International Joint Conference on Environmental and Light Industry Technologies
18-19 November 2010, Budapest, Hungary
Óbuda University

TOOL FOR PRODUCT DESIGN: NEW METHOD OF DATA DISSEMINATION BETWEEN MATERIAL RESEARCHERS AND PRODUCT DESIGNERS

(POSTER PRESENTATION)

Zoltán KOCZOR CsC[1], Katalin NÉMETH ERDŐDI Phd[2,] Vera GÖNDÖR[3], Zoltán KERTÉSZ[4]

[1 2 3 4] Óbuda University, Department of Quality Management and Technology, Budapest (Hungary)

Abstract: *Product designers using composites first interpret the functions of a product to meet the requirements, and then, as part of the design process, select the proper materials that fit these functions. To meet the requirements, designers can only use the results of materials research and development if these results are available in a clear and understandable format. The results of materials research and development today are published in a highly scientific way, and much less attendance is dedicated to the product designers' viewpoint – even though they are the real users of these new developments. We modelled this process in our research work, and designed a new surface for the knowledge transfer, which helps structuring and providing up-to-date information and innovative knowledge in an efficient way.*

Keywords: *composite, compromise model, product design, optimization*

1 INTRODUCTION

Product designers using modern materials first interpret the functions of a product to meet the requirements, and then, as part of the design process, select the proper materials that fit these functions. To meet the requirements, designers use the results of materials research and construction if these results are available in a clear and understandable format (according to the design criteria). We modelled this process in our research work, and designed a new surface: a database for the knowledge transfer and the publication of the new results. This way the innovation can be propelled and the marketability of the materials can be more successful.

2 METHOD OF KNOWLEDGE TRANSFER

Modern materials (composits, fiber- or knitted-reinforced composites) have special characteristics designed by or measured in the research process. (Modern composites are usually made of two components, a fiber and matrix. The fiber is most often glass, but sometimes Kevlar, carbon fiber, or polyethylene. The matrix is usually a thermoset like an epoxy resin, polydicyclopentadiene, or a polyimide. The fiber is embedded in the matrix in order to make the matrix stronger. Fiber-reinforced composites have two things going for them. They are strong and light. They're often stronger than steel, but weigh much less.)

These characteristics often interact in an opposing way when fulfilling several different functions (e.g. with increasing wale density the stability of the fabric increases, but its air permeability gets worse and the costs increase). Researches have analyzed different material characteristics according to input factors, these data are available in a large scale.

By the varied input parameter many, sometimes contradictory output expectations occur. Chances are low that the material will be chosen, if the designer can see only one realization of it (a demonstrating material). Applicability of the material is much more obvious, one receives the material characteristics as the variables of input parameters.[1]

This is because material developers do not know the objective targets, that is: the final requirements of a future product, for which compromise characteristics are needed. Results of material experiments, however, can well be built into the design process if these results are properly provided. We assume that "materials research" (fabric construction) is separated from the "product construction" using this material. Proper introduction of newly developed materials can highly contribute to their marketability. The design method raises the problem: what should be the adequate content and form of archiving the results of certain material experiment, if we wish to provide value-added for the designers using these materials.

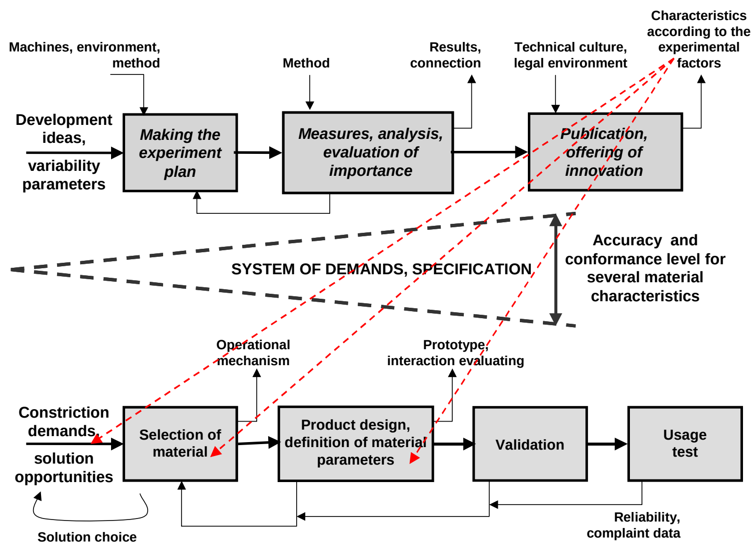

Figure 1: The connection between materials research and the design process

3 The model of information flow between the two processes

The designer defines the requirements for the whole life cycle of the product. He/she selects the materials on the basis of that, using the results of materials research. Materials researchers examine the production of the developed material by different settings, and according to our developmental ideas, they would publish the results as materials characteristics for these settings. For using the results, the organised collection of information is needed. The organization can be the task of data collectors, but even more important is that the data about each product group can be comparable in case of each producers.

By modifying the variable input characteristics (density of fibre systems, linear density of fibres, a constant parameter of the finishing can often result in controversial function fulfillment capabilities. The expectation of the designers is to receive the most suitable offer to fulfil the different, and sometimes contradictory, demands regarding materials. [3]

Defining the optimal level of input parameters is based on the compromise-optimum (compromise function).

These approaches are useful if inputs are variable and their effects on the outputs are known (usually from research experiments) or can be measured, so that the correlation analysis can give adequate information.

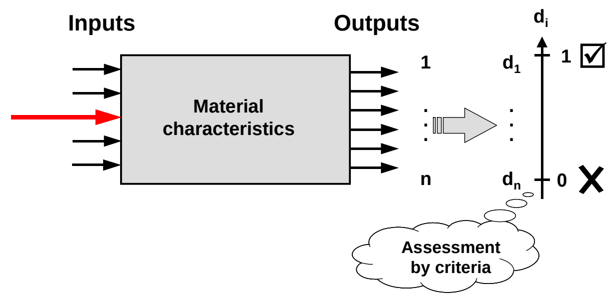

Figure 2: A theoretical model for seeking compromise solutions [4]

The result of the optimization is a material parameter setting that fulfils the demands of the designer. The researcher has most probably never tried the material for that purpose system. The main elements of the information flow between material researchers and product designers are:

- data collection about the material (sufficient structure and depth; database),
- demand interpretation of the product designers,
- finding the ideal material with ideal characteristics based on these data.

The optimization method must take into consideration the weighted format and, at the same time, the functional changes at the inputs. The optimal design parameters can be defined on the basis of these two aspects.

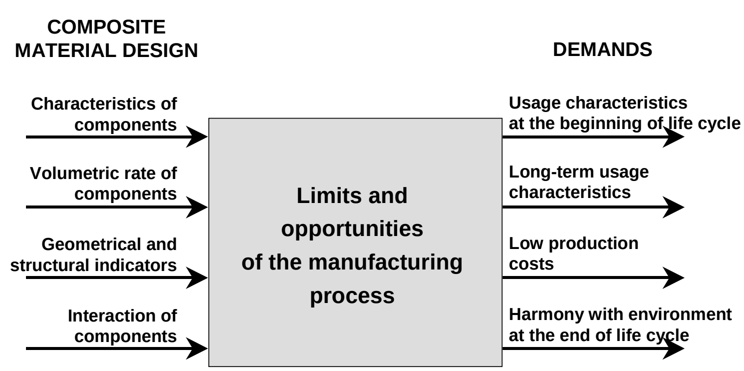

Figure 3: Case study for variable characteristics and the demands of a product

4 Application

From the several purpose functions we chose Harrington's desirability function for our case study.

The optimal level of input can be defined by finding the maximum value of the harmonic average of the desirability function (compromise function).

$$D(x) = \sqrt[n]{d_1(x) \cdot d_2(x) \cdot d_3(x) \cdots d_n(x)}$$

where

D(x) - is the function to be optimized, containing a compromise regarding n number of customer demands, di(x) - is the function expressing the fulfilment of different customer demands, according to the modified designer parameters.

From the D function calculated this way the optimal value of the design parameter can be defined, which regards contradictory customer demands.

Limit from below / above: Limit from both sides:

$$d_i = e^{-e^{-(b_0 + b_1 \cdot y_i)}} \qquad d_i = e^{-\left(\left|y_i^*\right|\right)^{n_i}}, \quad y_i^* = \frac{2y_i - (y_{max} + y_{min})}{y_{max} - y_{min}}$$

The practical usage of the method is demonstrated by the following example. A, B and C are material characteristics defined by experiments, and their relation with variable parameters (e. g. glass fibre content, linear density of glass fibre) is known. We provide the compromise analysis of these relations in accordance with the designer's demands.

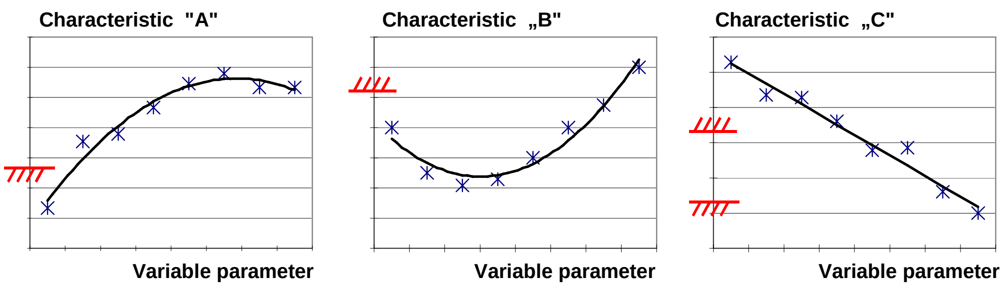

Figure 4: The results of materials research along a variable parameter

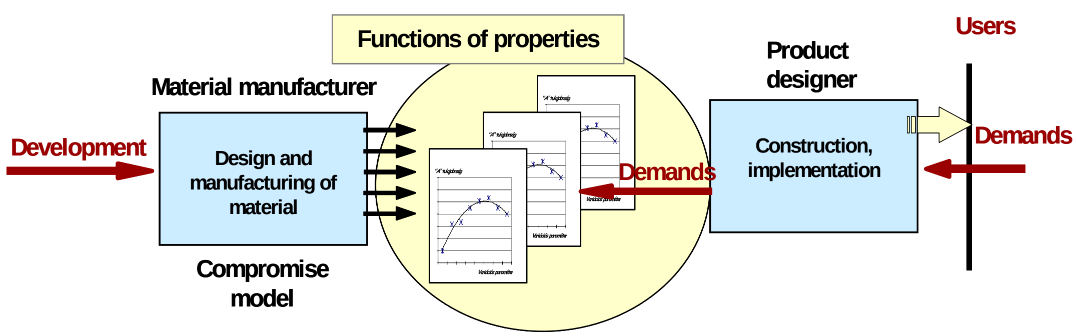

Figure 5: Information on the usability parameters of the fabric demanded by the designer [6]

From the D function calculated this way the optimal value of the design parameter can be defined, as it is shown in the following figure.

The result of the optimization is a material parameter setting that fulfils the demands of the designer. The researcher has most probably never tried the material for that purpose system.

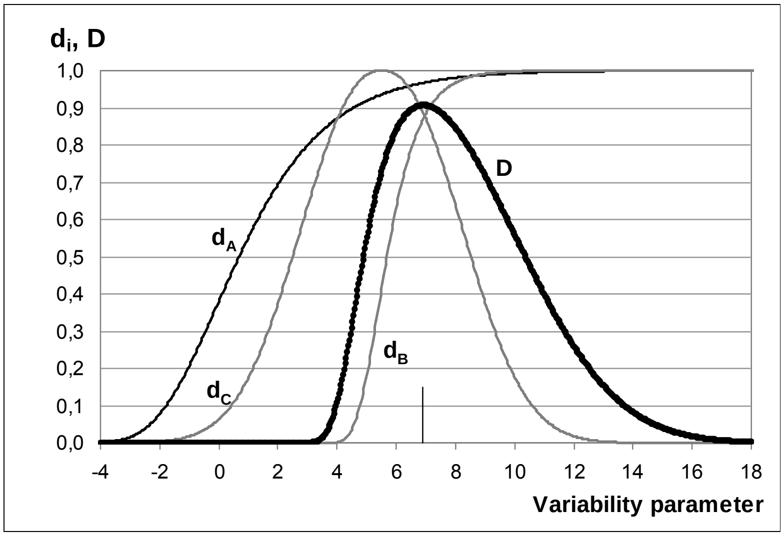

Figure 6: Compromise function calculated from d functions with the optimal value of the design parameter

The main elements of the information flow between material researchers and product designers are:

- data collection about the material (sufficient structure and depth; database),
- demand interpretation of the product designers,
- finding the ideal material with ideal characteristics based on these data.

5 Summary

The research provides a new method of data dissemination, which makes possible the communication between material researchers and product designers, and the fulfilment of demands based on compromise analysis. We chose an evaluation method that suitable our case from the compromise analyses mentioned in related literature. The different methods can be well automated in a relevant standardized communication framework.

6 References

[1] RÉTHY, Zs.; KOCZOR, Z.; ERDÉLYI, J.: *Handling contradicting requirements using desirability functions*, Acta Polytechnica Hungarica, IV (2004), pp 5-12.

[2] Derringer, G. and Suich, R.: “Simultaneous Optimization of Several Response Variables”. Journal of Quality Technology Vol. 12. No. 4. 1980, p. 214-219. (1980)

[3] NÉMETHNÉ ERDŐDI, K.; TÓTH, T.; KOKASNÉ P., L.: *Anwendung einer auf Kompromiss der Kundener-wartungen basierenden Prüfungsmethode in der Praxis der Produktplanung von Maschenwaren*, *Proceedings of IFKT Congress*, Zágráb (2003)

[4] KOCZOR, Z. (alkotószerk.): *Minőségirányítási rendszerek fejlesztése*, TÜV Rheinland interCert (2006)

[5] HARRINGTON JR., E.C.: *The desirability function*, Industrial Quality Control 21 (1965), pp. 494-498. (1965)

[6] GÖNDÖR, V.; PATAKI, M.: *Designing Textile Products for the Full Life Cycle with a Special Focus on Maintenance during Usage, New aspects in the Innovation of a Traditional Industry*, 35 Years of Higher Education and Research in The Light Industry, pp. 129-138 (2007)

[7] KERTÉSZ, Z.: *„Optimization by compromise model”* softver made by Z. Kertész (2005)

[8] KOCZOR, Z.; NÉMETHNÉ ERDŐDI, K.; GÖNDÖR, V.; KERTÉSZ, Z.: User-oriented management of the results of composite experiments, Aachen-Dresden Textil Conference (3-4. Dezember, 2008), CD, poster 71.

[9] KOCZOR, Z.; NÉMETHNÉ ERDŐDI, K., KERTÉSZ, Z., SZENCZI, P.; Information strategies for optimization of knitted composites, 45th International Congress IFKT, Ljubljana, 27-29 May 2010., pp. 204, ISBN 978-961-6045-79-7

Corresponding author:

Zoltán KOCZOR Csc
Department of Quality Management and Technology
Rejtő Sándor Faculty, Óbuda University
Bécsi u. 96/b
H-1034 Budapest
Hungary
Phone: 36 1 4532859 fax: 36 1 4532860 e-mail: koczor.zoltan@rkk.uni-obuda.hu