MedCrave
Step into the World of Research
Journal of Textile Engineering & Fashion Technology

Research Article

Open Access

CrossMark

Enhancing feel factor of designed fabric with global desirability of apparel through value engineering

Abstract

When the emphasis is on the textile and garments the desirability is known as overall desirability however with requirement engineering management as per global scenario including fashion, social desirability, climate and microclimate, it is termed as ''Global desirability'' and is being denoted as D_G. In this work, 'Physiological Control System' (PCS) of both comfort & handle is being upgraded to 'Engineering Control System' (ECS) by conversion of conceptual model to a mathematical model. Optimizing the fabric handle properties is based on the basic concept of neuroscience; artificial neuron model; physiological control system & engineering control system. Re-optimization of both comfort and handle by reverse engineering process is done to identify the best sample with maximum overall desirability termed as an 'Ideal Fabric' to achieve value added quality garment. 'Ideal Fabric' is identified as per the synergistic target & goal i.e. which satisfies & saddles both the parameters of comfort and handle in a compromise zone either as per the functionality of frugal engineering or by concurrent engineering.

Keywords: comfort; handle, overall desirability, global desirability, 3d body scanning, thermal conductivity, feel factor, database management, ideal fabric, reference fabric, knitted fabric, clothing appearance, surface methodology, desirability function, optimization technique

Volume 1 Issue 3 - 2017

Kanwar Varinder Pal Singh,[1] Arobindo Chatterjee,[1] Apurba Das,[2] Raul Fangueiro[3]
[1]Department of Textile Technology NIT Jalandhar, India
[2]Department of Textile Technology IIT Delhi, India
[3]Department of Textile Engineering University of MINHO, Portugal

Correspondence: Kanwar Varinder Pal Singh, Department of Textile Technology, National Institute of Technology, GT Road Bye-Pass, Jalandhar, Punjab, India, Tel 01813082000 Extension-3313, Fax 01812690324, Email singhkv@nitj.ac.in

Received: March 02, 2017 | **Published:** March 22, 2017

Abbreviations: PCS, physiological control system; ECS, engineering control system; PHV, primary hand value; THV, total hand value; D_G, global desirability; D_C, desirability of comfort; D_H, desirability of handle; Do, overall desirability

Introduction

Anthropometric study is being done with diagnostic case study by comparing the 'Feel Factor' of 'Ideal fabric' with 'Reference fabric' and quantifying its reduction in harshness assuming body metabolism and microclimate as constant and stationary respectively as biologically inspired cloud computing capabilities of the ANN allows the cognitive and sensory task, as per database management, to be performed more easily and more satisfactorily than with conventional serial processors.[1–10]

Antagonistic case study of 'Feel Factor' of 'Ideal fabric' with 'Reference fabric' is further be applied by using anthropometry with NX 16 3D body scanner (scheduled and controlled automated network system) on a digitized 3D model of human body to assist the spatial analysis of clothing appearance, body measurement, garment fit and for amity multitasking or rapid prototyping of apparels and medical textiles.

Materials and methods

The prepared plain knitted samples of both optimized modified friction spun yarn and conventional friction spun yarn were tested and compared for analysis with an objective to quantify and optimize the desirability of both comfort and handle in order to achieve the overall/ global desirability of an ideal fabric to achieve value added garment.[9]

To fulfill the objectives of the study, the methodology is planned out in the following manner:

a. Preparation of the circular knitted fabric from yarn samples.

b. Testing the knitted fabrics for desired properties.

Desirability function

Desirability function is used to quantify and optimize the overall desirability of comfort and handle. To optimize the desirability of value added garment from an 'Ideal Fabric, response surface methodology is used as a tool to develop a mathematical model. It is a useful approach for optimization of multiple responses of product by using the simultaneous optimization technique.

And its value varies between $0 \leq d \leq 1$.

When response 'Y_i' is at its goal; then d=1;

And when the response is outside an acceptable region; then d=0

Physiological comfort: The state of comfort can only be achieved when the complex interactions between a range of physiological, and physical factors have taken place in a satisfactory manner i.e. Desirability of Physiological comfort = f (a, b, c, d, e). At specific atmospheric conditions with predefined constraints. Where:

a. air permeability

b. thermal conductivity

c. wicking;

d. water absorbency

e. water vapour permeability is the discrete functions of physiological comfort.

Objective evaluation of the above mentioned responses of physiological comfort as per the functional requirement of apparel and

© 2017 Singh et al. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and build upon your work non-commercially.

Copyright: ©2017 Singh et al.

its simultaneous objective optimization is known as the desirability of physiological comfort.[6]

When, there are 'm' responses then overall combined desirability is calculated by considering;

'D_C'=(d_1, d_2, d_3, ----- d_5) $^{1/5}$ (Desirability function for physiological comfort)

Where;

D_C=combined desirability of overall responses of physiological comfort

d=desirability of specific response 'Y' as per specific end use

Handle: Desirability of Fabric handle= *f* (a, b, c, d, e, f, g, h, i, j)

At specific atmospheric conditions with predefined constraints

Where:

a-relaxation shrinkage

b-hygral expansion

c-formability

d-extensibility

e-bending rigidity

f-shear rigidity

g-thickness

h-surface thickness

i-released surface thickness

j-weight

These are the discrete functions of fabric handle.

When, there are 'm' responses then overall combined desirability is calculated by considering;

'D_H' = (d_1, d_2, d_3, ----- d_{10}) $^{1/10}$ (Desirability function for handle)

Where;

D_H = combined desirability of overall responses of handle

d = desirability of specific response 'Y' as per specific end use

Maximum enhancement in physiological comfort related properties of fabric with predefined constraints in desired atmospheric conditions and microclimate for specific end use along with achievement of all FAST parameters in good zone of fabric finger prints is termed as desirability of handle.

Overall desirability of physiological comfort and handle: It is a useful approach for optimization of multiple responses of physiological comfort and handle by using the simultaneous optimization technique in a compromise zone. Desirability of Comfort and Handle is denoted as D_C & D_H.

$$D_o = (D_C \cdot D_H)^{\frac{1}{2}} \quad (1)$$

Where D_o=Overall Desirability is the desirability of value added garment and is defined as simultaneous optimization of comfort and handle as per its specific end use with known constraints It can be compared with Total Hand value by comparing individual desirability of comfort & handle with Primary Hand values (PHV). Total Hand Value (THV) considers only handle properties but Overall Desirability (D_o) considers both the parameters of comfort and handle.[8]

Simulated and developed products with frugal engineering

Optimized yarn: Optimized yarn is a unique modified friction spun yarn, whose physiological comfort related responses are simultaneously optimized to avoid clamminess in summer.

Ideal fabric: It is a garment prepared with 'Ideal Fabric'. 'Ideal Fabric' can be defined as a fabric which satisfies all the parameters or responses of both comfort and handle simultaneously required for the specific end- use as per the desirability and concurrent engineering. 'Ideal Fabric' keeps on changing due to fabric properties required for specific end-use as per its functionality. After the prediction of values of considered factors and responses, an optimized yarn is developed with maximum desirability value, is converted into a knitted fabric and garment. Objective evaluation of the above mentioned responses of physiological comfort fabric handle as per the functional requirement of the apparel and its simultaneous objective optimization to achieve a unique resultant value in a compromise zone known as the overall desirability of an 'Ideal Fabric'. Optimized value of each response of comfort and handle may be treated as 'Primary Hand Value' (PHV). The desirability of both comfort and handle may be treated as 'Total Hand Value' (THV).

Further simultaneous optimization of desirability of both comfort and handle will provide a unique resultant value in a compromise zone known as an 'Overall Desirability' co-relating both comfort and handle with concurrent engineering. 'Total Hand Value' (THV) considers only handle properties; FAST system only provides finger prints but unable to provide any unique value however 'Overall Desirability' (D_o) considers both the parameters of comfort and handle.[9]

Reference fabric: It is a knitted fabric made from the 70:30 conventional friction spun yarn.[2,3]

Control systems

It can be classified as[5]

Qualitative control systems: It is collection of interconnected responses to achieve desired response. It is termed as Physiological control system (PCS)

a. PCS is an interrelated system to perform several different functions e.g. Metabolism.

b. It is generally non-linear.

c. It leads to qualitative conceptual model.

d. Quantitative control systems: It can be termed as follows;

Engineering control system (ECS)

a. ECS is a specific defined task for an optimal manner e.g. Thermostat

b. It can be linear or non-linear

c. It is up gradation of conceptual model to mathematical model

Copyright: ©2017 Singh et al.

Feel factor

Feel factor of both the samples will be evaluated by the Fabric Feel Tester developed by IIT, Delhi and used as a tool to diagnose the variation in harshness.[10]

$$Feel\ factor\ (f) = 26.58 + 20.65 \times P_E - 0.436 \times W_E - 0.131 \times a + 5.064 \times P_R - 0.361 \times D_R \quad (2)$$

Where:

P_E-Peak Height of Extraction curve (Kg)

W_E-Area under the curve for extraction curve (Kg.mm)

A-Unload fabric across orifice for extraction curve (mm)

P_R-Peak height for radial curve (kg)

D_R-Peak distance for radial curve (mm)

As the feel factor increases harshness increases i.e. decrease in softness and vice-versa.

Anthropometric study

This developed process along with 'Diagnostic & Antagonistic case study' was further be applied on a digitized 3D model of human body for amity multitasking, rapid prototyping for 3D personal avatar of apparels and medical textiles Antagonistic case study of 'Feel Factor' of 'Ideal fabric' with 'Reference fabric' was done by using anthropometry with NX 16 3D body scanner (scheduled and controlled automated network system) to assist the spatial analysis of clothing appearance, body measurement and garment fit with point cloud data and concurrent engineering.[11–13]

Result and discussions

Evaluation of overall desirability of 'ideal fabric'

As, overall desirability of 'Ideal Fabric' is;

$$D_o = (D_C . D_H)^{\frac{1}{2}} \quad (3)$$

D_C = 0.577 (desirability of comfort)

D_H = 0.570 (desirability of handle)

Therefore, overall desirability

$D_o = (0.577 \times 0.570)^{1/2}$

$= (0.32889)^{1/2}$

= 0.5734

If the overall desirability of fabric will be 0.5734 then we will be able to achieve the value added garment from a desired fabric known as an 'Ideal fabric'.

Evaluation of feel factor

Feel factor of reference fabric: (70:30 conventional friction spun yarn i.e. Reference fabric)

Feel factor of reference fabric is evaluated as per values derived from the graph generated by 'Fabric Feel Tester' shown in Figure 1

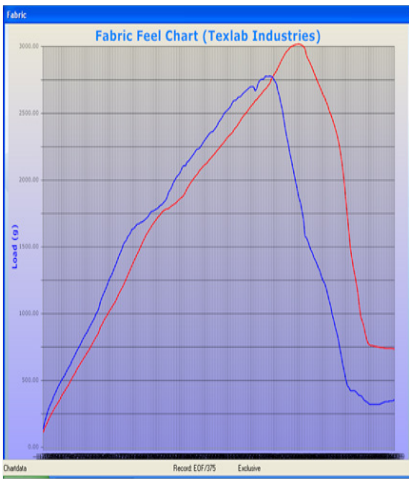

Figure 1 Feel Factor Graph of Reference Fabric.

$$Feel\ factor\ (f) = 26.58 + 20.65 \times 2.777 - 0.436 \times 0.626 - 0.131 \times 0 + 5.064 \times 3.017 - 0.361 \times 43.094 \quad (4)$$

Feel factor (f) = 83.23

As the feel factor increases, harshness increases.

Feel factor of ideal fabric: (Optimized friction spun yarn i.e. Ideal fabric)

Feel Factor of Ideal fabric is evaluated as per values derived from the graph generated by 'Fabric Feel Tester' shown in Figure 2

$$Feel\ Factor\ (f) = 26.58 + 20.65 \times 1.989 - 0.436 \times 0.443 - 0.131 \times 0 + 5.064 \times 3.017 - 0.361 \times 49.156 \quad (5)$$

Feel Factor (f) = 64.9

As the feel factor decreases harshness decreases i.e. increase in softness.

Anthropometric study

Antagonistic case study: Antagonistic case study of 'Feel Factor' of 'Ideal fabric' with 'Reference fabric' will be done by using anthropometry with NX 16 3D body scanner to assist the spatial analysis of clothing appearance, body measurement and garment fit with point cloud data and concurrent engineering; According to the degree of space allowance(F) affecting somesthetic and kinesthetic sensations, garments can be classified into three types; Foundation garments(F<0), perfectly fitting garments(F=0) and loose garments(F>0) however in this case we have assumed metabolism and microclimate as constant and stationary.[13,14]

Diagnostic case study: By comparing the feel factor of both the samples percentage reduction in harshness is being calculated

Citation: Singh KVP, Chatterjee A, Das A, et al. Enhancing feel factor of designed fabric with global desirability of apparel through value engineering. *J Textile Eng Fashion Technol.* 2017;1(3):87–91. DOI: 10.15406/jteft.2017.01.00015

Copyright: ©2017 Singh et al.

i.e. Reduction in harshness = (Feel Factor of 'Reference fabric')-(Feel Factor of 'Ideal fabric')

$$(83.23-64.9) \div 83.23) \times 100 = 21.91\% \quad (6)$$

So, after structural modifications of friction spun yarn with an objective to analyze its feasibility for apparel end use, its quantified reduction in harshness is being diagnosed i.e. we are able to reduce 21.91% harshness of friction spun yarn.

Global desirability to achieve international brand

When the emphasis is on the textile and garments the desirability is known as overall desirability however with requirement engineering management as per global scenario including fashion, social desirability, climate and microclimate, it is termed as ''Global desirability'' and is denoted as D_G. To achieve global desirability; specific global scenario with social desirability is to be considered under physiological control system with an attempt to convert it to engineering control system.[15,16]

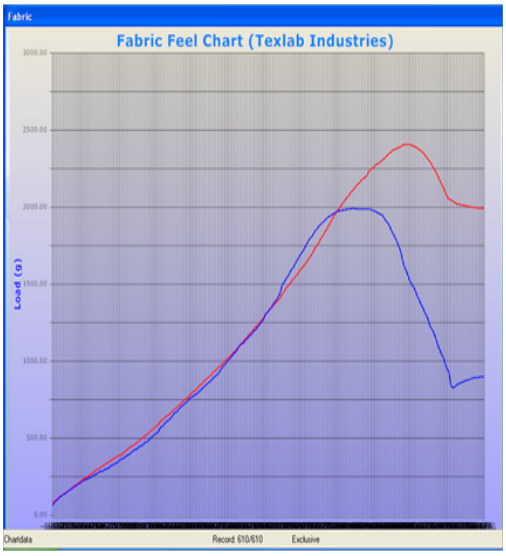

Figure 2 Feel Factor Graph of 'Ideal Fabric'.

Conclusion

To achieve global desirability from overall desirability; specific global scenario with social desirability is to be considered including fashion, climate and microclimate under physiological control system with an attempt to convert it to engineering control system. In this work, Physiological Control System (PCS) of both comfort & handle is being upgraded to Engineering Control System (ECS) by conversion of conceptual model to a mathematical model and achieving a unique resultant value in a compromise zone known as an 'Overall Desirability' either as per the functionality of frugal engineering or by concurrent engineering and engineering control system by developing a 'Feed Forward Back-Propagating Mathematical Model' with 'Artificial Neural Networks' (ANNs), also called Cloudburst Technology or Parallel Distributed Processing systems (PDPs) and connectionist system, are intended for modeling the organizational principles of the central nervous system.

Simulation of 'Ideal fabric' in terms of simultaneously re-optimized physiological comfort and handle properties, for its conversion into garment. In case of any technical problem during garment conversion after re-optimization; suitable solution to it should be provided. Optimization & quantification of the responses in good zone of FAST fabric finger prints with maximum enhanced physiological comfort; to achieve an 'Ideal fabric.

Antagonistic case study of 'Feel Factor' of 'Ideal fabric' with 'Reference fabric' is being done by using anthropometry with NX 16 3D body scanner to assist the spatial analysis of clothing appearance, body measurement and garment fit with concurrent engineering; however, in this case we have assumed metabolism and microclimate as constant and stationary.

This developed process along with 'Diagnostic& Antagonistic case study' is further being applied on a digitized 3D model of human body for amity multitasking, rapid prototyping for 3D personal avatar of apparels and medical textiles for global desirability.

Scope for future work

Though there is no thumb rule or fixed philosophy;

a. However, Kaizen philosophy for Software quality function deployment (SQFD) method may be used for amity multitasking or rapid prototyping of textile/garment.

b. Moreover, software like Rhinoceros; SAP HANA; Stat-ease; are useful for its 3 dimensional product simulation, characterization, optimization, development with Goal oriented requirements engineering (GORE) method; Knowledge acquisition in automated specification (KAOS) method, Analytical hierarchy process and concurrent engineering.

c. Feel Factor can be used as a tool to diagnose the functionality of different fabrics as per Software quality function deployment (SQFD) method with Attributed Goal oriented requirement engineering (AGORE) method.

d. Cloudburst technology for the database management or clapper's technology of Feel factor of entire fabrics using fabric feel tester and NX 16 3D body scanner (scheduled and controlled automated network system) with point cloud data.

e. Quantification of 'Global desirability'' with concurrent function deployment, value engineering and semiotic engineering with an emphasis on social desirability.

Acknowledgments

None.

Conflict of interest

Author declares there is no conflict of interest in publishing the article.

References

1. Singh KVP, Sinha SK, Sharma IC. *Effect of process variables on twist efficiency and some mechanical properties of Dref-III Yarn*. M.Tech Thesis, Department of Textile Technology, Technological Institute of Textile and Sciences, India; 2002.

2. Singh KVP, Das A, Chatterjee A. Study on physiological comfort of fabrics made up of structurally modified friction spun yarns: Part I-Vapour transmission. *Indian J Fibre Text Res.* 2010;35(1):31–37.

Copyright: ©2017 Singh et al.

3. Singh KVP, Das A, Chatterjee A. Study on physiological comfort of fabrics made up of structurally modified friction spun yarns: Part II-Liquid transmission. *Indian J Fibre Text Res*. 2010;35(2):134–138.
4. Singh KVP, Das A, Chatterjee A. *Modification of friction spun yarn for apparel end use.* PhD Thesis, Department of Textile Technology, NIT, India; 2009.
5. Michael CK Khoo. *Physiological control systems, Analysis, Simulation and Estimation*. 1st ed. Prentice-Hall of India, New Delhi; 2005. p. 1–10.
6. Douglas C Montgomery. *Design & Analysis of Experiments.* 5th ed. John Wiley and Sons, Singapore; 2004. p. 1–699.
7. Wong ASW, Li Y, Yeung PKW, et al. Neural Network Predictions of human physiological of clothing sensory comfort. *Text Res J*. 2003;73(1):31–37.
8. Singh KVP, Das A, Fanguiero R. Quantification and optimization of overall desirability to achieve value added garment. *International Conference on Emerging trends in Traditional & Technical Textiles*. 11-12th April, Department of Textile Technology, NIT, India; 2014. p. 397–399.
9. Singh KVP, Das A, Fangueiro R. *Quantification and optimization of overall desirability to achieve value added garment.* Department of Textile Engineering, University of MINHO, Portugal; 2014. p. 397–399.
10. Das A. *Objective evaluation of fabric hand characteristics using extraction principle*. Spring 2012-Empa, St Gallan, Switzerland; 2012.
11. Fan JT, Yu WM, Hunter L. *Clothing Appearance and Fit: Science and Technology*. Cambridge: Wood head Publishing Limited; 2004.
12. Lerch T. 3D Laser scanning technology: A model of multidisciplinary research. *J of Textile and Apparel Technology and Management*. 2006;34(5):1–22.
13. Das A, Alagirusamy R. *Science in clothing comfort.* England: Wood head Publishing Limited; 2010. p. 1–185.
14. Traci May-Plumlee, National Textile Center Annual Report. 2002.
15. Ghenawat P. *Redefining Global Strategy*. Harvard Business Review Press, Boston; 2007.
16. Hajer souid, Babay A, Sahnoun M. Fabric Quality Optimization by Using Desirability Function and Neural Networks. *Int J Computer Technology & Applications*. 2012;3(1):356–364.

Citation: Singh KVP, Chatterjee A, Das A, et al. Enhancing feel factor of designed fabric with global desirability of apparel through value engineering. *J Textile Eng Fashion Technol.* 2017;1(3):87–91. DOI: 10.15406/jteft.2017.01.00015