Use of Monte Carlo method to estimate subsystem redesign risk for complex products: aircraft redesign case study

ABSTRACT

Purpose – The purpose of this paper is to achieve the capability of redesigning complex products system with enhanced efficiency and effectiveness. Design/methodology/approach – It is noted that, by changing one subsystem in a complex product design architecture, the change effects can be propagated to other subsystems through their interrelationships. This condition has to be taken into account when deciding on which subsystems to be modified in the redesign plan because the subsequent effects might be too risky for the development process. Estimating redesign risk for complex product architectures is not an easy task, thus designers often need a decision-making aid to efficiently select the best "change initiating" subsystems. This can be done by providing the designers with a ranking of subsystems based on their estimated redesign risk. Moreover, this decision-making process is taking place during early redesign stages whereby the uncertainties related to the actual level and type of changes to be made on the subsystems are high. Because of this, a stochastic approach is taken to be more appropriate in deriving the redesign risk estimates. This leads to the proposed application of the Monte Carlo method to estimate the subsystem redesign risk for complex products, as demonstrated through an example case study of aircraft redesign. Findings – This use of the Monte Carlo method helps to distinguish the level of risks associated with each subsystem in the complex product design architecture, which is helpful for designers while making decisions on which subsystems to be changed for the redesign task at hand. Practical implications – This technique can be applied to assist designers in making decisions during the early stages of the redesign process under high design uncertainties. Originality/value – The work presents a new alternative method to estimate the redesign risks of subsystems in complex products that can improve the effectiveness of the designer's decision-making process in the early redesign stages. While many other available change methods tend to ignore the uncertainty associated with the decision-making process, the method presented here directly takes into account the stochastic nature of the process.

Keyword: Change propagation; Aircraft redesign; Change effects; Redesign risk; Subsystem ranking