonwovens Institute at North Carolina State University to begin scaling up the process for commercialization.

Additionally, Jaffe’s team has also been working on electrospinning soy nanofibers for use in medical devices, bandages, and tissue engineering substrates. Jaffe says using a soy substrate would provide an alternative to a collagen substrate, which normally comes from cows, horses, and pigs, and could be a potential issue with certain cultures and religious beliefs. “We were actually able to develop a process where we can make almost ...100% soy as nanofibers, and we’re able to show that cells actually kind of like it,” he adds.

### Soy Futures

According to Hogan, there are even more research projects in the pipeline, including additional applications and polymer blends. Researchers are even looking into producing a soy oil-based fiber. With so much attention placed on this little bean, it certainly seems that it may prove to be a big player in the future of the textile industry.

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**The Pros & Cons of Soy for Textile Fibers**

Soy protein has both advantages and disadvantages when it comes to being made into a fiber.

**Advantages:**

- **Soy is natural and biodegradable.**
  
  This, says Alexander Yarin, professor for the department of Mechanical and Industrial Engineering at University of Illinois at Chicago, makes soy fibers a more sustainable solution for nonwoven applications like wipes and filter membranes that are normally made from non-biodegradable, petroleum-derived materials, which gives them a longer life than they need.

- **Soy is available in abundance.**

  Michael Jaffe, professor in the department of Biomedical Engineering at the New Jersey Institute of Technology, says a growth in the use of soy polyols in polyurethanes and soy oil in biodiesel has created a much larger amount of soy protein than there was before. “While they take that protein and it becomes protein-enriched animal feed, they’ve always been looking for value-added opportunities that could give more income to farmers,” he says.

**Disadvantages:**

- **Soy is temperature sensitive.**

  “We have to find polymers that are compatible to soy proteins, but not get to the point where the soy is charred, burned, and degraded. So you’re limited to certain temperature levels,” explains Robina Hogan, commercialization manager, fibers for Omni Tech International Inc. and the United Soybean Board.

- **Soy fibers can be weak or brittle.**

  Because soy protein has about 18 different amino acids with different sizes, it cannot be crystalline, so fibers made from it end up having a weak structure, says Anil N. Netravali, professor of fiber science in the department of Fiber Science and Apparel Design at Cornell University. “Perhaps this may be corrected to some extent if [the fibers] are crosslinked,” he explains. “The disadvantage of this is that they become brittle and need plasticizer. If external plasticizer is used, there is always the possibility of the plasticizer leaching out during use.”
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According to the United States Environmental Protection Agency (EPA), in 2012 about 14.3 million tons of textile products made their way to landfills in the US—that’s 5.7% of all generated municipal solid waste. To find a way to lengthen the lives of textile products, and also increase the amount that are recycled, would obviously have a great impact on our environment.

This issue is one the textile industry is working to solve, and according to James Pruden, senior director of public relations at Cotton Incorporated, it’s an issue that touches the entire supply chain. “The industry is reacting with a combination of responsible self-scrutiny and innovation,” he explains. “There is a considerable amount of work already done to access the environmental impact of various fibers, products, and processes in the form of life cycle assessments and life cycle inventories. In addition, organizations and public companies are working to speed innovative technologies to market...that can help the industry reduce the environmental impact of related chemistries, energy, and water.”
According to Roshan Paul, head of European research for the Department of Function and Care at the Hohenstein Institute, much attention is being paid to the issue of used garments that end up in landfills, causing large amounts of waste. “Eco-awareness is increasing among people (and) many governments are promoting recycling,” he says. “Very recently—mainly due to fluctuating fiber prices—textile waste is [being] seen as a valuable raw material resource. They are of very low cost, are locally available, and can be used as raw materials for many other manufacturing industries.”

To give you a better idea of this issue, below we tell the story in detail of how four different fibers—wool, cotton, polyester and nylon—live their lives, from the very beginning to the very end. We will also talk about what technologies are being used to help these fibers last even longer, and how these fibers are being given second lives through recycling.

Sheared Wool

As we all know, wool comes from sheep. However, Ben Mead, textile sustainability specialist formerly with Textile Exchange and now with Hohenstein Institute America Inc., says most organic wool seen in the market comes from Merino sheep, which produces a smaller diameter fiber to make finer quality-type yarns. The sheep are generally sheared once or twice a year to collect the raw wool.

From there, Mead explains, the wool may be sent to a trader board to be classed or sold directly to a fiber buyer. The raw wool goes through a cleaning process called scouring, which removes sweat, oils, and other natural “trash” the sheep may have picked up from being outside. Once the wool is nice and clean, the fiber is either dyed in bulk; spun into yarn and then dyed; or spun into yarn, woven into a fabric, and then dyed. Mead says major textile applications for wool include hosiery, knitwear, sweaters, high-end carpets, and outdoor sportswear.

Mead says that how long the wool fiber lasts in these textile applications is dependent upon the fiber quality, yarn quality, what the end use is, and how the end user treats the textile. However, he says there are treatments being used to help lengthen the life of wool fibers. For instance, Mead says the fibers can be treated to make them more machine washable. “Without that sort of treatment, [wool is] susceptible to shrinkage and felting,” he explains. And, he says, some treatments can be used to make the fiber water or oil repellent.

When a wool textile comes to the end of its life, Mead says that many will end up in landfills or be used as an energy source through incineration, just like many other textiles. Alternatively, depending on the finishes or treatments used on the fiber, it could be placed in a composting environment and allowed to break down.

There is also another possibility—wool can be given another life through mechanical recycling. “The garment itself may have holes in it, but the bulk of the fiber will still have a lot of useful life in it, so it could be mechanically pulled apart and then respun into yarn,” Mead says. That gives the fiber a useful second life, and, according to Mead, a lot of the energy, water, and chemicals that go into the initial processing of virgin fibers can be avoided.

Harvested Cotton

According to Pruden, cotton is grown all over the world. Once the cotton plant matures, the fiber is already extruded within an open boll and ready for picking, and is picked either by a mechanized picker or by hand.

Using the US as an example, once the cotton is picked, Pruden says it is compressed into a rectangular brick called a module. The modules are taken to a cotton gin where the fibers are separated from seeds and any extraneous field debris. From there, the ginned cotton is compressed into a bale and shipped to the USDA for grading and classification. Then the bales are sold to spinning mills, where
Pruden says the cotton fiber is carded, combed, and spun into yarn, which eventually becomes a woven or knitted textile.

Pruden says cotton textiles are used in a variety of applications, from apparel to nonwovens to home products. How long the fibers last in the textile application, Pruden says, all comes down to how well it is cared for. “Cotton will decompose back to nature in a proper composting environment, but could remain intact for generations with proper storage and cleaning,” he explains.

To help increase the sustainability of cotton fiber, Pruden says it can be recycled to give it a second life. For its part, Cotton Incorporated has started a program called Blue Jeans Go Green, which he says collects unwanted denim and turns it into housing insulation that is given to building projects for communities in need. “There are (also) some small-scale projects involving the use of recycled cotton, and even some early testing in the chemical conversion of cotton textiles into a cellulosic fiber that can be re-knitted or re-woven,” Pruden adds.

**Melt-spun Polyester**

According to Meredith Boyd, product development manager for Unifi Manufacturing Inc., polyester gets its start from the combination of two chemicals—diethylene glycol and terephthalic acid—through a process called condensation reaction.

This process results in what Boyd calls a “molten polymer goo,” which is allowed to dry into a polymer resin. To make the polyester fiber, a process called melt-spinning is used where the resin is melted down again and extruded through a spinneret (which Boyd says looks like a showerhead, as it has many holes). The melted polymer comes out through the holes and is air-cooled, forming filament polyester fibers.

From there, Boyd says, the very long polyester fibers are crimped into smaller pieces and then can be spun together just like a natural fiber, or can be combined with other fibers. Additionally, the fibers may go through a process called texturizing that helps give them a soft, bulked-up yarn feel that would be appealing when used in garments. Boyd says bobbins of polyester yarn are then sold to a fabric manufacturer, where they are knit or woven into the desired fabric.
Boyd says some of the main textile applications for polyester fiber are apparel, upholstery, and automotive fabric, as well as non-traditional textile applications such as nonwovens and injection molded parts. She explains that although polyester fiber will not degrade under normal conditions, how long it will last in a textile comes down to how it is made and used. "If you have something that is constantly being abraded, or it's a fabric that's made with a loose construction, you will not see that last as long as something in a different construction," Boyd explains.

In regards to recyclability, Boyd says polyester’s thermoplastic nature—being able to be melted and cooled a number of times—is key. Unifi has been focusing its recycling efforts on not only pre- and post-consumer polyester products, but also other products that are made of polyester, such as plastic water bottles and containers, to combine them and end up with a virgin-equivalent polyester fiber. However, she says, much work still has to be done to change the aesthetic and performance stigmas surrounding recycled fibers, as well as make sure consumers are educated about the importance of recycling to help keep these items out of landfills.

Drawn Nylon

Nylon 6 and 6,6 are the most common nylons in fiber applications, according to Robert H. Barker, past vice-president of the American Fiber Manufacturers Association. Nylon 6 is made by the polymerization of caprolactam—during which, Barker says, the polymer is melted, extruded through a spinneret, cooled to solidify, and then drawn over a series of wheels to stretch them. Nylon 6,6 is made with the same process; however, Barker says, it is made from the polymerization of adipic acid and hexamethylenediamine.

Once the nylon fiber is created, it can go into a variety of applications, such as hosiery, swimwear, and outer wear, as well as carpeting, tents, rope, and luggage, says Ria Stern, global marketing director of the Textile Fibers Division for Hyosung Corp.

How long the nylon fibers last in a textile application is once again dependent on the end use, according to Barker. However, he adds that both polymer modifications and surface treatments are being explored to help nylon fibers have a longer lifespan. He says some of these modifications have included improved strength and abrasion resistance, as well as helping to keep the aesthetic properties of the fiber last longer.
When a nylon textile comes to the end of its life, Stern says it may be repurposed, depending on the product. For example, at Hyosung they collect post-consumer nylon waste—such as nylon rope and fishing nets—that is put through a de-polymerization process and turned into recycled nylon fiber. “It is basically a chemical recycling process where we recover the raw ingredient, caprolactam, and then use it to make recycled yarn,” she explains.

Barker says much has been done by the Carpet America Recovery Effort (CARE) to help recover fiber from used carpets. “Nylon 6 is particularly easy to recover from carpet waste, since it can be depolymerized by water and heat, and the caprolactam recovered and reused for new polymer,” he explains.

It’s a Sustainable Life

As is evident by the four fiber life stories presented here, much is being done today in the textile industry to make textile fibers as sustainable and recyclable as possible. Whether the fabrics used in textiles are made from natural or synthetic fibers, steps can be taken all along the textile value chain—all the way to the consumer—to make those fabrics more sustainable. A lot of the technology is already available to improve the sustainability of every textile fiber. It’s up to the industry to use that technology, and up to brands and consumers to create the demand for those sustainable fibers.
Introduction

Due to increased pressures arising from technological advancements, new product design and development has become essential in many areas, including the sportswear sector. Recently, sports activities rely on emerging technologies to develop textiles that have high performance value and varied applications. In addition, there is a growing emphasis on multi-functional smart sportswear since it enhances the wearers’ performance and protects their body from extreme conditions during activities. Therefore, the awareness of comfort should be promoted in sportswear R&D. Sportswear can be both comfortable and multifunctional when smart technical design is combined with smart textile materials. Promoting this new type of product can generate a niche market in the sportswear industry, which has been rapidly growing since the late 1990s.1,2

According to the World Health Organization (WHO), over one billion of the world’s population was found to be overweight or obese. A body mass index (BMI) greater than or equal to 25 is defined as overweight, while a BMI greater than or equal to 30 indicates obesity.3 BMI is an index of weight-for-height that is used to classify underweight, overweight, and obesity in adults. It is defined as a person’s weight in kilograms divided by the square of his or her height in meters.

As the number of overweight and obese people rises, related health issues such as hypertension, diabetes, metabolic syndrome, heart disease, and breast cancer also increase. Furthermore, the overweight and the obese have a significant economic impact—the estimated medical expenditure attributed to obesity was US$147 billion in 2008.4 Although not the only indicator of being overweight or obese, the measurement of waist circumference can reveal excessive abdominal fat that increases the risk of various health issues. According to Lakka, et al., middle-aged men with this excess are candidates for coronary heart disease, and therefore the amount of abdominal fat is even more important than overall overweight.5 Hypertension and high blood lipids often cause coronary heart disease and are accelerated by increasing waist circumference.6 Due to the awareness of these health risks, regardless of age, and an increasing interest in health and well-being, smart healthcare clothing, which monitor vital signs such as blood pressure, heart rate, electrocardiogram (ECG), respiration, and body temperature, has been developed and expanded.7-9 Research in this area is facing various challenging issues such as “biomedical sensors, scenarios of data security and confidentiality, risk analysis, user interface, medical knowledge/decision support, dissemination, user acceptance and awareness, and business models and exploitation.”10 Smart healthcare clothing can be both comfortable and efficacious for disease prevention when smart technical design is combined with smart textile materials.

However, it is not easy to find sportswear developed to help people practice weight management. Demand for developing multi-functional smart clothing is accelerating. Since the measurement of waist circumference can be a useful indicator for weight management, continuous self-monitoring and physical activities will play an important role in successful health management.11 Also, the use of sensor and wireless communication technologies in multi-functional healthcare clothing will likely accelerate. Therefore, this research focuses on developing smart multi-functional sportswear for the overweight, called a diet-facilitating suit, using smart textile materials that monitor the change of waist circumference, body temperature, and the amount of exercise.
**Methodology**

The major objective of this research was to design multi-functional smart sportswear that measures changes in body circumference and informs users with relevant data. Fig. 1 presents the methodology for this research, which was developed for prototyping smart sportswear that monitors waist circumference for smart weight management. The design concept included the garment design and the positioning of technical devices in the garment. A textile sensor, which is called an "e-strain gauge" in this research, was developed using carbon black and polyurethane. Cotton/spandex jersey knit fabric was used as the major fabric. Body measurements of the dress form were created using a 3D-body scanner, and patterns were generated using computer aided design (CAD). Fabric was automatically cut using computer aided manufacturing (CAM) and garment assembled by sewing. After an e-strain gauge was embedded in the prototype, the prototype was tested on a dress form.

**Design Considerations**

To measure the circumference of the body accurately, the garment has to fit closely on the body. Therefore, customized patterns for individuals are recommended for fitting the garment. However, current technology to make these customized patterns is cumbersome and has low efficiency compared to the production cost. Therefore, a method to select body types in the shape categories of torso, arms, and legs was proposed as a workable solution. The users were fitted based on not only their body size but also their body shape and garment preference. First, the various body shapes are reviewed.

**Body Shapes of the Overweight**

Body shapes of the overweight and the obese are different from body shapes of others. Understanding various body shapes is required to develop well-fitting garments for the overweight and the obese. In this research, focus was on the torso shape rather than discussing arms and leg shapes. In Fig. 2, the rectangular-8 body shape is considered to be the most even in scale regardless of the BMI value. This shape is characterized by well-proportioned torso curves. The barrel body shape has a thicker waist than the hips. The pear body shape has a narrow-shouldered torso where the body line meets round hips and large bulging thighs. Lastly, the box body shape has a thick and wide torso, and wide hips with no visible waistline.12

**Role of CAD/CAM**

Recently, automation that minimizes human intervention during manufacturing became a hot issue both in academia and the industry since CAD/CAM provides solutions to increase production efficiency and to lower production cost.5 However, the apparel industry still depends on skilled labor, despite the advanced techniques in automation, because industrial applications of CAD/CAM in the current apparel manufacturing are limited to helping experts' manual operations due to the complexity of standard body measurement.
Mesh Generation

After generating the 3D-garment model, a mesh generation method is widely used to transform 3D-body scans into 2D-flat patterns. The surface is divided into small pieces and the pieces are recombined on a 2D plane. Two primary mesh generation methods have been used: 1) the surface is separated into several zones by specified lines (e.g., center line, bust circumference line, and shoulder line), and then each section is divided into tiny pieces, or 2) the surface is entirely divided into small pieces. Of these two methods, the former does not create darts, while the latter generally creates darts during the flattening process. Mesh generation methods keep the size and arrangement of the meshes constant. Therefore, the width and height of zones are separated at regular intervals—such processes generate triangular or quadrilateral elements. The structure, which is well aligned horizontally and vertically, is related to the control of mesh sizes. It is important to determine the optimal size of elements to create clear darts.

Fig. 3 shows the generation of triangular darts. Triangulation is widely used to create meshes with points from the raw data generated by a 3D-body scanner while considering the curvature. Large meshes are generated in low-curvature surfaces, while small meshes are generated in high-curved surfaces. The more triangles there are, the more detailed expression there is.

Quadrilateral mesh generation adopts the same techniques as triangular mesh generation, while saving more time. However, triangles are more determinative than rectangles because the shape can be determined with three lengths and three angles. Hence, using a triangular structure can reduce the number of control factors while developing and generating an uncomplicated algorithm. When triangular elements are combined, the subsequent element is forced to attach to neighboring elements.
until the difference between angles before and after distortion does not exceed the predefined shear tolerance value. If the angle difference exceeds the tolerance, a dart is formed by detaching elements. This algorithm creates darts in the perpendicular direction with boundary lines of the pattern and shows a tendency to have a smaller number of darts with a larger shear angle allowance.

Flattening System
The goal of the former process (classic pattern design) is to flatten the virtual garment image and to develop garment patterns while the latter process (virtual garment construction) is to estimate the appearance of garments from 2D patterns.

Body size and shape varies based on the individual. Although some people might have the same bust size, their waist and hip circumferences might differ. In addition, even if they have the same measurement in specific parts of the body, the flat degree (angles in flat patterns generated due to curvy body shape) and the cross sectional area can be different. The obese and seniors especially show different body shapes compared to general body shapes. However, the conventional pattern making system is based on grading technology that uses a regression formula indicating the relationship between average measurements and bust girth. Therefore, mass production that applies the conventional pattern system cannot satisfy customers’ fit expectations. For structured suits or tight-fit garments, fit is a critically important factor. A 2D-pattern generation system reflecting the curved surface information of a body by using individual 3D-body scan data could be a solution to any fit problems.

Material Consideration
An electrical strain (e-strain) gauge was developed for use as a textile sensor by mixing carbon black with polyurethane. When incorporated into a garment, it can measure the change of body circumference.

E-Strain Gauge Production
Pellethane 2355-80AE polyurethane elastomer was supplied by Dow Chemical. Carbon black powder with the density 1.7-1.9 g/cm3 was provided by Cabot Corporation. Polyurethane pellets and carbon black powders were mixed using the Hakke MiniLab (Thermo Scientific) extruder. First, 6.25 g of polyurethane and 0.75 g of carbon black were loaded into the Hakke MiniLab. The twin screws were rotated for 10 min with a rotating speed of 100 rpm at 200 °C for complete dispersion of carbon black powders in the polyurethane elastomer. Finally, the polymer composite was extruded through a 2-mm cylindrical die at room temperature to produce the carbon black polyurethane composite fiber (Fig. 4a).

To create a film of the e-strain gauge suitable for laminating, this composite material was cut into tiny pieces and pressed in a Hakke press (Thermo Scientific). A carbon black concentration of 15 wt% was used as a standard for this research since previous research showed that films at 20 wt% were brittle and had low conductivity at 10 wt%. The mixture was pressed between Teflon sheets with 700 kg force at 200 °C for 15 min to acquire a film consisting of carbon black and polyurethane using a heat pressure machine (Fig. 4b).

Evaluation
The surface and cross-sectional area of the fiber e-strain gauge were examined with a scanning electron microscope (SEM, Hitachi S-3200N) operated at 5 kV and magnifications from 100× to 100K×. Revolution (4pi Analysis) was used for the image analysis of SEM images. Fig. 5 shows the cross section of the e-strain gauges.
The electric resistance of e-strain gauges was measured to evaluate the conductivity. All measurements were performed with a multimeter (EXTECH 420). E-strain gauges were stretched to a strain of 2.5% to 15%. Repetitive stretching and restoration of the e-strain gauge were conducted respectively for each strain. Measurements were repeated five times at each level of strain and at each subsequent relaxation. A rapid increase in electric resistance was observed (Fig. 6).

**Fig. 6. Relationship between strain and electric resistance of the e-strain gauge**

Fabric Selection
Cotton fabric provides comfort, allowing good air permeability and water absorption, while the high elongation of spandex responds to changes from active body movement. Hence, a 90% cotton/10% spandex jersey knit fabric was used for the substrate of the e-strain gauge, taking into consideration moisture management and tight fit. The jersey knit created a relatively lightweight fabric, compared to fabrics constructed by other stitches, but stretched more easily than woven fabrics. In addition, the fabric must be made superhydrophobic (highly water repellent) since the garment consists of e-devices, including e-strain gauge and multimeter. Also, because this is sportswear, the fabric was treated with nanosilver colloidal particles to give it antibacterial properties.

**Superhydrophobicity**
A superhydrophobic surface is defined as having a water contact angle greater than 150° (Fig. 7). This high contact angle is obtained by a combination of surface chemistry and surface morphology (e.g., fabric construction). Water easily rolls off of a superhydrophobic surface, washing dirt off in the process and effectively cleaning the surface, while keeping the fabric material breathable. Superhydrophobicity is also known as self-cleaning or the Lotus effect. Some researchers believe that superhydrophobic fabric should have water roll-off at a roll-off angle of smaller than 5°. However, roll-off angle should not be used as a definition of superhydrophobicity because the roll-off angle completely depends on the drop volume and the contact angle hysteresis, which is the difference between the advancing and the receding contact angles when water begins to roll off the fabric.

This amazing water repellency was obtained based on two criteria: a low surface energy and a well-designed surface roughness. The cotton/spandex jersey knit fabric was treated with a fluorosilane dissolved in isopropyl alcohol and was cured at 110 °C for 20 min. This treatment coated the fabric with micro and nano protuberances that had low surface energy (< 20 dyne/cm) and high water repellency.

**Antimicrobials**
Heavy metals are very reactive with proteins. The ability of microorganisms to survive or grow rapidly decreases in the presence of metals, reducing bacterial colonies. Metals bind to protein molecules, inhibiting cellular metabolism and leading to microorganism death. Alteration of chemical structures occurs. Metal toxicity is related to redox changes in metal ions. One metal, silver, is well known to be relatively non-toxic compared to other heavy metals that are bacteriocidal.

Novel properties of nanomaterials have led to breakthroughs in a multitude of cutting-edge technologies. Of particular interest to material scientists, nanoscale materials have greater surface areas than conventional materials. Therefore, in this research, fabric was treated with nanosilver particles to inhibit microorganism growth.

**Prototype Sample Construction**
A prototype of multi-functional smart sportswear for the obese (Fig. 8) was manufactured to test concept and performance. Body scanning and CAD were used to generate customized patterns. The patterns were created with the Gerber Accumark Pattern Design System (PDS) software, taking into account the stretch ratio for the chosen jersey knit.
fabric. Fabric was automatically cut using a Gerber Cutting Edge Cutter. The prototype garment was fitted on a dress form. After dressing the prototype on the form, the electrical resistance of the e-strain gauge was measured. An air inflatable package was used to simulate change of body circumference.

The single strain gauge was embedded around the waist to insert elastics by casing (Fig. 8). The fabric tape was made of the identical fabric as the suit and stitched on the inside of the garment with running stitches. Considering different degrees of technology integration, the e-strain gauge could be permanently integrated into the suit fabric by applying heat and then lamination. However, physical embedment was considered more appropriate due to the possible changes in electrical properties of the e-strain gauge.

**Monitoring**

Changes of electrical resistance in the e-strain gauge obtained from a multimeter can be sent to a cell phone or other electronic devices over Bluetooth daily or weekly. An appropriate software program installed in the electronic devices transforms the data to a user-friendly format, such as the amount of body circumference changed. The electronic device informs the user of estimated changes of body circumference and provides dietary suggestions along with a target level of aerobic exercise. In addition, an accelerometer (a Wireless Sensor Network, WSN (Sun Microsystems) that detects magnitude, direction, and speed of motion) attached to the garment quantitatively measures the amount of exercise (Fig. 9), and Radio Frequency Identification (RFID) device has user’s health information such as blood type, chronic disease, and recent health record. While the user exercises, a Global Positioning System (GPS) can monitor the location of the user for safety and security (Fig. 10).

Fig. 11 shows the prototype sample developed in this research. Users can wear the garment and the service package regularly to continually monitor their body status until they meet their target weights. The use of such multi-functional smart apparel for the overweight would help people maintain proper

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**Fig. 8. Structure of the diet-facilitating suit (DFS).**

**Fig. 9. The motion detected by an accelerometer that has been attached to the multi-functional smart sportswear. The magnitude, direction, and speed of motion are quantitatively measured.**

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weight and improve their health more strategically. To enhance comfort of the product, a cotton/spandex blended jersey knit was designed with moisture management properties to be comfortable during users’ exercise. To make the apparel product fit the user well, product patterns were developed using a 3D-body scanner and CAD/CAM.

Conclusion
A combination of apparel design, material science, and cutting edge technologies were used in the prototype of multi-functional smart sportswear available for the overweight. The prototype was created using a 3D-body scanner and CAD. An e-strain gauge was inserted into the waist of the prototype garment, which was made of cotton/spandex jersey knit fabric treated with nanosilver and a fluorosilane for antibacterial and self-cleaning effects. Waist circumference change was simulated by air injection while electric resistance of the e-strain gauge was measured. A multimeter was attached to the garment to detect and monitor the magnitude, direction, and speed of exercise motion. RFID, with user’s health information, such as blood type, chronic disease, and recent health record, was also attached to this smart sportswear in case the user experiences a medical emergency while exercising. This research did not show which variables affected the performance of the apparel on the human body, therefore, the DFS prototype was not tested for functionality. This study aimed to present the technologies required to develop multi-functional smart sportswear and its potential use to prove the concept by developing a prototype sample. The relationship between electric resistance of the e-strain gauge and waist circumference proved that both technical design and material selection are important to make mass-customized smart apparel. Such smart sportswear can be both comfortable and multi-functional when smart technical design is combined with smart textile materials. Promoting and commercializing this new product can generate a niche market in the sportswear industry and become a stepping stone towards success in the future smart apparel marketplace.

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Color Strength Method for Rating Odor-Resistant Effect of Cotton Socks

By Xie Weibin, Zhao Shanhong, and Wu Jianjian, Zhejiang Entry-exit Inspection and Quarantine Bureau; and Dong Xiaowen, Du Juan, and Chen Shuilin, Donghua University

Abstract
The odor-resistant property of socks is often linked with the antibacterial activity, depending on the antimicrobials used in odor-resistant finishing. However, antibacterial activity tests are not suitable for odor-resistant socks finished using non-antibacterial agents. In this study, a new method was developed to evaluate the odor-resistant effects of newly developed undyed, anti-odor cotton socks treated with a non-antibacterial agent. Worn, undyed (treated and untreated) cotton socks were sprayed with silver nitrate solution for color development under UV light. The resulting shade would be from white to brown, depending upon the intensities of the odor. A preliminary positive correlation between K/S values (color strength) and odor intensities with were found with the organoleptic test. The color strength method was more objective and had better reproducibility than the organoleptic test.

Key Terms
Color, Color Strength, Odor, Odor Resistance, Organoleptic

DOI: 10.14504/ajr.1.4.1

Enhancing the Protection Performance of Flame Resistant Fabrics Using Phase Change Materials

By Ramsis Farag, Auburn University

Abstract
Current application of phase change materials (PCMs) in protective clothing is mostly limited to providing comfort through temperature regulation in extremely hot or cold weather. In this research work, PCMs were incorporated into a firefighter’s garment fabrics to enhance its thermal protective performance. Woven and knit
Spentex (carbon-based flame resistant (FR) fiber) fabrics were permeated with selected hydrated salt PCMs. The rate of temperature rise on the wearer side was traced. Inclusion of PCMs increased the fabric thickness and its thermal conductivity which, in turn, resulted in a slight increase in thermal resistance. Thermal protective performance (TPP) testing showed a significant increase in protection time and performance with use of PCMs. Such extension in the tolerable rescue time can be important in preventing firefighters' burns.

**Key Terms**
Carbon-Based FR Fiber, Firefighters, Flame Resistance, Phase Change Materials, Protective Textiles

**DOI:** 10.14504/ajr.1.4.2

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**Multiple Reuse of Exhausted Acid Dye Batches for Wool Dyeing: Colorimetric Properties, Leveling Agent Effect, and Material Savings**

By Ali Moussaa, Amel El Ghalic, Sabrine Ellouzib, and Faouzi Saklia, University of Monastir

**Abstract**
The feasibility of reconstitution and reuse of an acid dye dyebath for wool dyeing with different dye concentrations was studied. The residual dyebath was analyzed and reconstituted to the required concentration of dye, auxiliaries, and water for repeated reuse without deterioration of colorimetric properties. Analysis of CIELAB coordinates of dyed samples showed that the qualities of samples dyed in reused dyebaths were the same as those obtained from initial fabric dyeing, despite the very high number of reuse cycles. The influence of leveling agent on dyeing behavior remained acceptable. Analysis revealed that such reuse could reduce the amount of water, dye, and leveling agent to reduce effluent treatment costs. A reduction of 90.48% in water consumption was achieved after twenty successive reuses.

**Key Terms**
Acid Dye, Color; Color Differences, Dyebath Reuse, Water Consumption

**DOI:** 10.14504/ajr.1.4.3

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**Fatigue Determination of Photochromic Dyes in Silica and Polyamide Matrices via Analysis of CIELAB Parameters**

By Vedran Durasevic, University of Leeds, and Durdica Parac-Osterman, University of Zagreb

**Abstract**
To address reported problems in investigating photochromic dye fatigue, this paper describes a new method of “dissolved” photochromic organic dye analysis within polar silica matrices. Conditions under which a photochromic response occurs in a given material are defined by specifying the light source (irradiation wavelength) and exposure time that leads to photochromism. Fatigue, defined as poor lightfastness, is researched through consecutive cycles of exposure to the direct influence of a defined UV irradiation source. From the spectrophotometric graphic analysis in CIELAB, a conclusion can be made on the lifespan of photochromic textile products. This paper addresses issues regarding the rate of color development, and the controlled, predictable return to a colorless state, which is the base of any device working on the principle of reversibility.

**Key Terms**
Anti-Counterfeiting, CIELAB, Color, Dyeing, Photochromism, Smart Textiles, UV

**DOI:** 10.14504/ajr.1.4.4
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