Proceedings of the 2010 Industrial Engineering Research Conference
A. Johnson and J. Miller, eds.

Integrating Preference and Possibility to Manage Uncertainty in Lean Design

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Abstract

Efforts to emulate the Toyota Design System in a western version called Lean Design are focused on the manipulation of uncertainty to search for feasible alternatives within the sets of possible solutions during the design process applying tools such as the Labeled Interval Calculus (LIC) of the Set Based Concurrent Engineering (SBCE) approach. To select a preferred solution from the feasible sets of alternatives, the Method of Imprecision (MI) based on fuzzy sets has been applied. Approaching methods to integrate the LIC and MI has been proposed, such as the Labeled Fuzzy Sets and Operators to Perform Mapping with Imprecise Quantities. This research analyzes and compares both approaching methods to propose a strategy of set-based concurrent engineering for lean design.

Abstract
Lean design, uncertainty, preference, fuzzy operator, set-based concurrent engineering

1. Introduction

Two situations typically arise during the early stages of product development: a) the consideration and manipulation of preference about requirements on parameters and variables to be met, especially those where every single value of a range has to be met; b) the manipulation of imprecision on design and performance parameters due to lack of precise knowledge about them and their final concept and configuration.

The challenge is more evident when mapping the multiple and interactive design and performance parameters that engineers must evaluate in order to move towards the more desirable designs.

An approach to perform this is applied at Toyota, where designers think about sets of design alternative rather than pursuing one alternative iteratively. They gradually narrow the sets until they come to a final solution [1]. This Toyota Design System, called in the west as Lean Design, results in shorter time to market, higher quality and reliability at competitive costs and satisfying customers needs [2].

Considering that Toyota´s approach is not well defined or documented [1], this research intends to make a contribution that will enable a practical application of Set-Based Concurrent Engineering. Through the definition of operators and mathematics future Lean Design will allow performing calculations, simulations and explore a larger number of alternatives in order to work on a set-based manner, instead of the traditional point based approach. .

This paper presents two developed methods to deal with situations a) and b), analyzing strengths and weaknesses in order to find robust operators to be added as foundation for a strategy of set-based concurrent engineering for lean design.