OPTIMAL MULTILEVEL SYSTEM DESIGN UNDER UNCERTAINTY

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Optimal design of complex engineering systems can be accomplished only by decomposition. The system is partitioned into subsystems, the subsystems are partitioned into components, the components into parts, and so on. This decomposition process results in a multilevel hierarchy of elements that comprise the system. Deterministic optimization approaches assume that complete information of the problem is available, and that design decisions can be implemented. These assumptions imply that optimization results are as good (and therefore useful) as the design and simulation/analysis models used to obtain them, and that they are meaningful only if they can be realized exactly. In reality, these assumptions do not hold. We are rarely in a position to represent a physical system without using approximations, have complete knowledge on all of its parameters, or control the design variables with high accuracy. It is therefore necessary to treat all quantities associated with uncertainty as stochastic. We consider hierarchically decomposed multilevel systems, and we extend deterministic methodologies for optimal and consistent design of such systems to account for the presence of uncertainties. We demonstrate our methodology by means of a simple yet illustrative optimal bi-level system design example. Our objective is to introduce the concept of uncertainty, model its propagation through the multilevel hierarchy, set the ground for the application of "single-element" optimization under uncertainty methods in multilevel systems, and identify needs for future research.