Managing Modularity and Commonality in Product and Process Development

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Managing modularity and commonality throughout product and process development has been well recognized as crucial to producing a large variety of products while maintaining low costs and quick response to the market. In recent years we have seen growing consensus and an increasing number of publications related to modularity and commonality, as well as many endeavors in industrial applications. This special issue is dedicated to reporting recent advances in modularity and commonality research. Of particular interest is a comprehensive view of modularity and commonality, encompassing design, production, logistics, and organizational aspects.

Based on thorough and strict peer reviews, a total of 10 papers were selected for publication from 48 submissions. These papers represent a snapshot of cutting-edge research and aim to disseminate recent developments in the field of managing modularity and commonality. The paper by Fixson, ‘Modularity and Commonality Research: Past Developments and Future Opportunities’, provides a comprehensive literature review. It substantially extends this editorial discussion on the status quo of approaches and techniques for managing modularity and commonality in product and process development. In the paper, each of the cited references is analyzed along the dimensions’ subject, effect, and research method. The subject of study involves the product, process, organization, and innovation, whereas the set of references indicate that a strong preference is geared towards the product. Also studied is a broad range of effects, with cost issues receiving the most attention. The survey reveals that a variety of research methods have been applied to the study of modularity and commonality, but the distribution of research methods differs substantially in modularity and commonality research. One important avenue for future research lies in studies that incorporate multiple effects of modularity and commonality on various players along the supply chain, that combine multiple research methods, and that follow systems over time.

Höltä-Otto and de Weck, in their paper, ‘Degree of Modularity in Engineering Systems and Products with Technical and Business Constraints’, observe that modularity has many benefits, from cost savings due to increased commonality to efficient realization of a higher variety of products. In regard to full modularity, they show how engineering systems and products, whose design is heavily influenced by technical constraints, tend to exhibit rather integral architectures. On the basis of a binary design structure matrix representation of a system or product, they propose a metric of nonzero fraction capturing the sparsity of the interrelationships between components, along with a singular value modularity index indicating the degree of internal coupling. Empirical evidence is presented suggesting that the lightweight variant of the same product tends to be more integral, contributing to higher mass efficiency. Comparative studies of sparsity and modularity reveal that some products are inherently less modular than others due to technological factors.

The paper by Thevenot, Simpson, Alizon, and Shooter, ‘An Index-Based Method to Manage the Tradeoff between Diversity and Commonality during Product Family Design’, emphasizes the commonality issue in product family design. This paper examines existing commonality indices with respect to the tradeoff between commonality and diversity inherent in product families. A design for commonality and diversity method is developed based on two new commonality indices: the commonality diversity index and the comprehensive metric for commonality. An example application involving a family of single-use cameras is reported, demonstrating decision making at both the functional and component levels during product family design.

With focus on design reuse, Meehan, Duffy, and Whitfield, in their paper, ‘Supporting “Design for