Title:
Customer Needs Uncertainty Quantification from the Context of CAD/RP Systems

Authors:
Ye Youzhi, yyzyale@163.com, Kitami Institute of Technology
A. M. M. Sharif Ullah, ullah@mail.kitami-it.ac.jp, Kitami Institute of Technology

Keywords:
Product development, customer needs, uncertainty, CAD, RP

DOI: 10.14733/cadconfP.2014.137-139

Introduction:

One of the key challenges of CAD/RP systems is how to make these systems more customer-needs-oriented [1-2]. A system called customer needs (CN) management system, as shown in Fig. 1, is needed to meet the challenge. The system should coordinate with CAD systems while creating the questionnaires for obtaining customer opinions. Based on the answers of the customers, the system should identify a preferred CAD model (or a set of CAD models). The system should also coordinate with the CAD/RP systems while creating the physical model(s) of the preferred model(s). Most of the times, the responses received are incomplete and difficult to comprehend [3]. Therefore, uncertainty assessment becomes a key function of CN management system [3]. At the same time, the questionnaire preparation should be meaningful from the viewpoints of both innovation and CAD/RP systems. Keeping all these in mind the authors have been conducting a set of studies for elucidating the nature of CN management system. Here, the authors describe some preliminary results obtained regarding the uncertainty assessment in CN management system.

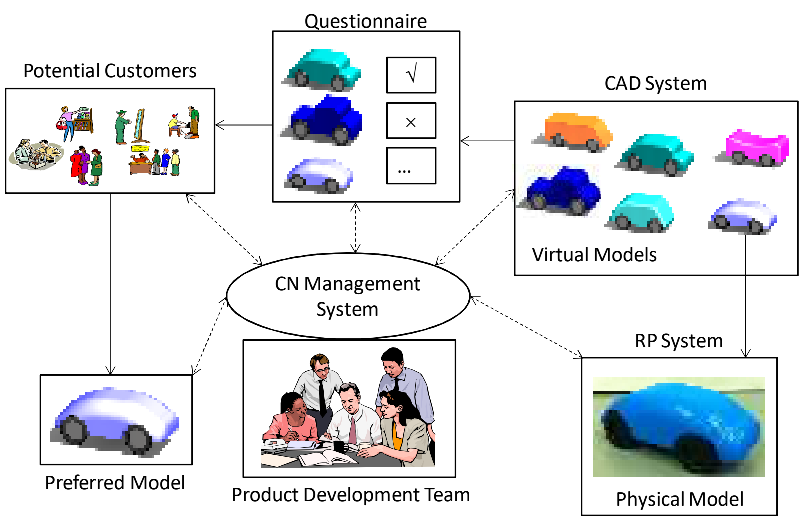
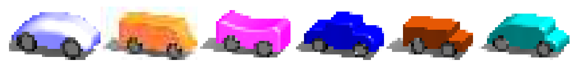
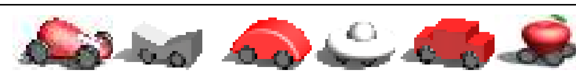


Fig. 1: Customer needs and CAD/RP system.

Main idea:

We propose a questionnaire preparation procedure based on the Theory of Inventive Problem Solving (TRIZ) [4]. The explanation is as follows. The main idea is to take advantage of 39 parameters, 40 principles, and contradiction matrix of TRIZ. For example, if we want to make a questionnaire on the theme called shape of an object, then it (i.e., shape (parameter 12 in TRIZ)) can be considered an improving or worsening feature. Using the improving-worsening relationships among shape and other 38 parameters as defined by the contradiction matrix, it is possible to identify a set of principles that are highly relevant and equally important as well, for it (shape). To control the size of the questionnaire, it is however important to consider only few principles at a time. Suppose that we consider 3 principles at a time. In this case, there are 9880 different sets of three-principle combinations. Out of these combinations, principle 14 (curvature), principle 15 (dynamics), and principle 35 (parameter changes) are equally important and highly relevant three-principle combination compared to others for shape. Therefore, one should use these principles to create a questionnaire on the theme called shape. Table 1 shows an example questionnaire. As seen from Table 1, questions 1, 2, and 3 correspond to principle 14 (curvature), principle 15 (dynamics), and principle 35 (parameter changes) of TRIZ. One may prefer different questions and illustrations to address the same set of principles, however.

Questions			Illustrations
1	Choose the shape you	Like:	 1 2 3 4 5 6
		Dislike:	
2	Car 1 performs better than Car 2.	True Not true Some true	 1 2
3	Choose the shape you	Like:	 1 2 3 4 5 6
		Dislike:	

Tab. 1: An example questionnaire.

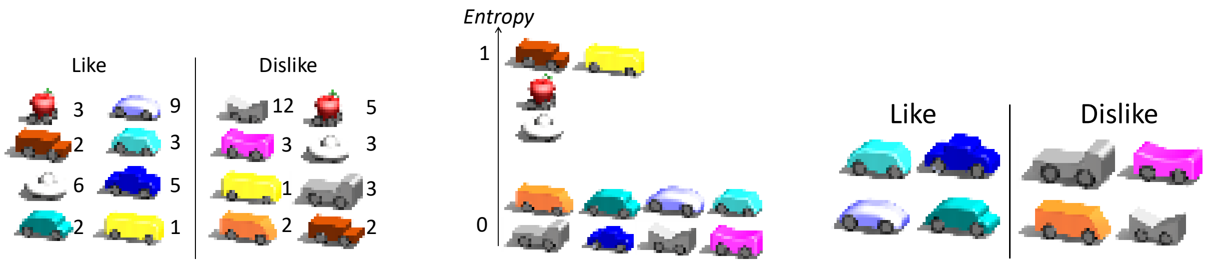
Results:

A questionnaire similar to that shown in Table 1 only for the question 1 (curvature) has been distributed among some students at Kitami Institute of Technology. The preferences of the students are shown in Fig. 2(a). The numbers next to the illustrations are the frequencies. Average information contents, or entropy [5], are calculated to quantify the uncertainty associated with the shapes. The results are shown in Fig. 2(b). The shapes having high entropies are eliminated and the zero-entropy shapes are identified for both Like and Dislike, as shown in Fig. 2(c). The shapes corresponding to Like in Fig. 3(c) are all convex in nature and the variability in the radius of curvature is mild. The shapes corresponding to Dislike in Fig. 3(c) are all concave in nature or having straight-lined segments. This means that a convex shape with mild variability in the radius of curvature is perhaps the shape that one prefers as a shape of a car. The 3D CAD model of one of the preferred shapes is used to create a physical model using a 3D printer available at Kitami Institute of Technology, as shown in Fig. 1.

Conclusion:

A systematic approach is developed to create questionnaire to obtained customer needs, deal with the uncertainty in the customer answers, and link the customer needs to CAD/RP systems. In particular, a TRIZ-based approach is presented to prepare the questionnaire. The effectiveness of the approach is demonstrated by using filed data.

Proceedings of CAD'14, Hong Kong, June 23-26, 2014, 137-139



(a) data obtained (b) entropies of shapes (c) preferred shapes

Fig. 2: Uncertainty based shape identification.

References:

[1] Piegl, L.A.: Ten challenges in computer-aided design, Computer-Aided Design, 37(4), 2005, 461–470. http://dx.doi.org/10.1016/j.cad.2004.08.012

[2] Ullah, S.: Various Challenges of the Present CAD/RP Systems, Design Engineering, 49(1), 2014, 20–24.

[3] Ullah, A.M.M.S.; Tamaki, J.: Analysis of Kano-Model-Based Customer Needs for Product Development, Systems Engineering, 14(2), 2011, 154–172.

[4] Altshuller, G.: 40 Principles: TRIZ keys to technical innovation, Technical Innovation Center, 1997.

[5] Shannon, C.E.: A mathematical theory of communication, Bell System Technical Journal, 27, 1948, 379–423.

Proceedings of CAD'14, Hong Kong, June 23-26, 2014, 137-139