

Complex System Optimization: A Review of Analytical Target Cascading, Collaborative Optimization, and Other Formulations

by

James T. Allison

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Master's Thesis Committee:

Professor Panos Papalambros,
Dr. Michael Kokkolaras

ABSTRACT

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Chair: Panos Papalambros

Design of some modern products requires special techniques to manage complexity. Various industries have specific needs in this regard, and several methodologies for *complex system optimization* have been developed in response. A critical review of these sometimes diverse approaches offers the design community enhanced resources for mapping approaches to present design problems. This thesis covers several selected single-level and multi-level methodologies for complex system optimization. Two novel and easily replicated engineering design example problems are introduced, facilitating an illustrative implementation of the said methodologies, and offering a venue for clear exposition of their distinctions.

Emphasis is given to two particular multi-level methodologies: *Analytical Target Cascading* (ATC), and *Collaborative Optimization* (CO). ATC was developed as a product development tool, and has ties to the automotive industry. CO is a Multidisciplinary Design Optimization formulation, evolved from established methods for Multidisciplinary Analysis. CO sees regular use in aerospace analysis and design

problems. The origin of each methodology colors its nature. Although ATC and CO emerged from different sources, their mathematical formulations appear to be similar. These formulations are investigated in detail, and it is shown that each has a unique solution process. Terminology for each formulation is clearly defined and compared.

This review is an important contribution toward better understanding of complex system optimization methodologies. This in turn helps advance industry acceptance and utilization of these methodologies.

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