EDSS FOR PRODUCT MAINTENANCE IN A GLOBAL ENVIRONMENT

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Despite the fact that product maintenance is a multi-billion dollar, multi-national business, decisions about service parts have historically been treated somewhat as an afterthought. Providing service parts in a timely manner on a global basis, while minimizing the associated costs, has become a strategic competitive factor. Decision models that have been employed are often based on simplifying assumptions which do not address the complexities of many of today’s products as well as the customers low tolerance for product failure. The expert decision support system developed in this paper is based on a comprehensive model which takes into account product reliability, warranty policies, maintenance contracts, staffing for service calls, and spare parts logistics. The primary feature of this system is its ability to employ expert system technology in the integration of engineering, production, marketing, and logistics related data.

Despite the fact that product maintenance is a multi-billion dollar business, planning of the production and management of inventories of service parts have not received the attention they deserve. Companies which try to compete on the basis of quality must pay attention to after-the-sale service as well as the production of a quality product (Takeuchi and Quelch, 1983). Providing service parts at the right time to meet customer needs while minimizing the associated costs can provide such a competitive advantage. This is particularly important in light of the complexity of many of today’s products and customers’ low tolerance for failure of these products. For products and product systems with long operating lives (e.g., aircraft, tractors), it is crucial to accurately predict spare part requirements at the time of system design as well as coordinate the spare parts production with regular production. Despite the importance of these considerations, few companies consider replacement part costs from a product life cycle perspective.

Production of service parts has historically been treated somewhat as an afterthought. Decision models that have been employed are often based on simplifying assumptions which fail to address the magnitude and scope of the problem, limiting their effectiveness. The proposed EDSS is based on a comprehensive model (see Figure 1) which takes into account the following managerial concerns:

A. Product reliability - tradeoffs between designed
product reliability versus life cycle costs of spare parts.
B. Warranty policies - determination of basic and extended warranty periods and conditions.
C. Maintenance contracts - feasibility and economics of in-house versus third party maintenance service.
D. Staffing for service calls - human resource planning for the maintenance function.
E. Spare parts logistics - production scheduling, inventory control, and distribution.

System output will enable managers to make better engineering, production, inventory, and marketing decisions and update these decisions over the planning horizon as new information becomes available. Control provided by this system results in better customer service, lower production and inventory costs, and improvement in a variety of other spare parts related management decisions. One particular strength of this system is its wide range of application. It is not industry/product specific.

The planning and scheduling of production of service parts poses unique problems because (1) demand for service parts is uncertain; it is tied to the reliability and failure characteristics of the product; (2) service parts production may have to take place in a separate facility if service parts production is farmed out to other companies (a practice followed by many firms in OEM business); (3) service parts production has to be integrated with regular production. Many firms are pursuing a life cycle oriented approach to design of products whereby they attempt to reduce the subsequent demand for service parts by improving the reliability and quality of the product with higher initial costs of design. The model developed here will also provide insights into such trade-offs. Some firms may not have any incentive to carry out such design and process improvements if other firms are made responsible for providing the after sales service and field support and bearing its costs (Juran, 1978). Even in such a case, the firm providing service parts needs to coordinate with the OEM firm for developing a database for its service parts decision. The model addresses these issues as well. The model is developed in the following section.

The EDSS Model

The model for production and inventory decisions concerning service parts will be developed in two stages. In the first stage, the expression for the demand for service parts will be derived. In the second stage, a mixed integer linear programming model will be formulated using this demand information. The model’s output will be the optimal production and inventory decisions for service parts over the planning horizon.

Stage I: Statistical Inference Module

The demand for service parts is dependent upon (1) the failure characteristics of the product or system; (2) anticipated useful service life of the product or system; and (3) the number of units or systems in use. In order to keep the model analytically tractable, it will be assumed that the number of service parts required per unit per unit time is described by a simple Poisson distribution. This assumption is not too unrealistic and is a reasonable approximation to the distribution of usage of service parts for many durable goods (Bain and Wright, 1982). It is a well established result in the literature regarding reliability that for many components the time interval between successive failure events is exponentially distributed (constant failure rate). This directly leads to a Poisson distribution for service part demand. The distribution of the useful service life of the product is not specified. It is clear that the parameters of these distributions can be varied within certain limits by the design and manufacturing specifications of the product. To that extent, the producer of products can exert influence over these characteristics.

The producer, however, has less control over the third aspect, i.e., the number of units in use at any point in time. This would depend upon the number of units sold and are in use up to that point in time. In the context of planning production and inventory decisions as well as decisions regarding design parameters (which influence service life and failure characteristics) an estimate of sales growth profile or the product life cycle curve is needed.
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