Using product family evaluation graphs in product family design

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Abstract

Product family design and platform-based product development have garnered much attention. They have been used to provide nearly customised products to satisfy individual customer requirements and simultaneously achieve economies of scale during production. The inherent challenge in product family design is to balance the trade-off between product commonality (how well the components and functions can be shared across a product family) and variety (the range of different products in a product family). Quantifying this trade-off at the product family planning stage in a way that supports the engineering design process has yet to be accomplished. In this paper, we introduce a graphical evaluation method, the product family evaluation graph (PFEG), that allows designers to choose the 'best' product family design option among sets of alternatives based on their performance with respect to an ideal commonality/variety trade-off determined by a company's particular competitive focus, and guides designers towards a more desirable trade-off between commonality and variety in an existing product family. Two necessary supporting pieces for developing the PFEG are also proposed. One piece is the
development of commonality and variety indices to quantitatively capture the degree of commonality and variety in a product family and its functions and components. We introduce two sets of commonality and variety indices—the CDI (commonality versus diversity index) for commonality (CDIC) and variety (CDIV), and the CMC (comprehensive metric for commonality) for commonality (CMCC) and variety (CMCV)—to achieve this. The other supporting piece is the development of a quantitative representation of the ideal trade-off between commonality and variety in a product family, known as the commonality/variety trade-off angle $\alpha$, based on the elements that characterise a company's competitive focus and their industry-wide competitors. A linear regression model is used to link the qualitative competitive focus to a quantitative engineering perspective, and then to estimate the ideal trade-off angle. The commonality/variety trade-off angle can then be applied to the PFEG to help designers evaluate a product family or compare product family design alternatives. Most importantly, the PFEG is not just the graph of the two sets of indices; it is the representation of the commonality/variety trade-off relative to the desired competitive focus. Four families of power tools are used to illustrate how the computation of such indices supports product family design evaluation in the PFEG. In this paper, we only use the CDI in the example application, but the CMC can be computed using the same approach.

**Keywords:** product family; product platform; commonality index; variety index; product family evaluation