Chapter 18
Optimal Ordering of Activities of New Product Development Projects with Time and Cost Considerations

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ABSTRACT

This chapter presents a Discrete Multi-objective Particle Swarm Optimization (MOPSO) algorithm that determines the optimal order of activities execution within a design project that minimizes project total iterative time and cost. Numerical Design Structure Matrix (DSM) was used to model project activities' execution order along with their interactions providing a base for calculating the objective functions. Algorithm performance was tested on a hypothetical project data and results showed its ability to reach Pareto fronts on different sets of objective functions.

INTRODUCTION

The need to reconsider traditional methods of product development and introduction has been recognized since early 1990s (Fiksel, 1991). Because products that meet the needs of customers faster than competitors grow at a rapid pace, both in terms of market share and profitability, a competitive product needs to be introduced quickly without compromising product performance (Chakravarty, 2001; Kotler, 1991). The significance of time-to-market was further demonstrated by (Stalk, 1988; Blackburn, 1991; House and Price, 1991) leading to a conclusion that reduction in product development cycle time has become an essential goal (Fiksel, 1991).

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In a pamphlet issued by the National Research Council (1991), four requirements for using product design as a source of competitive advantage were cited including establishing a corporate Product Realization Process (PRP) supported by top management and developing and/or adopting integrating advanced design practices into the PRP. Subsequently, planning for product evolution beyond the current design and planning concurrently for design and manufacturing were defined as means for effective PRP practice. In this spirit, the term 'Integrated Product Development' (IPD) was coined to describe a process that has been adopted by most progressive manufacturing firms, even though firms may have different names for this process (Peet and Hladik, 1989).

The motivation for adopting IPD can be further understood when the economics of product development are considered; where between 60 and 80 percent of the overall product costs are committed between the concept and preliminary design phases of the program (Armstrong, 2001). And, since only a small cumulative expenditure of funding is committed during early phases in the classical serial approach, the cost of design change increases exponentially as the development process advances as shown in Figure1. For example, in the automotive and electronics industry, it has been shown that up to 80% of product life-cycle costs are committed during the concept and preliminary design stages, and that the cost of design changes steeply increases as a product proceeds into full-scale development and prototyping (Peet and Hladik, 1989; Port, 1990; National Research Council, 1991). Another study included in (Nevins and Whitney, 1989) showed that about 70% of the life cycle cost of a product is determined at the conceptual design stage. Furthermore, O'Grady, Ramers, and Bowen (1988) showed that design of products determines their quality and 70% to 80% of the final production cost.

Thus, the motivation for current research can be summarized as follows: (1) there is a need to reduce both product time-to-market and product development cost; (2) dealing with complex products adds more difficulty to the management of the design process within product development projects; (3) as a result, a more effective methodology – that is IPD - has to be implemented; (4) since about 80% of cost is committed at early

Figure 1. Cost impact (Source: Armstrong, 2001)