Chapter 13
PDD Trends: Research Driven by Laws of Product Evolution

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ABSTRACT

One of the most important research issues in the product design and development field is concerned with the emergence of organizational undesirable behaviors caused by product architecture innovations. These undesired effects occur when the architectural innovation requires, for example, the training and acquisition of new skills. If those are not accomplished in the right time the product quality will deteriorate, affecting negatively the organization. For this reason research is being developed to predict and mitigate the undesirable behaviors, but this is not an easy task, because it requires the creation of an evolutionary process applicable on complex and large engineering systems, such as the product design and development organization. The objective of this chapter is to propose a framework for the development of this evolutionary process.

INTRODUCTION

The view of product design and development changed in the past few years. Researchers started to migrate to a system’s view of the product design and development process that integrates the domains of product architecture, development process and development organization, and began to study the interactions within and across them to understand how they affect each other. However, this is a static view of the problem, because there are architectural changes that have a cumulative effect in the future that can be harmful to the product development organization. For example, organizational adaptation to technical change requires training and acquisition of new skills, which interfere with the product quality if not accomplished on time.

These cumulative effects or emergent behaviors are a consequence of the system evolution.
Because of this researchers are looking for an evolutionary process to predict and to mitigate the undesirable behaviors. Even if it seems, this is not an easy task, because the product development systems are large and complex, particularly in the cases where dispersed teams are used, i.e. Global Product Development (GPD). The absence of a starting point to develop the evolutionary process also increases the problem difficulty. Some researchers may argue that it can be developed from a theory of heuristics or algorithms that must be found and described (Whitney, 2004b).

The work explained in this chapter was done around this research clue. The research questions were: where we can find a theory of heuristics to apply on the engineering systems? What kind of similarities can be found between the two conceptual structures (heuristics and engineering systems)? Is it possible to describe the architectural evolutionary process? Can it be tested? What are the expected impacts on the engineering systems research?

During the research, a theory of heuristics was found that can be adapted to develop and test an evolutionary process for large and complex engineering systems. The finding of an evolutionary process that takes into account the relations within and across the three domains of product design and development provides a direction to create a research framework.

If the test of this framework is successful, it will bring benefits to the academic and technical communities in terms of research, teaching and application of new methodologies of product development, reorganization management, innovation management, product and organization innovation, and enhanced creativity. All of these benefits are given in a system’s view of PDD – where possible – to study the influence of product architecture on the development organization.

BACKGROUND

Architectural Evolution in Product Design and Development

The system’s view on product design and development led the researchers to a study of the interactions within and across the product architecture, development organization and development process domains. The research procedure used consisted on (Sosa, 2003; Eppinger, 2002; Gulati, 1996): (1) capturing the product architecture by recording the design interfaces (see Table 1 for a detailed explanation of the concepts, (2) capturing the development organization by recording the team interactions and (3) comparing design interfaces with the team interactions. All the recordings were translated into matrices adapted from the design structure matrices (DSM’s). This procedure was applied on a one-to-one mapping basis, among the product development domains. Usually this kind of structure is found in large and complex systems.

The data was then analyzed in order to answer the following research questions: “does the organization properly execute the development process?”, “Is the development process effectively implementing the product architecture?”, “Are the architecture interactions driving the organizational communications?” (Eppinger, 2002, p. 2). Some important conclusions were found, and presented as hypotheses for further research work:

- Domain evolution: The density of the interactions within each domain varies with the domain maturity and the pattern of those interactions change over time;
- Co-evolution: The interaction patterns in the three domains are coupled and co-evolve together.
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