Center for e-Design

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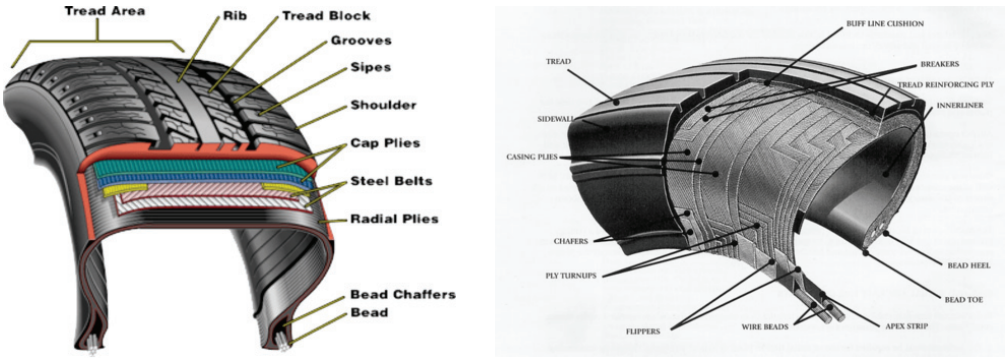
Iowa State University, Janis Terpenny, Director, 515.294.1287, terpenny@iastate.edu
Iowa State University, Judy Vance, 515.294.9474, jmvance@iastate.edu
Virginia Tech, Richard Goff, 540.231.9537, richgoff@vt.edu
Virginia Tech, Nicholar Polys, 540.231.0968, npolys@vt.edu
University of Massachusetts, Sundar Krishnamurty, 413.545.0297, skrishna@ecs.umass.edu
University at Buffalo, Kemper Lewis, 716.645.2685, kelewis@buffalo.edu
University at Buffalo, Ken English, 716.645.2683, kwe@buffalo.edu
Brigham Young University, Gregory Jensen, 801.422.6540, cjensen@byu.edu
Brigham Young University, Walter (Ed) Red, 801.422.5539, ered@byu.edu
Wayne State University, Kyoung-Yun Kim, 313.577.4396, kykim@eng.wayne.edu
Wayne State University, Darin Ellis, 313.577.3040, rdellis@wayne.edu
Oregon State University, Irem Tumer, 541.737.6627, irem.tumer@oregonstate.edu
Oregon State University, Rob Stone, 541.737.3638, rob.stone@oregonstate.edu

Center website: http://www.centerforedesign.org

Complexity Management Methodology: A Tool for Developing Product Families

In today's market, in order to have a substantial advantage over competitors, companies must be able to respond quickly and efficiently to the rapidly changing customer demand. While increasing variety and choices pleases customers and supports market share increase, the costs of doing so can be significant.



A tire is a very complex product, with dozens of components and hundreds of raw materials.

The proliferation of products entails managing a variety of components, functional requirements, quality standards, and production processes, all of which are considered main sources of product complexity. Variety is just one commonly known cause of product complexity. Other sources related to functionality, structure, and production of products have been identified as elements that further cause product complexity. Many have attempted to classify and categorize product complexity (PC) on an application-specific basis, yet unfortunately, to a large degree PC still remains a theoretical concept with no unified and commonly validated approach or measurement. This makes it difficult for companies to understand and manage PC.

In this collaborative Complexity Management Methodology (CMM) researchers at the Center for e-Design tackle the challenge of managing variety and product complexity. The CMM collaboration led to a comprehensive quantitative methodology to support product family development decisions that consider sources and impacts of complexity. Four main dimensions of PC within the context of a generalized definition were identified. Product complexity indicators suitable in product design, development, and production were then derived. By establishing measurements for identified PC indicators and using clustering techniques, a complexity evaluation approach for product family designs was developed. The breakthrough evaluation approach also supports the identification of Critical Components that are main sources of and contributors to PC within product families.

The approach also identifies cost saving redesign opportunities through complexity management by standardizing identified Critical Components. It has been tested on several tire product lines. Tires are a product that consists of hundreds of raw material and tens of components. They go through several assembly and integrative production processes. This makes tires good examples to study and understand complex products and to support the generalization analyses of the developed approach.

Research has documented many disadvantages associated with product complexity. A complex product typically results in complicated product design and development processes that lead to inefficiencies at the product realization stage. Manufacturing of complex products entails less efficiency, higher set-up costs, higher quality control requirements, more complex product scheduling, and difficulty in balancing assembly lines. All of this will cause various managerial and logistical problems in supply chain systems. In other words, PC can cause operational inefficiencies as well as increases in direct and indirect costs throughout the different stages of products lifecycles.

> **Economic Impact:** It is reasonable to conclude from available research that the new CMM method and tool will have significant favorable economic and efficiency benefits. Outcomes of CMM application on selected tire product lines further highlights these benefits. Results identified significant complexity reduction and cost saving re-design opportunities. For example, production cost reduction opportunities for one of the analyzed product families and related components ranged from 10% to 40%, or approximately $230,000 in savings annually for that product family. There are cases in the literature that report impacts and costs of product complexity affecting manufacturers throughout the US and globally. For example, one company identified over $4 million in cost savings through managing PC. Another study estimated an additional $600 million required in production to manage complex products/parts. With ever-increasing pressures to provide variety, quality, and high value at reduced costs, the need for solutions and strategies to minimize PC is dire.

For more information, contact Janis Terpenny, 515.294.1287, terpenny@iastate.edu or Nihal Orfi, 540.808.9173, norfi@vt.edu.