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Evaluation of sub-component alternatives in product design processes

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Abstract

In this paper, a sub-component selection methodology for product design is described. The described technique incorporates the analytic hierarchy process and linear goal programming into the process of evaluating alternatives for sub-components and parts, which enables the design of products by satisfying customer, technical, and financial requirements. Also, an additional comparison technique for comparing sub-component alternatives is developed, called "scoring matrix". In this technique, pair-wise comparisons are performed within one matrix for all possible criteria to measure the strength of one-to-one relationship between sub-component alternatives. This technique is more appropriate than traditional analytical hierarchy process in addressing problems such as the comparison of sub-component alternatives. An illustrative example demonstrates the application of our methodology to the design of a computer system. © 2002 Elsevier Science Ltd. All rights reserved.

Keywords: Analytic hierarchy process; Product design; Linear programming

1. Introduction

Most products having more than one part can be represented in terms of their components and sub-components in a hierarchy (an example of a PC hierarchical representation is given in Fig. 1). The one-to-one interaction between components and sub-components in this hierarchy influences the ultimate performance of the product. When designing a product, it is common that basic *design features* (general attributes that are related to the size, shape, functionality etc. of the product) are defined first, and then components and sub-components are selected. In this case, selected design features are the key inputs to the sub-component selection process.

The first step of the design process, definition of product features, must account for both technical design requirements and customer requirements. Success in today's marketplace is dependent on the level of customer satisfaction. If the designed product enables more features, which are required by the customer, the level of satisfaction is increased. As a result, consumer preferences will be the major input to the selection of design features. Due to technical and financial constraints, it would not be possible to accommodate all the customer requirements in the final product. Hence, the product design team should be capable to cope with tradeoffs in the selection of design features, which results in the highest possible level of customer satisfaction subject to the given constraints [1]. Next step of the design process is selecting the components and sub-components. Since the product design technique requires initial definition of product features, the sub-component selection will be based on these pre-defined features.

There are cases when a selected best input[1] (considered individually) might not lead to the best final product performance in combination with other selected inputs. Typically, inputs that are supplied from outside sources are not exclusively produced for the particular product being designed but rather for more generic purposes. Such inputs can also be supplied from more than one source. When the inputs of a product are supplied from a number of different sources, there is a high probability of quality loss in the final product. To get around this disadvantage, we have developed a bottom-up methodology for selecting the optimal combination of sub-components from multiple

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[1] Either a candidate part raw material or a sub-component alternative.

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