Editorial On Influencing Agents of CE

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Editorial
On Influencing Agents of CE

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The most commonly referred definition of Concurrent Engineering is that of Winner [1]. Some experts recognize influencing agents of CE as forces of change [2]. We have chosen to divide forces that influence the domain of CE into seven agents (called here the 7 Ts): talents, tasks, teams, techniques, technology, time, and tools (see Figure 1). One of the primary team issues is the decomposition of tasks. The people's issue is the composition of teams. *Teams* are often used to cooperatively solve the problem. *Technology* issues arise due to drive for competitiveness. Examples of popular technologies in CE are soft prototyping, visualization, product data management, design for X-ability, multimedia, electronic data interchange (EDI), etc. *Tools* means computer software, hardware, and networks that make CE practical in today's world of multinational corporations, multi-partner projects, and virtual corporations. From the *time* point of view, CE is an initiative of the product development community that has the goal of reducing the length of the product design and manufacturing cycle time by allowing teams of engineers to develop design modules concurrently from their perspectives [3]. *Training* also plays an important role in CE. A popular word in the business press is "reengineering," meaning, in short, revamp the processes by which one satisfies customers' needs. From a business account, CE means re-engineering the product development process so that tasks are organized concurrently. The Department of Defense (DOD) and some aerospace companies refer to this CE process as integrated product development (IPD).

$$\text{IPD} \Leftrightarrow \text{Minimize (Cycle-time)} + \text{Paralleling-of}$$
$$\text{(life-cycle-functions)}$$

Concurrent Engineering (CE) systems stem from Computer Integrated Manufacturing (CIM) systems [4,5] or Engineering Information Systems (EIS), and are closely related to Computer Aided Acquisitions and Logistics Support (CALS) [6]. Formal needs for these systems have been developed and published [7,8]. The first tenet of CE is cooperation—from the human side as well as the data management side. Closely related are the ideas of "design for X-ability" and "concurrent part and process design" [9]. The latter can be met by cooperating early in the design process. Most traditional systems require complete or nearly complete part geometry before the start of any design iteration. CE systems are intended to work with approximate models of constraints and tradeoffs involving generic parameters common to multiple disciplines across the life-cycle.

CE has a major impact on the process set up and the way we conduct the business. As shown in Figure 2, Concurrent Engineering replaces the traditional sequential "over the wall" approach to a simultaneous design and manufacture spectrum with parallel, less interrelated processes. It aims at reducing the total effort in bringing the product from concept to delivery, while meeting the needs of both the consumers and industrial customers. The four major phases of the product development (as shown in Figure 2) have been detailed into 8 tracks (shown in Figure 3) running in parallel. They show the different tracks of the development process. These tracks are: mission definition, concept definition, engineering and analysis, product design, prototyping, production engineering and planning, production operation and control and finally, manufacturing. These tracks are not unique to any particular product, and steps may differ from product to product. Once a product is decomposed into a set of tracks, they become one full set of steps leading to product realization. The staggering of their start points and overlaps are indicative of partial information sharing and their orders are indicative of their precedence. The amounts of overlap between two consecutive tasks are indicative of the degree of dependency that may exist between them. If the tasks are completely independent, they all can be aligned along the left margin of the diagram keeping the precedence intact. The time-to-market in that case would be dominated by tasks that takes longest time to finish. This is a case of a true "Simultaneity" or "Simultaneous Engineering" situation. The idea of "best concurrency," when the tasks are not completely independent, is to align each step to the farthest left of the diagram as possible, satisfying the following:

1. Maintain the precedence of the tasks that were decomposed.
2. Minimize the horizontal overlap between the consecutive tasks.
3. Maximize the independence of the decomposed tasks.

In general, there are greater affinity and dependence be-

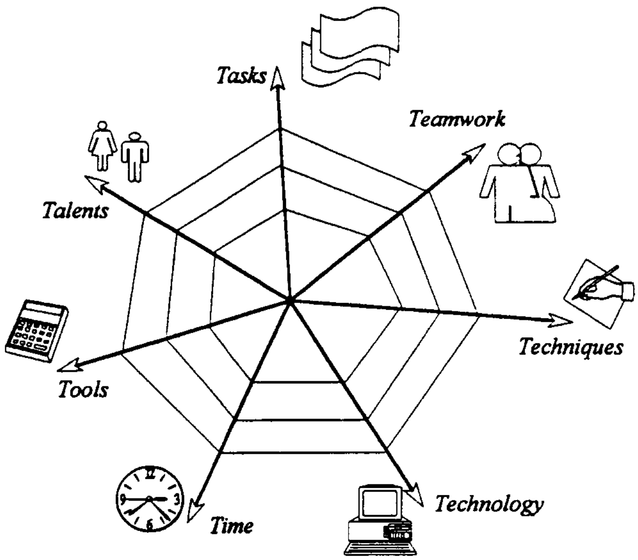

Figure 1. 7Ts: Seven influencing agents of CE.

tween pairs of activities, which are adjacent to each other. The farther away the activities are positioned from each other, the lesser would be the degree of affinity or the need for information transfer among them. For example, mission definition would be more closely related to concept definition but would have very little bearing with activities such as manufacturing. Similarly, manufacturing would be closely related to production operations and control but would be quite less sensitive to tracks such as engineering and analysis. The arrows in Figure 3 represent the interactions between the various tracks. The downward-slant arrows represent the resultant of enrichment (a horizontal component) and needs (a down vertical component). The upward-slant arrows indicate the net results of feedback (reverse horizontal component) and consequences and constraints (up-vertical component). A general description of the arrows is given in the Figure 3 legend. The concurrent approach is gaining worldwide attention at the moment. The paralleling of life-cycle activities in process restructuring is being

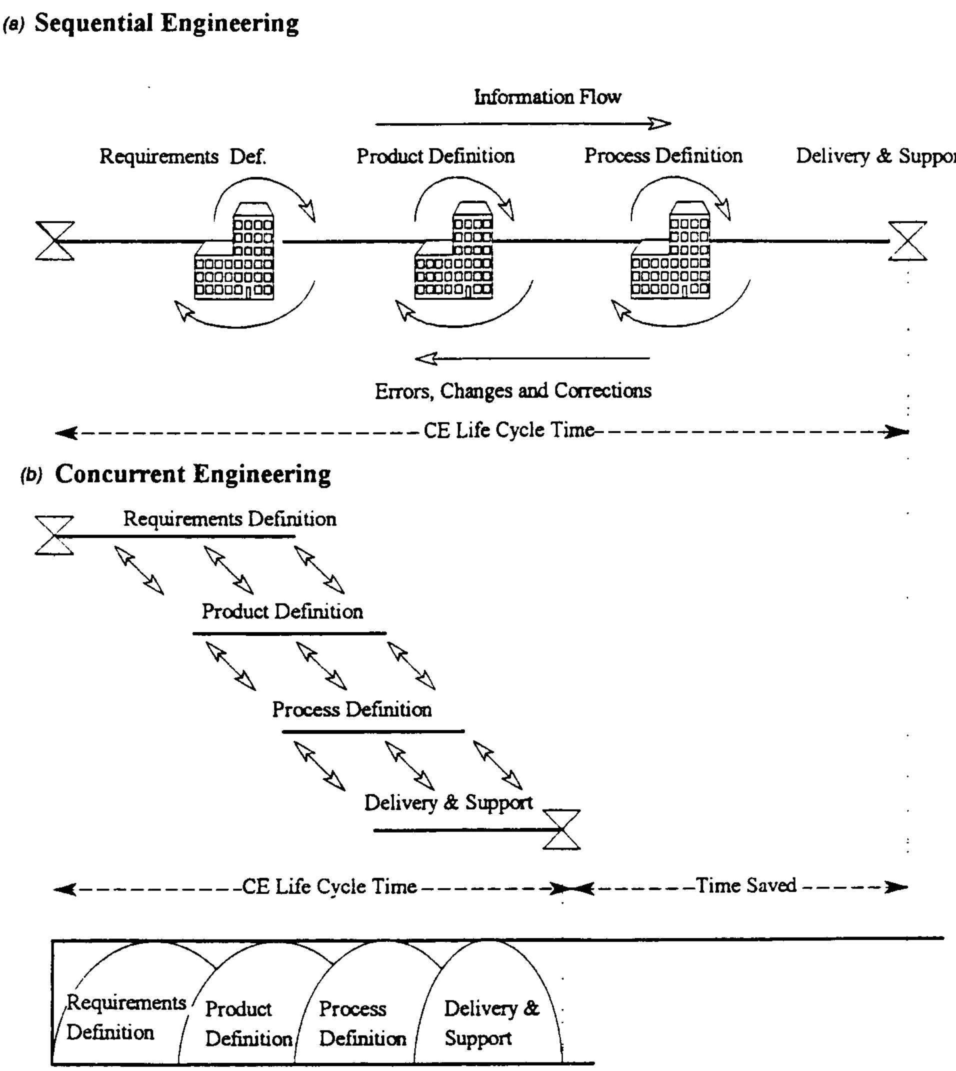

Figure 2. Traditional design process.

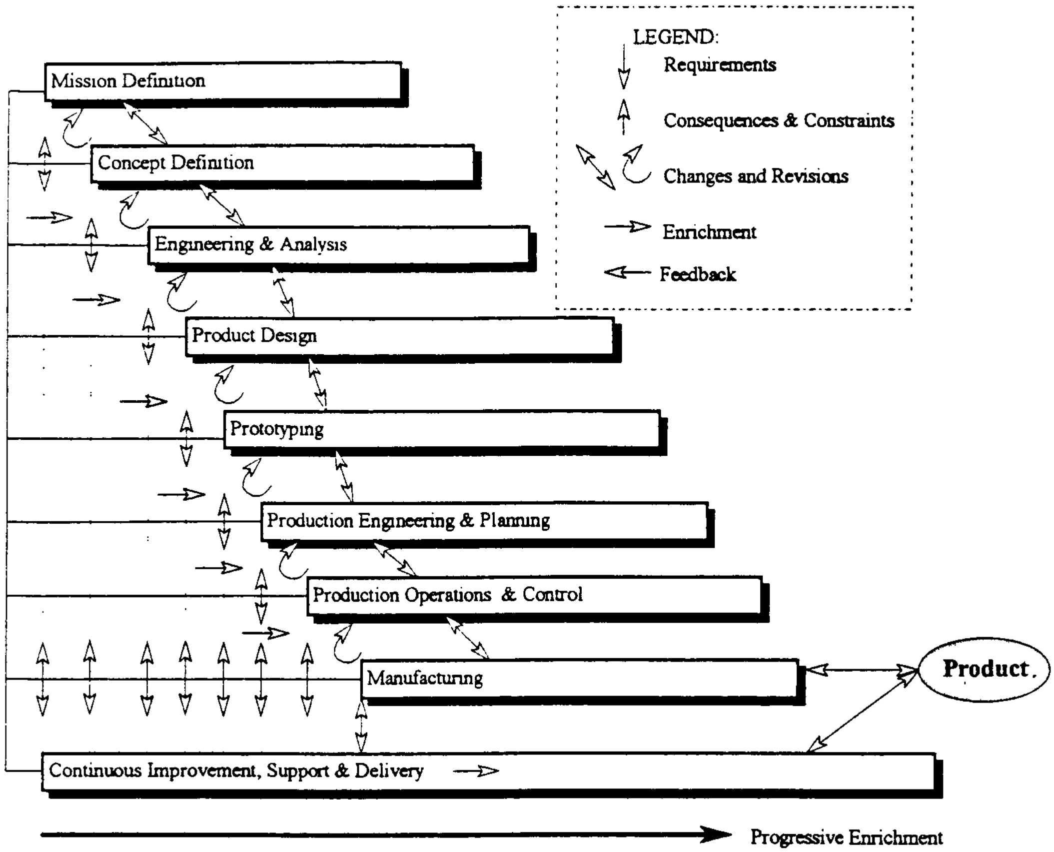

Figure 3. Showing concurrency during phases of product design and development process.

deemed necessary by more and more industries to adapt quickly to changing market conditions and reduced time-to-market demands. Additional savings may come from cost-avoidance—early recognition of possible faults, thereby preventing unnecessary issuance of so called change orders after the product is released.

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