

From Functional Modeling to Optimization: Risk and Safety in the Design Process for Large-Scale Systems

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Abstract

In order to more effectively design large, complex systems, risk must be accounted for throughout the design process. A systematic way to account for risk is by using system model simulation. During the conceptual design phase, functional models can be drawn to help the engineer design their system's functional architecture. This dissertation describes new functional modeling software to quickly assign nominal and failure behavior to functions in order to experiment over failure scenarios. An algorithm is then presented to identify, semi-autonomously with input from the engineer, unforeseen hazards among the multitude of simulated failure scenarios. This will help guide engineers toward less risky functional architectures. Once designs are more developed, they can be subjected to optimization in order to minimize cost and maximize performance. Risk minimization and management are necessary at this stage as well. An improved optimization under uncertainty method is presented in order to efficiently simultaneously allow the inclusion of a robust objective and probabilistic constraints.

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