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# Concurrent engineering performance: Incremental versus radical innovation

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ABSTRACT

This article analyzes the link between the use of concurrent engineering (CE) and success in new product development (NPD) under varying conditions of uncertainty and complexity—radical versus incremental innovations. Using linear regression, the results obtained indicate that overlapping activities, inter-functional integration and teamwork positively affect NPD performance in terms of development time and new product superiority in the case of incremental innovations and in terms of development cost in the case of radical innovations. The conclusion is that the use of CE should be contingent to the context or particular conditions which characterize each innovation process and the order of priority given to the objectives pursued.



## 1. Introduction

Many of the companies competing today in international markets consider new product development (NPD) as an important factor for achieving sustainable competitive advantages. Both researchers and managers are constantly searching for methods and practices that will allow them to improve the organization and management of their NPD processes and boost their effectiveness or success—the average success rate of NPD projects today is approximately 60% (Cooper and Edgett, 2003). The challenge is to achieve excellence in three specific objectives: (1) shorter new product development times, (2) more efficient developments, and (3) superior products.

Taking these objectives into account, companies have reorganized their NPD processes and have moved from a sequential path, in which there is minimal interaction amongst the departments involved and the activities required to develop the product are carried out sequentially, towards an integrated path, known as concurrent engineering (CE), in which the activities overlap and all the departments collaborate from the beginning.

This new organizational design has helped companies improve their performance by leading to lower costs, higher quality, major knowledge creation and shorter product development times (Riedel and Pawar, 1991; Rosenblatt and Watson, 1991; Shenas and Derakhshan, 1992; Lawson and Karandikar, 1994; Prasad, 1996; Brookes and Backhouse, 1998; Pawar and Haque, 1998; Barba, 2001; Umemoto et al., 2004), all of which, in turn, has raised their competitive skills. There are many examples illustrating this, to the extent that CE has been considered one of the "best practices" for achieving sustainable competitiveness (Voss et al., 1995).

However, more recent research shows that the use of CE does not always lead to positive results and that success in improving innovation capabilities depends on the context in which CE is applied, that is, on the prevailing competitive and technological circumstances. The conclusion is reached that the degree of uncertainty and complexity present in the process of innovation may moderate the impact of NPD characteristics on performance.

The matter to be considered is not, therefore, whether CE is a mechanism for improving performance in the

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introduction of new products but, rather, under what circumstances such improvement can be achieved. It seems, however, in spite of many research efforts studying this aspect, that no consensus has been reached and that there are many empirical contradictions.

This lack of unanimity is the reason for the present study, the main aim of which is to help determine the circumstances under which the application of CE is effective. With this aim, the impact of this methodology on the results of the NPD process is analyzed in a large sample of Spanish manufacturers, and different innovation scenarios are distinguished according to the degree of uncertainty and complexity involved in the NPD projects.

The research is structured as follows. Firstly, the literature is reviewed with regard to the concept of CE and its objectives and basic pillars. Secondly, the empirical contradictions that exist regarding effective application of this path are explained and hypotheses are formulate linking the use of CE to several indicators for success in the NPD process depending on the type of innovation being carried out. Thirdly, the research methodology is explained. Fourthly, the statistical analyses carried out are presented, with the results obtained. Finally, the main contributions are summarized, the conclusions are drawn, some limitations are described and the lines for future research are considered.

## 2. Theoretical framework

### 2.1. Definition of concurrent engineering

One of the widest known definitions of CE is the one given by the American Institute for Defense Analysis, which considers it to be "a systematic approach to the integrated, concurrent design of products and related processes, including manufacturing and support. This approach is intended to cause the developers to consider all elements of the product life cycle from conception through disposal, including quality, cost, schedule, and user requirements" (Winner et al., 1988, p. 2).

Therefore, CE can be seen as "integrated problem solving" (Wheelwright and Clark, 1992), where all activities necessary for the introduction of a new product are considered simultaneously (Shenas and Derakhshan, 1992), so that all factors and questions "downstream" of product development are incorporated into the "upstream" phase of development (Lee, 1992; Hatch and Badinelli, 1999).

### 2.2. Concurrent engineering versus sequential engineering

From the beginning, CE was proposed as a method for dealing with the problems that tend to arise when companies adopt the traditional approach for developing new products. This approach, generally known as "throwing it over the wall", focuses on developing a structured process with clearly-defined and sequential phases, through which the future product is defined, designed, transferred to the manufacturing plant and rolled out to the market (Iansiti, 1995). Each one of these activities only starts when the one before has completely finished, resulting in a total lack of integration and co-ordination between different functional areas and other contributors involved in the process. Each function carries out its work in isolation, with minimum reference to the needs of others. All this translates into continuous retracing of steps in each of the different phases of the project to correct the mistakes made, thereby resulting in very long development times and in additional costs for the design process (Takeuchi and Nonaka, 1986; Cordero, 1991). Similarly, many quality problems arise, basically owing to a lack of communication and understanding between product design, production, and consumers' needs.

As a result, companies resort to a new organizational structure for their NPD processes which, unlike the traditional way, is based on an integrated approach to product development in which everyone involved works in parallel and proper links are established amongst the activities of the different departments. The aim is to avoid continuous setbacks and the other problems that arise with the traditional approach, improving NPD performance. This new practice, named CE, tries to speed up the process, increasing flexibility, adopting a more strategic perspective with more sensitivity to change in the environment, solving problems through teamwork, developing diverse skills, and improving internal communication (Barba, 2001).

### 2.3. The basic elements of concurrent engineering

To achieve the above-mentioned objectives, CE is based on three basic elements (Koufteros et al., 2001): (1) concurrent work-flow, (2) early involvement of all participants and groups contributing to product development, and (3) team work. In other words, CE is the early involvement of a cross-functional team to simultaneously plan product, process and manufacturing activities (Hartley, 1992).

#### 2.3.1. Concurrent work-flow

Unlike sequential development, this first basic element stimulates parallel development, either total or partial, of the activities that form part of the NPD process. For example, product design and process planning can be carried out concurrently, process planning can be integrated with production planning, and control or product planning can start long before the concept is finalized. This does not reduce the duration of each activity, but it does decrease the overall development time (De Meyer and Van Hooland, 1990). In addition, such working in parallel allows frequent bilateral exchanges of information amongst the parties, so that activities which traditionally occur much later in the product development process benefit from information generated in much earlier activities (Yassine et al., 1999), thus minimizing errors and unplanned developments. Simultaneous planning of the product, the process and production means that manufacturing issues can be taken into account in final product design. This reduces uncertainty and allows for early detection of problems, avoiding the need for