A Systems View of Design Engineering Capacity / Continuous Improvement Policy Interaction

by

Anil B. Jambekar, Michigan Technological University, Houghton, Michigan 49931

With many companies implementing continuous improvement policy to enhance all company operations, everybody is knocking on design engineering's door because 'coordinated up-front design definition' has become a critical requirement for new product introduction and because design engineering plays a central role in enhancing the performance of re-engineered or improved manufacturing processes. Today, many manufacturing strategies embrace the goals of reducing "time to development", "time to ship", "defects per million," and "cost" every year. The articulated associated policies create pressures on various manufacturing divisions, design engineering, and marketing and product planning to respond by continuous examinations of their operations for potential improvements or re-engineering. The consequence is production of the design work-load that some times far exceeds existing design capacity. This clearly emerges as a management problem that has been viewed in this paper through systems thinking lens.

Introduction

Today many manufacturing firms are stressed by global competitive pressures, new technologies, and government regulations. In response to these demand, most have adopted continuous improvement polices for all operations which require on-going product and process re-engineering and improvements to enhance performance and productivity. The associated policies to support organization wide implementation of continuous improvement policies create pressures on various manufacturing divisions and design engineering to respond by continual examinations of their operations for potential improvements or re-engineering. Simultaneously marketing and product planning divisions are also under pressure to respond to customer requirements and competitive pressures to generate new and improved product concepts. Reward structures are also tinkered with in order to attribute credit to appropriate individuals for new product or process improvement ideas. The consequence has been production of the design work-load that some times far exceeds existing design capacity. This clearly emerges as a management problem at an organizational level and also at design engineering unit level. The both problems are interrelated, since many hiring and budgetary decisions are made at the organizational level where as resource allocation to various engineering projects is done at the design engineering unit level. These problems are viewed in this paper through systems thinking lens. The observations presented here are based on understanding developed at two different manufacturing firms At the organizational level, the problem of managing design engineering capacity is structurally similar to the "Tragedy of Commons" archetype [Senge, 1990]. Looking at the design engineering level, the design engineering capacity management problem has structural similarity to the problems faced by a service business [Parasuraman A., V. A. Zeithaml and L. L. Berry, 1985; Senge and Sterman, 1992] An objective of this paper is to show how systems view and the insights already available can be leveraged to improve the relevant decision making processes. The next section presents the underlying structure that generates the problem at the organizational level. The following section shows the structure of the feedback processes at design engineering level. The presentation is restricted to the structural diagrams.

Tragedy of Commons Structure

It is assumed that marketing and product planning respond to competitive pressures and customer needs. Their outcome is new product ideas in the form of sales release, which become new design engineering projects. When the projects are completed satisfactorily, marketing and product planning receive credit. The underlying structure is presented in Figure 1.

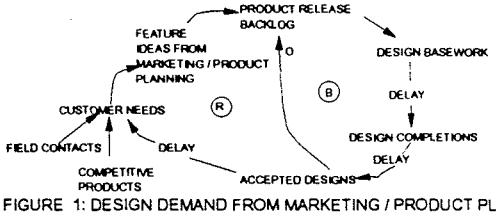

FIGURE 1: DESIGN DEMAND FROM MARKETING / PRODUCT PLANNING

Typical manufacturing division responds to continuous improvement polices by re-engineering and quality management initiatives. Frequently requests for product design changes come in the form engineering changes to which design engineers have to respond. The corresponding structure is shown in Figure 2.

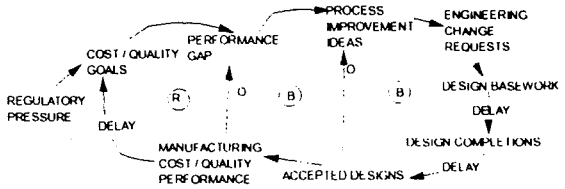

FIGURE 2: DESIGN DEMAND FROM MANUFACTURING DIVISION

Figure 3 shows a causal loop diagram of how design engineering generates own internal projects in response to warranty and repair notices, to perceived cost and functional quality performances gaps.

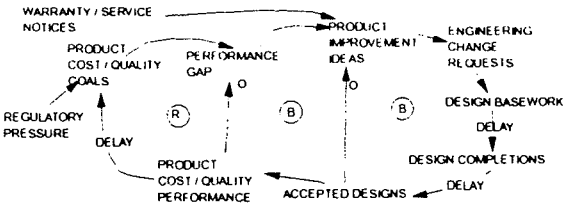

FIGURE 3: INTERNALLY GENERATED DESIGN DEMAND

Design engineering resource is the common resource in all of theses structures. Consequently, the engineering capability has potential of becoming a limiting force. When all of these structures are stitched together, a tragedy of commons structure evolves as shown in Figure 4.

Feedback Processes at Design Engineering Level

At the design engineering level, the engineering projects are the driving force for resource allocation decisions. Figure 5 shows the feedback structure which underlies a potential drift to lower performance. Design engineering unit managers constantly adjust the pace of work to control the backlog of engineering projects. There are six basic aspects of the problem of management at this level.

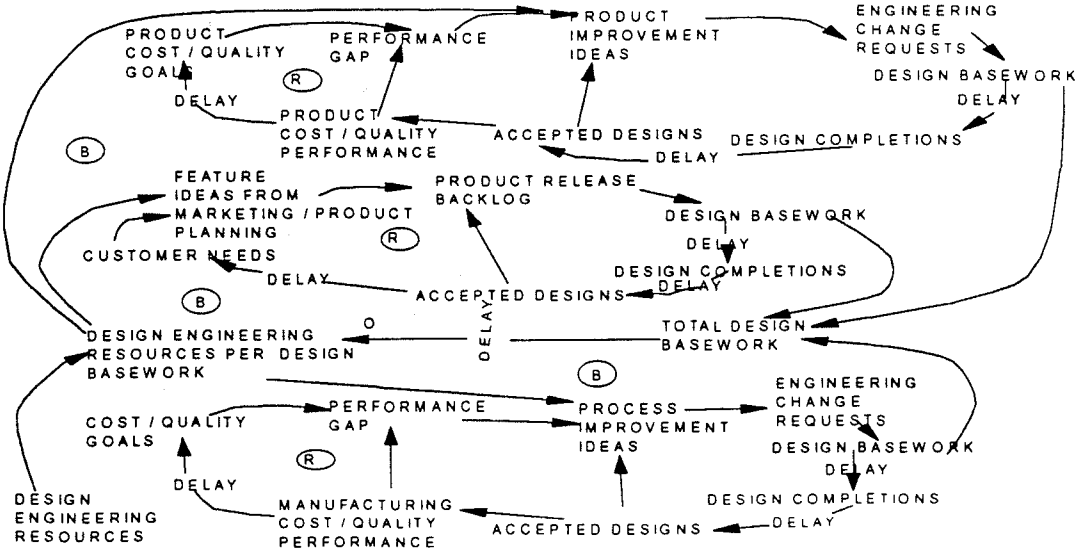

FIGURE 4: TRAGEDY OF COMMONS STRUCTURE

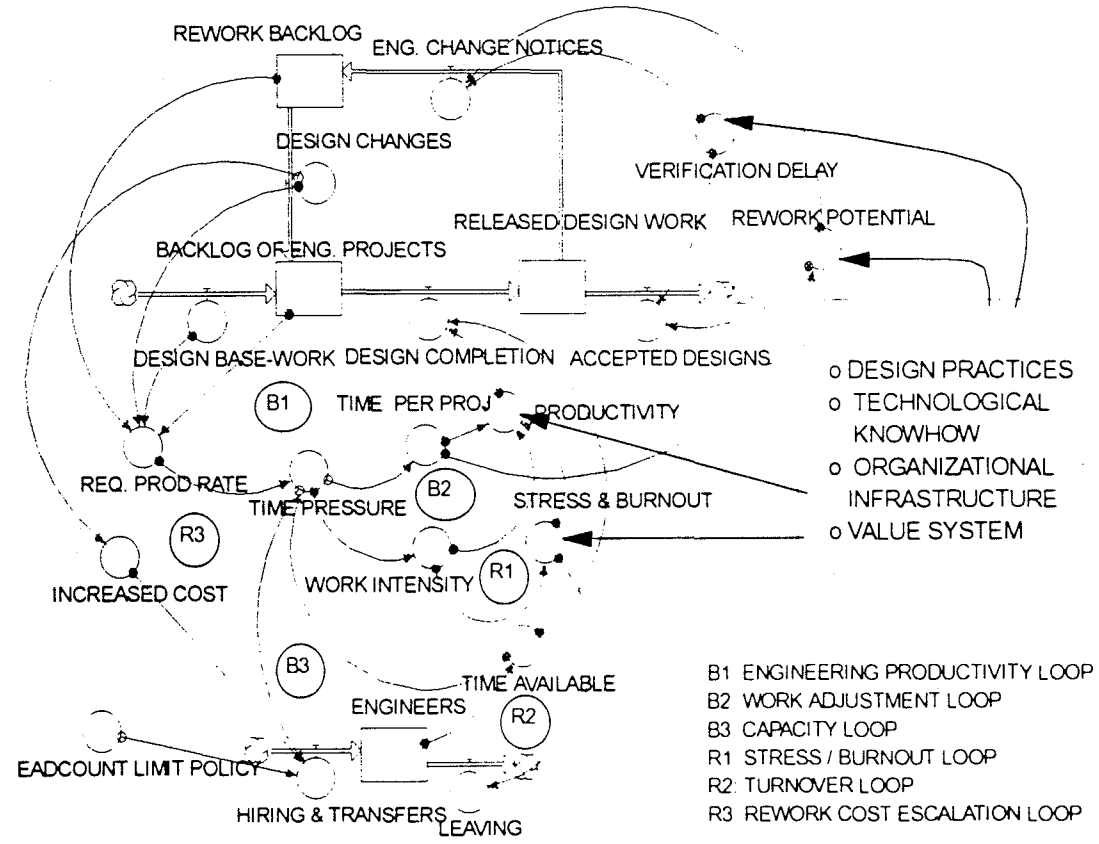

FIGURE 5: FEEDBACK PROCESSES AT DESIGN ENGINEERING LEVEL

1. Mix of design projects
2. Design capability - learning and re-learning
3. Customer focused design
4. Technological changes.
5. Rework and returns - unplanned and receives scares resources
6. Continuous improvement policies

The difficulty is that the performance of the system depends more on the interaction among its connections and management policies to govern these connections, than on the independent actions of various functional groups. An implication is that since management has control over the system and its polices, then it is possible to obtain a competitive advantage by vigorously viewing the organization as a system to locate high leverage points.

Final Remarks

The transferable insights for the above developed structures are already available in the literature [Senge, 1990; Senge and Sterman 1992]. Another interesting point is that when both the tragedy of commons and the feedback process at design engineering level are hooked together, an archetype, "Growth and Under-investment," [Forrester, 1968; Senge, 1990] emerges. An obvious implication is that the design engineering capability should be built ahead of the demand generation due to continuous improvement culture transformation efforts. Furthermore operationally, design engineering function resembles that of job shop and service organizations as the pressure to reduce "time to development" increases.

References

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