AN INTERACTIVE MODELING ENVIRONMENT FOR AUTOMOTIVE EXTERIOR DESIGN

By

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ABSTRACT

Multidisciplinary design activities require negotiation among different disciplines including engineering, aesthetics and business. In the design of complex artifacts, negotiation exists throughout the conceptual, physical and digital design phases, and it often introduces iterative modification of the design geometry to balance objectives from the different disciplines. In current automotive industry practice, iteration is reduced by using a sequential design procedure: the exterior design is first created with styling objectives constrained by basic engineering boundaries; the model is then modified to meet engineering objectives more closely but only to the extent that the original styling character does not change. This procedure provides good solutions in reasonable time but better solutions may be explored if iterations could take place efficiently in early product development stages.

This kind of iterations can take place within a system optimization framework, such as Analytical Target Cascading, developed to coordinate subsystem design solutions into an overall solution. It is worth examining whether such a framework can be applied to the automotive exterior design problem, taking shape preferences into account. This can be achieved if a quantitative representation of shape preference is available, which requires defining the relationship between preference and the mathematical form of automotive exterior design.

As a first step in developing this relationship, this thesis presents a three-dimensional surface parametric modeling environment for representing basic exterior vehicle shapes. Google SketchUp is used to develop the representation because it allows rapid modeling through coding. Parametric representation allows shapes to be modified quickly and inexpensively based on user preference input. This representation is then used in conjunction with an Interactive Genetic Algorithm to demonstrate its value in eliciting user shape preferences. The developed interacting modeling environment is a building block towards a system optimization capability that integrates engineering attributes with customer shape preferences in automotive product development.

CHAPTER 1
Introduction

1.1 Motivation

Multidisciplinary design activities require negotiation among different disciplines including engineering, aesthetics and business. In the design of complex artifacts such as automotive exteriors, such negotiation exists throughout the conceptual, physical and digital design phases, and it often introduces iterative modification of the design geometry to balance objectives from the different disciplines. In current automotive industry practice, iteration is reduced by using a sequential design procedure: the exterior design is first created with styling objectives constrained by basic engineering boundaries; the model is then modified to meet engineering objectives more closely but only to the extent that the original styling character does not change [1]. This procedure provides good solutions in reasonable time but better solutions may be explored if iterations could take place efficiently in early product development stages.

This kind of iterations can take place within a system optimization framework, such as Analytical Target Cascading (ATC) [2], which is developed to coordinate subsystem design solutions into an overall solution. This technique has shown its value in linking marketing and engineering design decisions [4]. Therefore, it is worth studying if the same framework can be extended to the automotive exterior design problem, taking shape preferences into account. Here we use the general term "shape" instead of "aesthetic" because it is un necessary to strictly isolate aesthetic preference from other type of preferences such as "luxury" in this early stage of exploration.

Such extension can be achieved if a quantitative representation of shape preference is available. This requires defining the relationship between preference and the mathematical form of automotive exterior design. Some prevailing survey techniques correlating preference and design include Self Explicated Preference Ranking [9], Pairwise Comparison [11], Conjoint Analysis [12] and Kansei Engineering [6]. A