Predicting Final Construction of Jersey Knits Composed of Island-in-the-sea Fibers: An Empirical Process Model

Jeffrey A. Joinesme[1], Brandon King[2] and Lori Rothenberg[3]

[1] Textile Engineering, Chemistry and Science Dept, NC State University, e-mail: jeffjoines@ncsu.edu
[2] Textile Engineering, Chemistry and Science Dept, NC State University, e-mail: bking2415@gmail.com
[3] Textile Apparel and Technology Management, Dept, NC State University, address, e-mail: lfrothen@ncsu.edu

Abstract: Fabrics made from micro- and nanofibers offer desirable characteristics including tactile comfort and enhanced wicking for moisture management. However, predicting the final construction (weight, thickness, loop dimensions, etc.) for micro-fiber fabrics made from "island-in-the-sea" bicomponent yarns is very difficult. The goal of the research was to develop model(s) that can predict the final fabric weight and density of commercial bicomponent microfiber knits (including CPI and WPI) based on processing parameter inputs for the bicomponent polyester "parent" microfibers. Therefore, a series of empirical process models were created to predict the finished weight and geometry (CPI and WPI) of Jersey knits composed of 100% "island-in-the-sea" bicomponent yarns. The models were based on real, non-idealized knit structures. The project also determined best practices for critical steps in wet processing and heat setting bicomponent knits and provided a new understanding of knit structure changes caused by shrinkage accompanying sea-polymer removal. Key observations include:

- Process order has the most important impact in controlling the final geometry of Jersey knits as seen in Figure 1; More robust detailed predictive models for controlling the final knit structure can be developed by separating the operations according to wash, then heat-set processing versus heat-set, then wash, and
- The research compared three different modeling techniques: simple polynomial stepwise regression, random forest trees, and multi-layer perceptron neural networks (MLP).
- Models can be successfully tested and demonstrated by either bootstrapping data from the experimental design (in Phase II) or by predicting the final structure for a series of validation samples produced (in Phase III).
- The outcome of the research demonstrates the empirical models for Jersey knits and suggests the potential for creating models that could predict structures of Interlock and other knits. The random forest and stepwise regression methodologies performed the best.

KEYWORDS: ***MACHINE LEARNING, EMPIRICAL PROCESS MODEL, FINAL KNIT GEOMETRICS.***

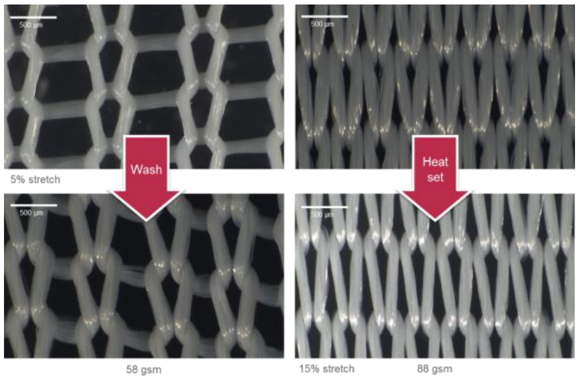

Figure 1 : Jersey Changes Based on Processing Order

In conclusion, the predictive models were successful in predicting finished weight, CPI, and WPI. However, the models produced better results for finished weight than finished CPI or WPI. This could be because the actual measurements for finished weight were calculated by a gauge, while finished CPI and WPI were counted by a research team member. When physically counting the metrics (i.e., finished CPI and WPI), there is expected to be human error, so this could cause outliers and make these variables harder to predict.

The yarn denier was important for all the models for the finished weight as denier has a high correlation to greige weight. Greige weight had the most significant positive coefficient for the interlock and all data models. As expected, the process type was significant for the aggregate jersey, interlock, and all models, while the stitch type was very significant for the "All" model.

Acknowledgment: A portion *of the research was funded by Eastman Chemical, Inc.*

REFERENCES

[1] King, Brandon Isaiah. Applying Data Analysis and Machine Learning Methods to Model Healthcare and Textile Data Applications. Unpublished Dissertation https://www.lib.ncsu.edu/resolver/1840.20/39283