

Design Margins as a Strategy for Early Stage Design: A Design Theory Approach

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Abstract: It is well reported in literature and industrial case studies that complex industrial systems suffer from certification, in-service reliability and life cycle issues due to design defects. Such deficiencies are often traced to poor design decisions early in design. This PhD dissertation proposes a novel approach of addressing them by using design margins as epistemic uncertainty buffers for early design of complex industrial systems. To achieve the research objective, a corporate design process in a typical aerospace corporation was studied, and the impact of design decisions was determined. It was found that design decisions during conceptual design had a significant impact on later observed design defects. Thereafter, uncertainties along with early stage design, safety factors and margins were analyzed for clarity in the relation to design processes. Once clarified, design margins were demonstrated as an early stage design strategy incorporating a mix of multidisciplinary design optimization and prototyping. The result of this strategy is that epistemic uncertainties can be tested and made known early, resulting in better early stage design decisions. The utilization of design margins as a strategy is facilitated by the use of an in-house design concept exploration tool known as ITEPS. Therefore, this PhD research has demonstrated we can use design margins as a strategy to improve the early stage design process using a combination of computation, simulation and low fidelity prototyping. Foreknowledge of design defects become more apparent early on and thus, improve the quality of early design decisions.

Speaker Bio:

Prior to starting his graduate studies and grinding into the depths of design research, James has been working in the aerospace industry. Starting his career as a crew chief, he has gotten his hands dirty to keep aircraft flying. Progressing from grease and dirt, he has also worked in engineering roles in operations engineer, product support and airworthiness certification. At present, he is working on how to make the process of aircraft design safer, less resource intensive and more radical from systems engineering point of view. He is currently under the Industrial Partnership Programme with ST Aerospace Ltd and under supervision of Professor Kristin L Wood.