

TO REDUCE OR TO EXTEND A COMPLEX ENGINEERING SYSTEM DESIGN LIFETIME?

What is at Stake, and How to Resolve the Dilemma

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Abstract

The attitude towards systems design lifetime has often been ambiguous, and at times uninformed. Although the issue has received almost no attention in the technical literature, there have been a few qualitative arguments fraught with subjectivity for or against extending a system design lifetime. In this paper, we explore the engineering and economic issues at stake for reducing or extending a complex system's design lifetime using spacecraft as example, from both an operator and a manufacturer's perspective. We address the question of whether there is an optimal design lifetime for complex engineering systems in general, and spacecraft in particular, and what it takes to answer this question: this includes a mindset change in thinking about system architecture in general, as well as quantitative analyses of both dynamics and volatility of the market the system is serving in the case of a commercial venture, and the obsolescence of the system's technology base. Preliminary results indicate that optimal design lifetimes do exist that maximize a system's financial/value metric, therefore that even if it is technically feasible to field a system or launch spacecraft with longer lifetime, it is not necessarily in the best interest of an operator, and definitely not in the interest of the manufacturer, to do so. Preliminary results also show that the design lifetime is, in the case of a spacecraft, a key requirement in sizing various subsystems—and consequently has a significant impact on the overall cost of the spacecraft—but also, at the level of the entire space industry value chain, i.e., the spacecraft manufacturers, launch industry and the operators, the design lifetime is a powerful lever that can significantly impact the whole industry's performance, financial health, and employment. Overall, we show that the specification or selection of a complex engineering system's lifetime begs careful consideration and requires much more attention than what it has received so far in the literature as its impact will ripple throughout an entire industry value chain.

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