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Creative system design methodologies: the case of complex technical systems

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Abstract

This paper explores the impact creative engineering design methodologies will have on the development of conceptual system designs for technically complex systems. To meet the requirements of the many innovations of products and their technology, these technically complex systems must be innovative to make effective use of them. This report generates a value-chain that shows the link between creativity techniques in system design and value to an industry. With the Creativity, Innovation, Competitiveness (CIC) model and the Carayannis, Gonzales and Wetter Innovation framework (Handbook of Innovation Chapters, Elsevier, October 2003), the authors will explore the impact of creative conceptual designs for complex technical systems at the micro, meso, and macro levels of society (Fig. 1). Thus, we will propose a creative engineering design method to increase the innovativeness of these technically complex systems. Furthermore, this creative design methodology is tailored to work with the processes, content, context, and provide the desired impact.

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1. Introduction

Designing complex technical systems is critical to the sustaining of a healthy economy. As many economists discovered some 50 years ago, technological innovation is a powerful force in economic progress. A major part of the economy is the many technology-based systems that use and support the products generated by federal government and commercial industries. Take for example, the extensive communication system used to support wireless telephones or the broad computer networks to support the web-based services and commerce. Without innovation, our existing complex technical systems will not fully support or leverage the accelerating pace of innovative products, processes, services, and technologies entering the market. To meet the growing requirements resulting from innovations found in new products and their technologies, systems engineers must develop innovative complex technical systems that make effective use of these new products as well as drive the innovation for future products.

To further support the need for creativity in the design of complex technical system, we will quote Lobert and Dologite's (1994) three reasons that warrant the use of creativity by system designers. These are as follows:

Technology is evolving almost on a daily basis and we can continually look for new ways to utilize resources

Most simple systems have already been developed and implemented and the challenging ones are still ahead

Many information systems are old, not meeting existing demand, and will soon become obsolete.

With the effective use of creativity techniques, system designers can introduce new successful systems that increase value to the users, develop redesigns of decaying or obsolete systems, and extend the life old and decaying systems by creatively using existing systems (Lobert and Dologite, 1994). These reasons will have a significant impact on the larger economy. The larger question is how we integrate creativity into the system design process.

One proposal to increase the innovativeness of these complex technical systems is to integrate more creativity

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into the system design process (Couger, 1990). Without creativity involved in the system design process, designers are likely to converge and sub-optimize solutions to the design problem (Couger, 1990). This may lead to simply meeting the user’s request, yet it may not provide the full function and capability to add value to the user; thus, increasing the innovation. The proposition is that system designers can use creativity techniques at key points in the system design process to increase system innovation (Couger, 1990). In this article, we will show how we derived a creative system design methodology by using an innovation frame, innovation models, and creativity techniques.

2. The objectives for a creative system design method

To first understand the larger problem, we will begin by exploring the work of Carayannis et al. (2003) and Carayannis and Gonzalez (2003). First, to understand the relationship between creativity and economic impact, we describe the innovation framework model (Carayannis et al., 2003). If you were to review the current literature, it refers to innovation as sustaining and discontinuous, revolutionary and evolutionary, and non-disruptive and disruptive forms of innovation. In addition, there is incremental, modular, radical, and architectural innovation. Carayannis et al. (2003) based the framework on the premise that innovations are part of a social system. The framework classifies

the variety of innovation types based on their relationship to four dimensions that they tie to this social system. These dimensions are process, content, context, and impact. Evolutionary and revolutionary innovations are a statement of the process used to develop an innovation. The forms, incremental, modular, radical, and architectural, are statement of the content of an innovation. Continuous and discontinuous innovations are a statement of the context or environment surrounding an innovation. Finally, disruptive and non-disruptive innovations are a statement to the impact an innovation has on a socio-technological landscape (Figs. 1, 2 and 3) and we consider the following quote significant:

Not all innovations are discontinuous and not all discontinuous innovations prove to be disruptive and not all disruptive innovations are discontinuous. This is determined by the scope, timing, and impact of the innovation under consideration and there are different strategies to deal with the challenges and opportunities arising from planned or serendipitous technological discontinuities and disruptions (Carayannis et al., 2003).

As for the design methodology for complex technical systems, it should be effective at the processes, content, context, and impact dimensions. First, an effective creative design methodology for complex technical systems will use revolutionary-style innovation process (Table 1).

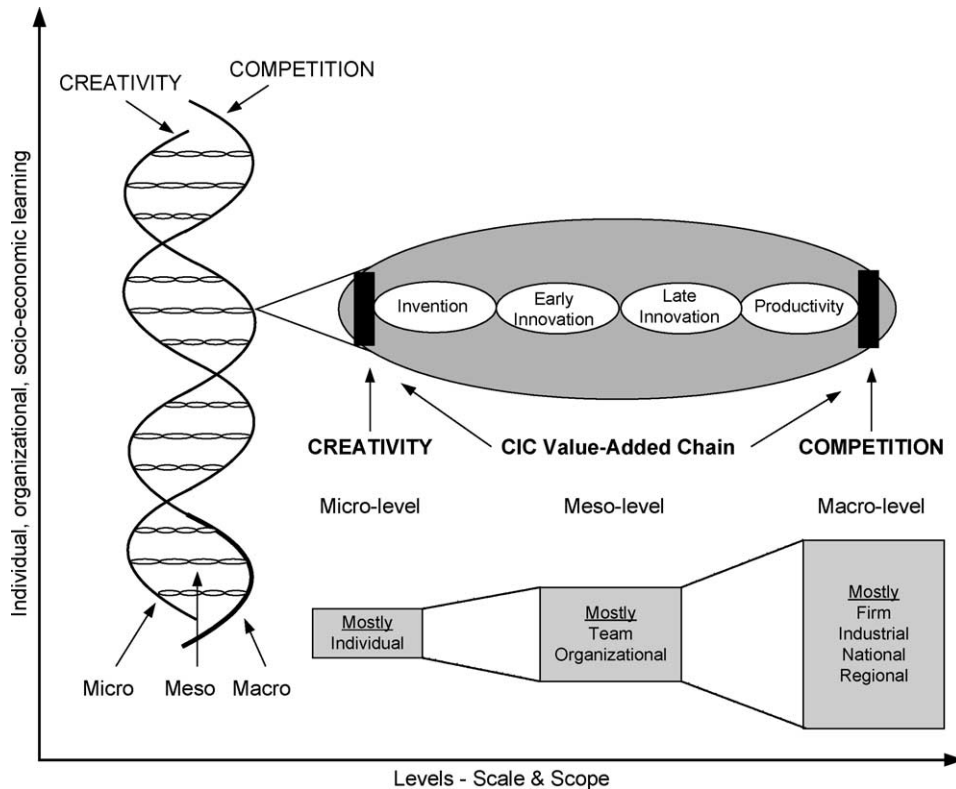


Fig. 1. Adapted from Carayannis and Gonzalez (2003).

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