DECISION TECHNOLOGY SYSTEMS, CONCURRENT ENGINEERING AND SUPPLY CHAIN MANAGEMENT IN LIFE SUPPORT

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Summary

Supply Chain Management (SCM) and concurrent engineering (CE) can reduce the lead time and the cost of developing, and improving the quality of, human life support systems. To achieve these benefits, design, engineering (or professional), and manufacturing (or service) knowledge must be shared in a systematic, complete, integrated, and timely manner among the affected decision makers. The enterprise must meet significant organizational and information technology support challenges to promote the free flow of

the necessary knowledge.

The concurrent engineering life support system (CELSS) can help meet the support challenges and enable effective concurrent engineering for life support. This framework is a workstation-based combination of decision support, executive information, expert, and idea processing system functions that:

1. provide central repositories for CE data, ideas, models, knowledge,
2. incorporate a user-extensible, object-oriented knowledge-representation scheme that links CE information, knowledge, and models,
3. deliver environmentally-cognizant, enterprise-oriented, wisdom-creating models that support the design, engineering (or professional), and manufacturing (or service) decisions involved in concurrent engineering for life support,
4. automatically alert the user to particular product (or service) and environmental features that are incompatible with specified tasks, events, and processes,
5. assist participating personnel in understanding design tasks, engineering (or professional) events, and manufacturing (or service) processes, and
6. serve as a learning tool for future designers, engineers, and other professionals.

Results, which can be provided in vivid detail, can be used to explain, justify, and communicate the information and knowledge to colleagues in a real-time, very user-friendly manner.

By enabling effective concurrent engineering, CELSS can serve as an important strategic weapon for enterprises directly or indirectly involved in the life support process. As the automobile emission, breast cancer detection, and railroad crossing investment examples illustrate, such use can yield significant economic, environmental, and management benefits for deploying enterprises and society.

1. Introduction

For long-term survival, society must utilize available land, energy, and other natural resources to produce food and additional valued goods or services in a way that maintains, or improves, the quality of life on earth. This strategic problem has been examined from a variety of perspectives, including engineering, social, economic, political, and scientific studies, among others. Such studies have contributed significantly to life support knowledge.

Wide-ranging technical and domain expertise is necessary to comprehend, integrate, and utilize the created knowledge. Yet, life support practitioners may be unaware of, or be unable to use, the expertise in the integrated and comprehensive manner required to fully, or even partially, solve persistent life support problems. The Total Quality Management (TQM) philosophy and Supply Chain Management (SCM) principles can help managers in the responsible public and private organizations achieve the desired strategic results.

In TQM, there is an emphasis on the prevention of problems, interest group satisfaction, and continuous improvement in organizational processes. A quality team is created to identify problems and improve relevant processes in a systematic and integrated manner.

Systems are established to ensure that organizations maximize quality and provide competitive, environmentally-sustainable products or services. Rewards come in the form of continuous and concrete improvements that, over time, achieve strategic objectives, such as lowering costs, improving productivity, differentiating products/services from the competition, enhancing the environment, and innovating organizational processes.

Supply Chain Management recognizes the inherent links between consumers, distributors, and manufacturers and attempts to coordinate interrelated activities among the parties. The coordination can oocur vertically between the parties or horizontally between entities in the parties' organizations. Coordination can be accomplished through a formal, privately contracted, relationship between the parties or through regulated public central planning. Rewards are similar to, and enhance, the benefits achieved from TQM.

Concurrent engineering (CE) can facilitate TQM and SCM and help public and private organizations realize their strategic objectives. In CE, the food, product, or service cycle is treated as a harmonious process that focuses on the priorities and requirements of the pertinent interest groups. Participating personnel are stimulated to continuously improve design, production, and support processes in an integrated and systematic manner. The goals of the effort are to improve quality, reduce costs, and decrease the lead time from conception to development for new or modified products and services.

At each phase of the CE process, professionals and managers must make complex strategic and operational decisions. Analytical techniques will be required to methodically evaluate the decision alternatives, and these techniques will employ and generate a large volume of cost, design, quality, cycle time, and other information. This information and the created knowledge must be shared among affected personnel to assure that designs meet strategic objectives and that operations conform with design specifications, to optimize the use of scarce natural and created resources, and to better plan and manage the concurrent engineering process.

A variety of information systems can be used to provide the strategic and operational support needed in concurrent engineering. While each of the systems can bolster a separate segment of the process, none are designed to provide all of the essential CE support. Comprehensive support will require a consolidation of the separate information system functions and an effective delivery of the integrated capabilities.

This article presents an information system, called the **Concurrent Engineering Life Support System (CELSS)** that can deliver comprehensive CE support for life support. It first overviews the life support process, discusses the role of concurrent engineering in improving this process, and catalogs gaps in existing CE support. The article then explains how information system functions can help close these support gaps, presents the CELSS architecture for integrating and delivering these functions, and examines the role of CELSS in enabling CE for life support. Also, there are illustrations of the concept with examples from auto emission testing, breast cancer detection, and railroad crossing investments.

2. Life Support Process

Life on earth depends on a sound ecological system of air, energy, land, water, and other natural resources. These resources are used by enterprises to produce the food that sustains, and valued products and services that improve, the quality of, life. Food can encompass agricultural items, groceries, nutritional supplements, or other consumables. Valued goods can involve raw natural resources, processed energy, or industrial and commercial merchandise, and valued services can include education and training, financial and legal advice, medical diagnoses and prescriptions, or government aid.

In the enterprises, operations are triggered by the receipt (or forecast) of customer orders for the food, products, or services. These orders are used to develop design requirements, which activate engineering or professional events that result in specifications for the food, products, or services and their various components. The requirements and specifications should incorporate environmental considerations that protect the life-sustaining ecology. Manufacturing engineers or service personnel then use the specifications to develop environmentally-cognizant processes and subprocesses that create the finished food, products, or services and identify a suitable distribution plan.

2.1 Sequential Engineering

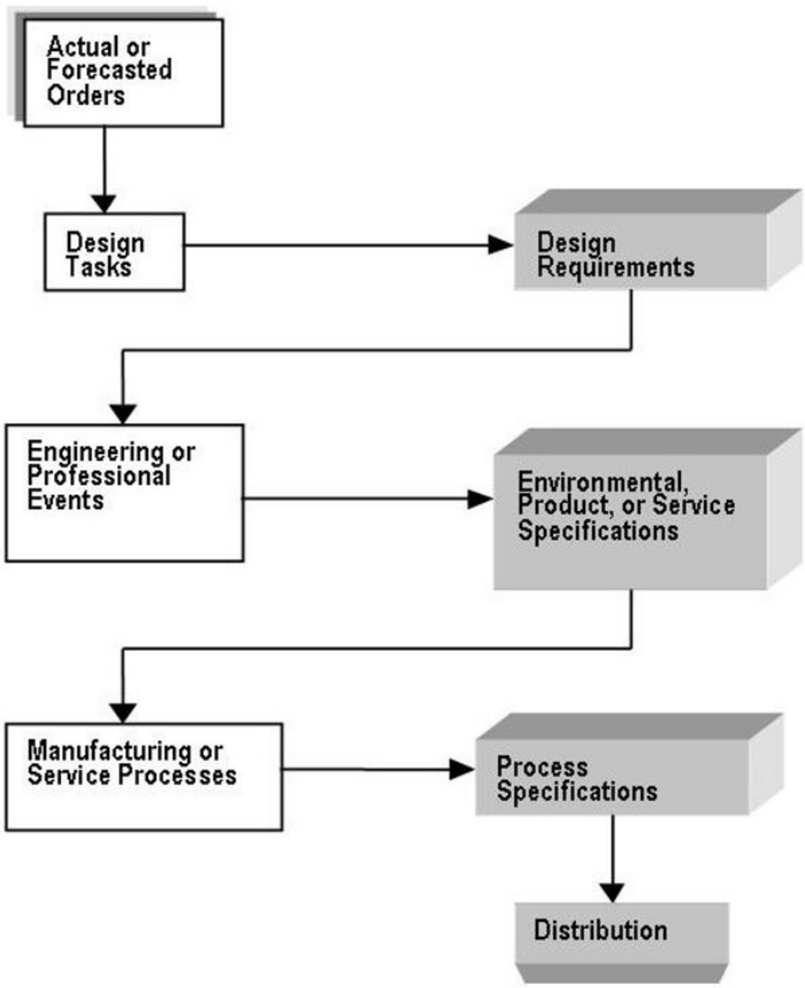

Figure 1: Sequential Life Support Engineering

Traditionally, the life support process has been implemented through the sequential engineering approach portrayed in Figure 1.

As this figure illustrates, sequential engineering involves a successive set of steps from actual or forecasted customer orders through distribution. Outputs from each preceding step become inputs to the succeeding step in the process. For example, engineering, professional, and internally- or externally-imposed environmental specifications become guidelines for manufacturing or service processes.

Information and knowledge from a preceding step flow unidirectionally to a succeeding step at the discretion of the participating personnel. For example, designers decide the level of detail included in the requirements sent forward for engineering.

The sequential engineering can result in operational inefficiencies and knowledge transfer difficulties.

2.1.1 Operational Inefficiencies

Training, experience, and other factors influence personnel to focus on domain-specific, rather than enterprise, performance. A domain-productive action at a preceding stage may inadvertently hinder operations at a succeeding stage of the sequential process.

For example, a designer may stipulate market- and environmentally-effective requirements that unknowingly create engineering difficulties.

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Biographical Sketch

Guisseppi A. Forgionne is Professor of Information Systems at the University of Maryland Baltimore County (UMBC). Professor Forgionne holds a B.S. in Commerce and Finance, an M. A. in Econometrics, an M. B. A., and a Ph. D. in Management Science and Econometrics. He has published 26 books and approximately 175 research articles and consulted for a variety of public and private organizations on decision making support systems theory and applications. Professor Forgionne's work has appeared in Interfaces, The European Journal of Operations Research, Information & Management, Decision Support Systems, Information Systems Engineering, The Journal of Information Systems Management, International Transactions on Operational Research, OMEGA, Science, Information Processing and Management, Computers and Operations Research, The International Journal of Geographical Information Systems, and other refereed journals. His research has been funded through competitively-earned grants, and his work has been recognized with many national and international awards for his work. Professor Forgionne also has served as department chair at UMBC, Mount Vernon College, and Cal Poly Pomona.