How to Achieve Agility in Food and Drink Manufacturing

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ABSTRACT
Food and Drink manufactures are facing competitive and customer pressures. The consumers are changing behavior, and the markets are fragmented and small niches emerge. This paper outlines the characteristics and the specific problems in achieving efficient manufacturing in this type of industry. Further, it discuss how to use manufacturing strategies, methods and techniques, successfully used in other industries (e.g. automobile and electronic industry), in order to meet present and future market challenges.

KEYWORDS Agile Manufacturing, Food an Drink Industry, Consumer Trends, Time Compression, Cooperation and Networking

INTRODUCTION

Food and drink (F&D) manufactures face the same competitive pressures as every other manufacturing sector, amplified by the special problems of their product and a relatively weak market position (Jones and Kruse, 1999). Traditional food products are produced in high volumes and with low margins. New consumer patterns and fierce competition enforces food companies to supply a broader range of products and simultaneously lower their costs. This requires improved efficiency in production and logistics operations.

Leading companies, particularly in the "Original Equipment Manufacturer" (OEM) industry, have successfully applied agile and lean manufacturing concepts to improve their competitiveness. In order to apply such concepts in the F&D industry, it is crucial to understand the distinctive characteristic of both the products and the production.

The project "*Competitive Logistics in Processing Chains*" focus on how the food and drink industry can improve their ability to meet customer's demands through competitive logistics. The project aims to develop analysis- and decision-models that support the design of efficient and agile food manufacturing systems. This paper will present the prerequisites and initial project results and discusses some ideas for applying agile manufacturing concepts in the Norwegian food industry as a response to the future markets challenges.

CHARACTERISTICS OF FOOD AND DRINK MANUFACTURING

The principles for agile manufacturing that will be outlined in this paper, are written with references to the automobile and electronic industry. Manufacturing systems in F&D industry share many of the characteristics of such manufacturing systems, but there are some vital differences:

Food and Drink Products

F&D products, when compared to OEM products, have five distinctive characteristics:

- Low complexity. The F&D products are often standard products consisting of few components/ingredients.
- Low margins and high volume. F&D manufactures are forced to accept low prices to keep their share of the market. Food products are typically high-volume products produced with low margins.
- Perishability. Raw materials, semi-final products and the final products are perishable and have limited durability (1 day - 2 weeks)
- Availability is crucial. Customers buy substitutes if a product not is available on the shelf.
- The packing is an important element of food products. The packing serve two purposes: First it shall protect the product from the surroundings, such as the sun, heat, cold, air etc. Secondly, the packing determines how the product appears for customers, and is a crucial part of marketing.

Food and Drink manufacturing

Both the supply of raw material and the demand in the consumer market are often strongly seasonal and not necessarily in synchronism (Moore, 1991). This requires efficiency in production and logistics operations.

The production of F&D products can be characterized as batch-flow production, with many similarities to process industry. A number of ingredients or components are mixed and processed in one or a series of operations to create a batch of an end product. Routings are simple, the flow is continuous and lead times are short. The number of input materials and components depends on the product, but a few input materials often result in an broad range of end-products variants, see Figure 1.

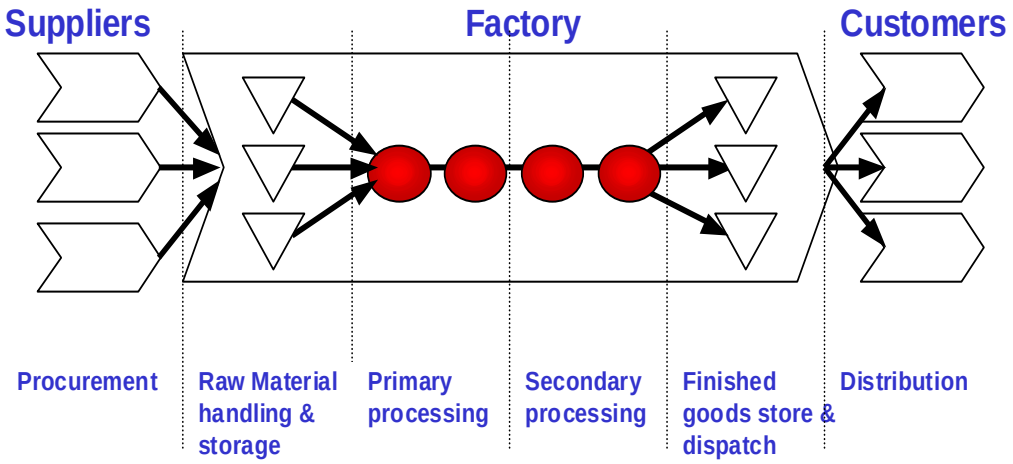

Figure 1 Manufacturing of Food and Drink Products

Figure 1 shows the steps in a food supply chain. Raw materials are delivered and stocked. These are perishable and the handling and storage is therefor crucial for the further processing of the product. Primary processing involves the actual production of the F&D product and can consist of one or a series of processes. Secondary processing is the handling and packaging of the product. The packaging implies a variant explosion, as the same products are wrapped-up in different packings. Stored goods are dispatched and distributed to retailers.

Figure 1 illustrates some of the differences between OEM and F&D manufacturing. Six major differences are outlined below:

- Production of F&D products has a high degree of similarity to process industry. The production is executed on process lines with long setup times. This requires batch production.

- The manufacturing equipment has a high degree of specialization. Each line is engineered for a few products, and it can be difficult to introduce new products on an existing line.
- Stringent hygienic demands necessitate periodic (daily) cleaning, and also cleaning between production of different products. The result is long setup times and reduced capacity utilization.
- Manufacturing of F&D products is normally make-to-stock. Long set-up times combined with short delivery times makes it necessary to supply from a final stock.
- Raw materials are organic and supply can be erratic because of seasonal variations and other variations like e.g. weather. As a consequence it is necessary to carry stocks of raw materials.
- The production line is very vulnerable to stop during production. A stop can cause serious damage on products, damages that not can be restored.

It is not straightforward to transfer manufacturing principles to the F&D industry. The special problems of F&D productions make it difficult to apply agile principles like e.g. just-in-time supply or single-minute-exchange-of-die. However, the next section will show the necessity of applying (modified versions of) agile principles in order to become more responsive to the market.

MARKET SITUATION IN THE FOOD AND DRINK INDUSTRY

The market situations for many food and drink (F&D) manufactures are under great alteration with regard to both consumer trends and the collaboration with retailers.

The consumer and customization

Most customers can still be regarded as conventional with high focus on cost. But there is a tendency that they change behavior depending of what circumstance they occur in. A consumer today can both be (Strandhagen et. al., 1999):

- Conventional – with focus on cost and with declining loyalty to brands.
- Critical – with focus on food quality, ecology and freshness.
- Identity seeking – with focus on the symbolic value represented by the food.

As a result the homogenous markets are fragmented and food companies are increasingly forced to compete in smaller market segments.

Demand situation

In the last 10-15 years, there has been a restructuring of the food retailers in Norway. Today, four companies control more than 98% of the retailer market (Borch and Stræte, 1999). These retailers have traditionally based their sale on low costs and restricted assortment. However, changing consumer patterns and increasing international competition have initiated new trends in the Norwegian retailer market.

- The product range is increasing. The assortment seems to grow and a variety of profiles and concepts are introduced in the market. These profiles include high-quality and low-volume products that allow higher margins.
- The consumer expects a higher degree of freshness. This requires shorter throughput times and agile supply.
- Retailers increasingly promote them self through national wide advertising campaigns. This implies huge volume fluctuations and fast refilling of products. Profitable sale campaigns require shorter planning time, the ability to handle variable quantities and improved delivery performance in the total supply chain.

These trends point toward increasing demand fluctuations and broader product ranges in a market situation characterized by strong competition and low margins. The new market situation is illustrated in Terry Hills volume/variety matrix (Hill 1993).

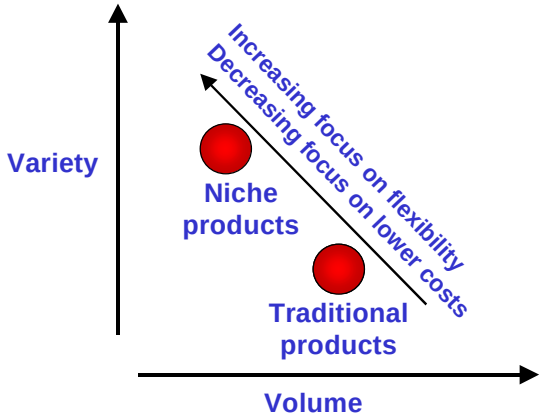

Figure 2 Volume and variety for food products

A majority of consumers are price-oriented in their consumer patterns. Thus, traditional high-volume products still constitute a major share of the Norwegian food market. Success in this market segment requires continuos improvements in order to utilize capacity and provide efficient replenishment. However, the market share of niche products is increasing. Such low-volume products forward new requirements for flexible and responsive processes, and many companies experience that their system design no longer matches their market situation. Success will increasingly require agile manufacturing and closer collaboration through the supply chain.

AGILE MANUFACTURING

An agile enterprise is flexible, adaptable and has the ability to thrive into a continuously changing business environment where markets consist of rapidly changing niches, serving increasingly sophisticated customer demand. The major principles of agility are outlined by Goldman *et al.* (1995):

- Enriching the customer
- Co-operating to enhance competitiveness
- Mastering change and uncertainty
- Leveraging people and information

Some authors, like Huang and Nof (1999), point out that agility can be viewed from two different perspectives. Agility is the dynamic collaboration with other companies in order to exploit market opportunities. The focus is on effective management of relationships between participating enterprises. Secondly, agility is the capability of each individual company to handle variations and respond to customer demand. The focus is on effective operations and logistics that enable flexibility and speed. This paper holds the second perspective and focus on agile manufacturing.

Agile manufacturing can be defined as a manufacturing system with extraordinary capability to meet the rapidly changing needs of the marketplace (Youssef, 1994). An agile manufacturing system must have the ability to shift rapidly amongst product models or between product lines, ideally in real-time response to customer demands. Agile manufacturing is based on a mixture of techniques and methods from various manufacturing strategies (Kidd, 1994). These techniques and methods are applied in the intention to become flexible and respond quickly to market demands. This paper claims that the most important manufacturing strategies for agile manufacturing are:

- lean production
- time-based competition

- socio-technical system design
- demand chain management

The strategies are outlined below:

Lean Production.
The term 'lean' was coined by IMVP (the 5 year International Motor Vehicle Program at MIT) and was based on a thorough study of American, European and Japanese automobile manufactures (in particularly the Toyota Production System TPS). The term 'lean' was used because TPS banish waste and used significantly less of every resource than mass production systems (Womack *et al*, 1990).

According to Nicholas (1998) there are seven fundamental elements of lean production, because they all deal directly with sources of manufacturing waste, including waste from defects and quality problems: 1) *Small-lot production,* 2) *setup-time reduction,* 3) *maintaining and improving equipment,* 4) *pull production systems*, 5) *focused factories and group technology,* 6) *workcells and cellular manufacturing and* 7) *standard operations.*

Time-based Competition.
Manufacturing companies can compete in terms of time in two different ways. On the one hand, they can achieve competitive advantage by a faster development and introduction of new products. On the other hand, manufacturing companies can achieve sustainable competitive advantage through a faster filling of customer orders. Those firms emphasize speed in terms of responding to customer's orders demands for established products (Handfield, 1995).

Time compression is a major enabler for cost efficient, responsiveness and flexibility. Stalk and Hout (1990) outline four strategic advantages by compressing the throughput time:
- Productivity is increased
- Prices can be increased
- Risks are reduced
- Market share is increased

Thun *et al*. (2000) present a framework for time-based manufacturing, which is defined as a set of six practices designed to reduce cycle time: *Simplification, standardization, availability, acceleration, integration* and *control.* The compression of throughput times is crucial in achieving agility.

Socio-technical System Design.
The "socio-technical" concept reflects a focus on joint optimisation of technology and social systems, indicating that really effective systems can only be generated when technology and people are properly matched (Trist, 1981). In a socio-technical system, activities are no longer separated into narrow areas of responsibility. Teams of multi-skilled and empowered workers replace the conventional hierarchy (Taylor & Felten, 1993). Major socio-technical principles are outlined below:
- *Semi-autonomous groups*. - the best decisions are based on the decision makers' practical knowledge and insight in a specific situation, and information must be provided at the place where decision and actions will be taken.
- *Boundary management.* - the degree of self-regulation should be maximized throughout the enterprise. This is enabled though a design guided by the *minimum specification criteria* (Trist, 1981), which is to specify no more than is absolutely necessary regarding tasks, jobs, roles etc.

- *Participatory design*. Technology (tools, information, machines, procedures etc) should be designed for competent worker performance, rather than for automation or command and control. This requires extensive worker participation in design (Ehn, 1992).

Design by socio-technical principles enables enterprises to handle variation and uncertainty, and provide solutions that improve peoples' work quality and performance

Demand Chain Management.
Supply chain management (SCM) can be defined as the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole (Christopher, 1998). At the operational level, the supply chain supports three types of flows that require careful control and extensive communication:

- Material flows, which represent physical product flows from the suppliers to the customers
- Requirement flows, which represent order transmission
- Financial flows, which represent credit terms and payments.

According to Wortmann (1999) the basics principles of SCM are: Postponement, partnerships to streamline merchandising and distribution processes, sharing of resources and capabilities between manufactures and distributors, sharing demand information to improve forecasts, using modern information technology to rethink (de)centralization of processes.

SCM may give the impression that the general task is managing supplies to be fed or pushed to the customers down the chain. But the chain of supplies and deliveries should be driven by true end-customer demand, and thereby the term Demand Chain Management (DCM).

AGILE MANUFACTURING PRINCIPLES APPLIED IN THE FOOD AND DRINK INDUSTRY

In the previous chapters we have on one hand discussed the characteristics of the food and drink products, manufacturing and market. On the other hand we have presented agile manufacturing and discussed some its prerequisites. We will now like to combine these to discussions.

In the following we will present and discuss some major principles that are crucial in achieving agility in the F&D industry. These principles are chosen with consideration of the special market situation in the F&D industry and the characteristic of F&D products and production.

Strategic Positing of the Decoupling Point.
The decoupling point separates the part of the enterprise where manufacturing is based on customers' orders from the part that is based on planning and level control. The decoupling point is also a point to stock components as a buffer that smoothes demand variety (Strandhagen & Skarlo, 1995). Such strategic positioning of stocks enables the variant explosion, speed and cost efficiency required for mass customization of products.

In the F&D industry, a natural choice of decoupling point would be the stage between primary and secondary processing, see Figure 1. In doing so, the manufacturer is able to present a standard product in a unique way to each customer.

Focused production lines.
The robustness and flexibility of an enterprise depend on a product-oriented and flow-oriented layout. The design is carried out through Burbidge’s material flow analysis and group technology (Burbidge, 1979). Material flow is analyzed and resources are grouped into segments that form clusters of operations with joint input and output channels.

In F&D manufacturing, it is often beneficial to separate niche products from traditional products (see Figure 2). Traditional products require automated, high speed and specialized process lines that can produce high volumes of a limited product range. Niche products require flexible lines that rapidly can produce low volumes of many different products. Flexible lines are not as efficient as high volume lines and often involve a greater share of manual work.

Setup Time Reduction

The food and drink industry has traditional been known to have long setup times. Reduced setup time permit reduced lot-size production and result in increased production capacity, flexibility and resource utilization, as well as improved quality and customer satisfaction.

Shingo (1985) has developed a methodology to improve setup time, called single-minute-exchange-of-die. This methodology can also be used to improve setup times in food manufacturing. However, continuous production and hygienic regulations makes it more difficult to achieve rapid setup times in food manufacturing, (F&D manufacturers are often obligated to do cleaning between product changes). Still, in order to increase productivity and flexibility in the F&D industry, reduction of setup time is of extreme importance.

Flexible and Multi-Skilled Workforce

As the demand for different products varies, different production lines will be bottlenecks in the manufacturing system. To exploit the full potential of the production lines, multi-skilled workers should alternate between different production tasks. Training and job-rotation enable manufactures to allocate their operators in line with demand fluctuations.

Integration of process across company border.

Close supplier coordination/integration in the delivery process is viewed necessary for several reasons. The overall issues are *time compression*, *quality requirements*, *process improvement* to reduce cost and *information sharing*. Integration with customers are argued to give the followings effects (Raabe, 1999):

1. *Efficient replenishment* - fast and frequent refilling of products in the stores.
2. *Efficient assortment* – seeks to optimize the sale per sqm.
3. *Efficient promotion* – order, produce, ship and stock exactly what sells
4. *Efficient product introduction* – product development and introduction is a joint effort

The integration of suppliers and customers is achieved through linking processes across the companies' boarder. Perhaps the most crucial element in linking processes together is the use of Information and Communication Technology (ICT). Allowing information exchange between companies ERP systems, through e.g. EDI or portals technologies, gives the parties access to real time information about activities both upstream and downstream in the value chain.

CONCLUSION

In attempting to achieve agile manufacturing of food and drink products, there are some pitfalls that have to be examined. First, these methods and techniques applied in agile manufacturing are not developed for the food and drink industry. They have their origin in other industries like e.g. automobile and electronic industry (OEM), and therefor not perfectly adaptable. Secondly, the F&D manufactures are under great alteration with regard to both consumer trends and the power structure of the industry. By focusing on the market situation and consumer trends in the food and drink industry, together with the characteristics of both the F&D products and the manufacturing of these products, we have tried give an understanding of some of the challenges in this industry.

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