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INTEGRATING LOGISTICS IN CONCURRENT PRODUCT AND PROCESS DESIGN

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ABSTRACT

In the last 15 years, considerable efforts have been placed on integrating product and process design. This integration can improve product quality, reduce product development time and costs, and reduce manufacturing costs. However, logistics, which can account for an important portion of the total costs, generally has been considered only subsequent to the product and process design. This sequential approach restricts the alternatives for design and operation of the logistics system, and can result in suboptimal performance and substantially increased cost.

This paper provides an overview of logistics functions, and describes how activities such as packaging, material handling, warehousing, transportation, etc. are affected by product and process design decisions. The linkages between logistics operations and product and process design decisions indicate the necessity to develop new, more inclusive, concurrent methodologies of design. The challenge of the 21st century is to integrate logistics, product and process design to optimize manufacturing design.

KEYWORDS

Logistics; Logistics decision; Concurrent engineering; Product design

RÉSUMÉ

Dans les 15 dernières années, des efforts considérables ont été déployés pour intégrer le design des produits et celui de leur procédé. Cette intégration pourra améliorer la qualité des produits, réduire le temps et le coût de leur développement, et réduire leur coût de production. Cependant, la logistique qui constitue une portion importante des coûts n'est prise en compte qu'après le design des produits et des procédés. Cette approche séquentielle limite les choix pour la mise en place du système logistique. Ceci peut engendrer des performances sous-optimales et un accroissement substantiel des coûts.

Cet article présente un survol des fonctions logistiques et décrit comment les activités comme le conditionnement des produits, la manutention, l'entreposage, le transport, etc., sont affectées par les décisions prises lors du design des produits et de leur procédé. Les liens entre les opérations logistiques et les décisions de design montrent la nécessité de développer de nouvelles méthodologies concourantes de design. Le défi du 21^{e} siècle consiste à intégrer la logistique et le design des produits et procédés de façon à optimiser la production.

MOTS-CLÉS

Logistique; Décisions logistiques; Ingénierie concourante; Design de produit.

1. Introduction

A well accepted definition of concurrent engineering is that of Winner et al. [1]: a systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support. This approach is intended to cause the developers, from the outset, to consider all elements of the product life cycle from conception through disposal, including quality, cost, schedule, and user requirements.

This definition incorporates an ambitious objective. However, recent literature reviews [2,3,4] show that research efforts have not yet addressed well the integration of logistics (or support) components with product and process design. Because of the substantial costs involved in logistics activities, the lack of interfaces between logistics and product and process design constitutes important and challenging issues to be addressed. In this paper, we provide an overview of logistics functions, and describe how activities such as packaging, material handling, warehousing, transportation, etc. are affected by product and process design decisions.

2. Logistics Functions

Logistics encompasses both strategic level decisions, such as customer service levels and network design, as well as operational decisions. This paper focuses on operational logistics decisions and their links with product design. Riopel et al. [5] describes fundamental logistics operational functions, and details relevant decisions for each of these functions.

Figure 1 presents eight fundamental logistics operational functions, which are affected by product characteristics. Other logistics functions, such as demand forecasting and order processing, are not directly affected by product characteristics. The logistics functions shown in Figure 1 are highly interrelated and decisions within one function may impact decisions in

several other functions. In the next section, we discuss logistics decisions in the context of an existing steady-state production facility, for which product designs must be revised in response to customer needs, market changes, etc.

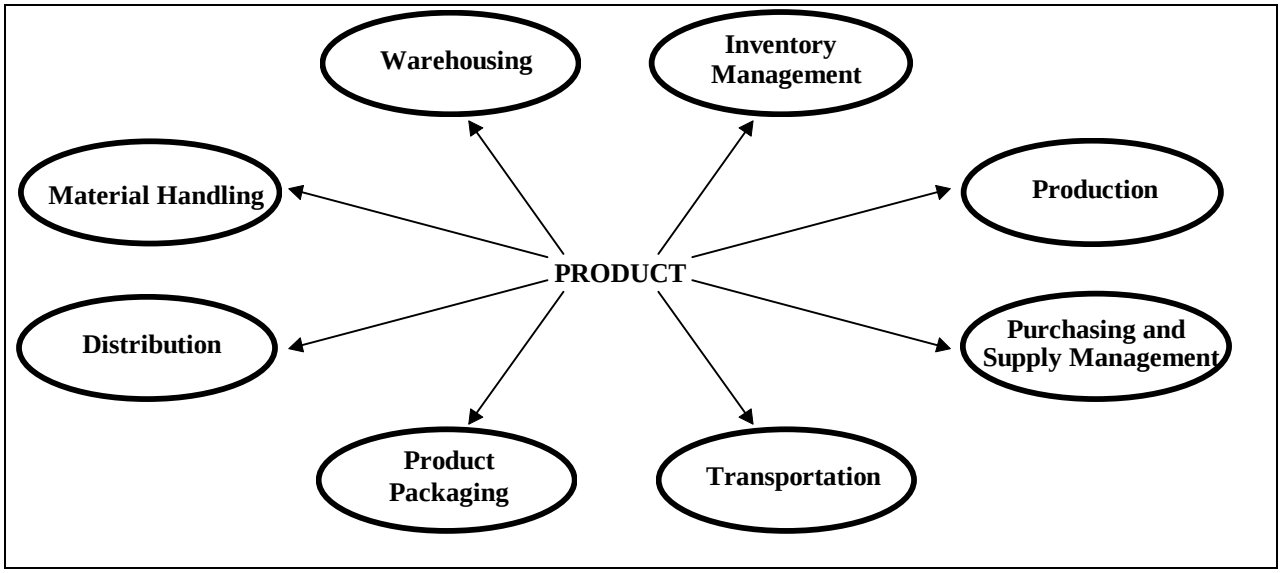

Figure 1. Logistics Operational Functions Related to Product.

3. Linkages between Product Design and Logistics Decisions

A design change that modifies product characteristics may impact logistics decisions in many areas, as illustrated in the following two examples. First, consider a change in product size, such as a 15% increase in product content for a special promotion. This change may have an impact on the production and material handling functions. The larger product size may no longer be compatible with current production equipment, thus requiring a change in production equipment. This in turn may require the product routing to be redefined, which then may force the production scheduling to be revised. Similarly, unit loads may have to be redefined (the new dimensions may, for instance, not be compatible with the tray). Hence, a

new type of material handling equipment could be required and consequently, new specific handling equipment must be selected.

As another example, consider a product formerly sold only locally, that is now to be distributed internationally. In this case, the product design may have to be modified so that the product specifications meet international standards. In addition to changes in the production function, the logistics functions of product packaging, transportation, and distribution may have to be updated. Depending on the region or country where the products will be distributed, modifications may be needed in the information provided (e.g., on the packaging itself, or in assembly instructions), and in the level of protection required (e.g., temperature control, or additional padding may be needed). This may affect how the information is communicated (e.g., via bar-codes, text) as well as the type of packaging (e.g., boxes or bags). Consequently, the packaging will need to be redesigned. For the transportation function, in order to meet the international requirements of transportation, one has to select a transportation mode and subsequently, the type of carriers (private, public, proprietary fleet), and eventually, a specific carrier. In the same spirit, all the logistics decisions within the distribution function should be analyzed.

Figure 2 shows linkages between product design and logistics decisions within each of the eight major logistics functions (shown in Figure 1). Each of the eight sections of Figure 2 treats a single function, and each section indicates the impact of a change in product design on the relevant decisions within that function. Many other links exist between logistics decisions of different functions, but are not presented herein (because of lack of space).

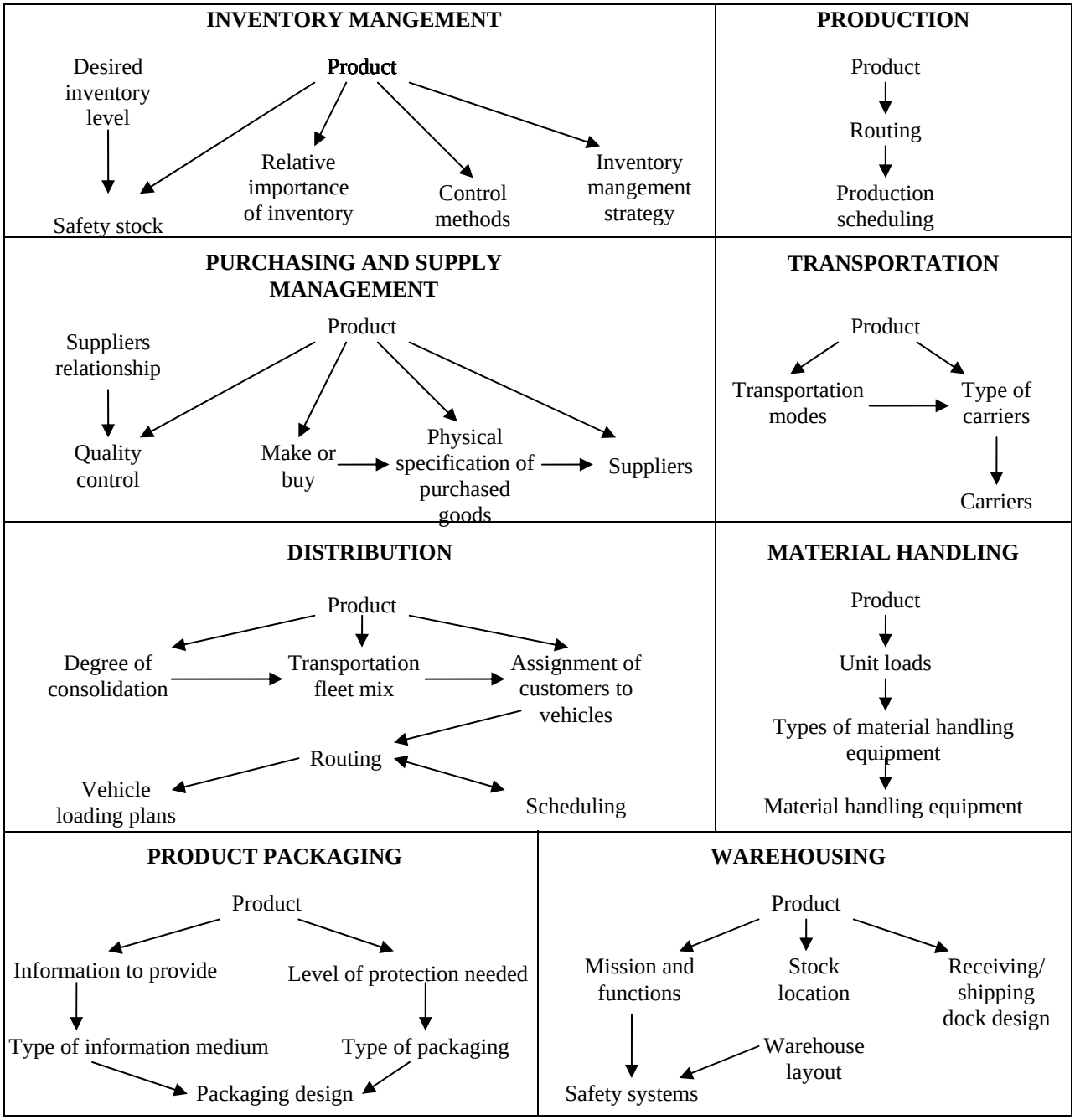

Figure 2. Linkages between Product Design and Logistics Decisions

4. Conclusion

Concurrent engineering is used to accelerate the development of products by integrating product and process design. However, attention to logistics issues in current engineering has been lacking [6]. Ignoring logistics in product and process design can lead to excessive costs and delays in bringing products to market.

An integrated approach to product and process design that includes logistics is likely to lead to better designs and lower cost. Such an integrated approach requires that designers have an understanding of logistics operations and access to relevant logistics information. This paper has provided an overview of logistics decisions, and illustrated how they are affected by modifications of product characteristics.

The linkages between logistics operations and product and process design decisions indicate the necessity to develop new, more inclusive, concurrent methodologies of design. The challenge of the 21st century is to integrate logistics, product and process design to optimize manufacturing design.

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