

BENEFIT OF MASS CUSTOMIZATION AS A MANUFACTURING STRATEGY WITH A CASE STUDY

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ABSTRACT

Mass customization entails the ability to provide customized products and services to individual customers using technology (information) at optimal production efficiency and cost levels. This strategy requires having specific processes in place to create the ability to deliver highly customized products at the lowest total costs. The core of mass customization is the ability to increase product variety and customization without increasing costs. The key to mass customization is to standardize early portions of the production process and to postpone the task of differentiation until the last possible point in the supply chain network. This paper examines the advantage of product customization on four competitive priorities: cost, quality, delivery, and flexibility with the case study regarding (upholstery fabric). In the case study, we contacted Aydin Tekstil (AT) firm. It was investigated whether the mass customization affect their production or not. After examining AT's manufacturing system, applying MC would benefit AT. Case study showed us that AT is lowering its inventory carrying cost, while increasing its service quality and profitability by being able to meet variety of customer needs.

Key words: Mass customization,

INTRODUCTION AND LITERATURE REVIEW

Mass customization aims at better serving customers (better) with products and services that are closer to their needs and building products upon economy of scale leading to mass production efficiency. To this end, an orchestrated effort in the entire product life cycle, from design to recycle, is necessary. The challenge lies in how to leverage product families and how to achieve synergy among different functional capabilities in the value chain. This may lead to significant impact on the organizational structure of company in terms of new methods, education, and

division of labor in marketing, sales, design, and manufacturing. The technological roadmap of mass customization can also lead to redefinition of job, methodology, and investment strategies as witnessed in current practice. For instance, the sales department will be able to position itself to sell its capabilities instead of a group of point products.

As a new frontier of business competition and production paradigm, mass customization has emerged as a critical issue. Mass customization can best be realized by grounding up, instead of by directly synthesizing existing thrusts of advanced manufacturing technologies, such as JIT, flexible, lean and agile manufacturing, and many others. With the advent of industrial revolution and interchangeable parts, manufacturing moved from the craft era to the mass production era.

At the beginning of 20th century, industrialized economies adopted mass production, mass distribution, mass marketing and mass media to cut cost, and produce homogeneous products. However, as time shift to the new century, customers cares more and more on uniqueness and want to have distinct products that are tailored for individual(s). Thus, Mass Production seems to fail in adapting it self to customers' needs; therefore, with the help from advanced information and technology synergy, a new business strategy, Mass Customization, start to take over in today's business.

Just as mass production was crucial to manufacturing in the 20th century, mass customization (MC) will be the key to economic growth in the 21st century. Mass customization is a way to mix the concepts of economy of scale with that of economy of scope. This makes it possible to produce at the low cost of mass production but still being able to produce individually customized products (Hart, 1996). It is also important to acknowledge the difference between product variety and mass customization. With product variety, you

can satisfy more customers, but in contrast to mass customization, the customer has no possibility to influence the product properties and specifications. (Duray et al, 2000). This may seem as a subtle difference, but it shows a big difference in the way a company looks upon customer involvement in the product development process. A system of large product variety can be described as a *push system*, whereas a mass customization system mainly is a *pull system*, if the terminology of lean production is used. MC is the ability to design and manufacture customized products tailored to meet a customer's needs at mass production costs and speed. Mass customization is the use of flexible processes and organizational structures to produce varied and often individually customized products and services at the price of standardized, mass-produced alternatives (Hart, C.W., and Taylor, J.R., 1996). When customization is done on a mass basis, it is called mass customization (Pine 1993). In the mass customization concept, goods and services are produced to meet individual customer's needs with near mass production efficiency (Tseng & Jiao 2001). In Toffler's book "The Third Wave", Robert H. Anderson predicted that "the most creative thing a person will do twenty years from now is to be a very creative consumer, especially, you'll be sitting there doing things like designing a suit of clothes for yourself or making modifications to a standard design, so the computers can cut one for you by laser and sew it together for you by numerical control machine." (Dewan, & Seidmann, 2000) "Mass customization" was coined by Davis (1996) with an explicit reference to the above mentioned Anderson and Toffler. The term was later developed into a business approach by Pine (1993) and by many other authors following his approach (e.g. Duray 2000; Piller 2003; Tseng & Jiao 2003). It became popular in academia and was adapted by practitioners as an e-business approach (Fulkerson & Shank 2000; Lee et al. 2000).

Theoretically, there is no restriction with respect to the area of industry MC could be applied to. In order to organize the diversity of this strategy several classification schemes have been developed and published (Gilmore/Pine, 1997 and Piller, 2001). They illustrate explicitly that MC could be implemented to different types of goods and branches. Understanding MC as an abstract business model, it has impacts on product design, manufacturing, and assembly processes as well as logistics and information processing, e.g. small lot sizes and increased diversity of variants (cf. Piller/Stotko, 2002). Mass production clearly shows an advantage. However, in low to medium volume production, where production quantity cannot justify

and leverage the investment, customers are otherwise willing to pay more because their special needs are satisfied. This is the area where we believe mass customization provides a tremendous advantage in business competition (Tseng and Jiao, 1996). Mass customization is basically a synthesis of the two management systems, mass production and customization. The introduction of innovative product strategies, advanced manufacturing technologies, and organizational structures have minimized the traditional sacrifices of customized products. This has led scholars to claim that mass customization offers superior customer value compared to other strategies (Gilmore and Pine, 2000). On the other hand, mass customization combines the best of the craft era, where products were individualized but at high cost, with the best of mass production, where products were affordable but highly standardized (Fralix, 2000). Companies are expected to pursue both efficiency and effectiveness at the same time. Combining these two aspects is difficult at best and requires reasonable trade-off between cost control and production of customer value.

As is understood the definition above of the mass customization, Mass customization is the ability to satisfy the particular needs and wants of individual customers at prices below those of mass produced products and services that only approximate the wishes of many customers in large market niches. Mass customization requires six core competencies:

- Eliminating Customer Sacrifice
- Modular Design and Integration
- Supply Chain Management
- Lean Production
- Process Organization
- Multi-project Management

This paper examines the impact of product customization on four competitive priorities: **cost, quality, delivery, and flexibility**. The theory of manufacturing trade-offs dictates that the four priorities are in conflict, an improvement in one necessitates a decrease in performance of another. However, if we are to accept the claims of mass customization, these four priorities should be compatible with product customization.

Mass Customization Manufacturing

Today's customers are now demanding highly customized products and services. The niche markets are becoming the markets. Mass customization requires rethinking and integrating the product design, the

manufacturing processes, the delivery processes, the configuration of the entire supply network to deliver products, and light manufacturing in distribution centers to support final customization steps. Competition for mass customization manufacturing is focused on the cost, quality, flexibility, delivery and responsiveness in order to satisfy dynamic changes of global markets. The traditional metrics of cost and quality are still necessary conditions for companies to outpace their competitors, but they are no longer the deciding factors between winners and losers. Major trends are:

1. A major part of manufacturing will gradually shift from mass production to the manufacturing of semicustomized or customized products to meet increasingly diverse demands.
2. The "made-in-house" mindset will gradually shift to distributed locations, and various entities will team up with others to utilize special capabilities at different locations to speed up product development, reduce risk, and penetrate local markets.
3. Centralized control of various entities with different objectives, locations, and cultures is almost out of the question now. Control systems to enable effective coordination among distributed entities have become critical to modern manufacturing systems.

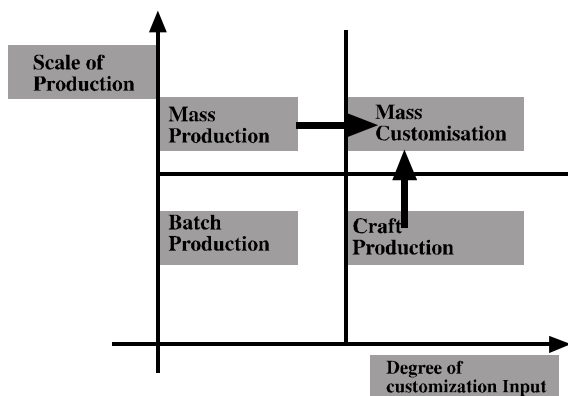


Figure 1: Shifts in manufacturing (Fralix, 2001).

To achieve this, it is becoming increasingly important to develop production planning and control architectures that are modifiable, extensible, reconfigurable, adaptable, and fault tolerant. Flexible manufacturing focuses on batch production environments using multipurpose programmable work cells, automated transport, improved material handling, operation and resource scheduling, and computerized control to enhance throughput. Mass customization introduces multiple dimensions, including drastic

increase of variety, multiple product types manufactured simultaneously in small batches, product mixes that change dynamically to accommodate random arrival of orders and wide spread of due dates, and throughput that is minimally affected by transient disruptions in manufacturing processes, such as breakdown of individual workstations.

Why Do Companies Need Mass Customization?

The reasons of using Mass Customization instead of Mass Production can be identified as an adaptive behavior of the business. As the consumer preferences are always changing, and are becoming more diverse and unpredictable, gaining advantages among competitors need to be achieved by acknowledging customer needs and reacting accordingly.

Market and technology forces affecting today's competitive environment are changing dramatically. Mass production of identical products - the business model for the industrial complexes of the past - is no longer viable for many industry sectors. Market niches continue to narrow. Customer preferences shift literally overnight. Customers demand products with lower prices, higher quality, and faster delivery - but more customized to match their unique needs. To cope with these demands, companies are vigorously racing to embrace the strategy of mass customization: "The development, production, marketing, and delivery of customized products and services on a mass basis," a definition popularized by Joseph Pine, a leading spokesman. Mass customization means that customers can select, order, and receive a specially configured product - often choosing from among hundreds of product options - to meet their specific needs. Mass customization also means major shifts in operating methods throughout the organization - engineering, manufacturing, and marketing - including the supply chain. For the engineering design and development community, successfully implementing mass customization has major implications such as: the compelling need for parts standardization and modular design; effective use of Product Configurators; and, linking the "front-office" systems with the "backoffice" applications of an agile (lean and flexible) manufacturing organization.

Starting from World War II to 80's, public had been accepting whatever goods that is available to them. However, nowadays, with the ease of idea sharing, mass production has, in many cases, over produced. Also, people are more unpredictable and diverse-

minded; they refused to be considered see as collective groups but as individual person. To approach the goal, customer requires more unique products to exhibit their distinctness and uniqueness.

Besides this consumer style change, Mass Customization also applied by companies to gain a competitive edge among other competitors. First, lots of companies produce substitutes at low prices; thus, a price advantage would be minimized by cheap and replicated products. However, by providing success customized products to customers, companies can shift the focus of their buyers from how much they are to pay to how much benefit they can get. Since manufacturers make products after receiving orders, the risk of over-producing an item that no one need and stocking it in the inventory are reduced. Moreover, companies create a close relationship with their suppliers, distributors and customers when the customers return again and again, sending their unique orders. Also, satisfied customers will provide excellent references and referrals. Besides, current technology can aid suppliers, distributors and customers to work together; provide a fast and efficient process to produce customized products. Company can also enters customers' preferences into database, perform data mining, individual profiles can then be compiled and analyze for new market opportunities. If acting properly, companies are able to satisfy both current and new customers.

Benefits of Mass Customization

Mass customization refers to the use of technology, such as Dell computer's service delivery platform, to deliver customized services to end clients on a large scale basis at much lower price points. This results in addressing each customer's specific needs without having to resort to specialized processes and one-off deals that reduce margin. The benefits of mass customization are:

- Lower total cost
- Improved customer satisfaction
- Competitive advantage
- Flexibility under changing market conditions
- Broader product lines
- Higher quality products
- Higher profits
- Avoidance of forecast errors
- Avoidance of purchasing delays
- Optimize margins by productizing and standardizing your services
- Provide consistent response times and service deliverables by moving away from
- "one-offs" and custom deals

- Simplify service and client setup; turn-up customers faster
- Minimize service provisioning errors; automate error-prone tasks
- Reduce the number of support calls
- Reduce overall operating costs by streamlining ongoing management tasks
- Align operational delivery with services sold

The driving force in MC is the potential benefits of MC compared to the existing system of mass production. Improved fit with each customer's unique needs will help to satisfy the customers and increase customer loyalty. For example, "the repurchase rate for Levi's Personal Pair custom fit jeans was 38 percent as opposed to 12 percent for its traditional jeans". The ability to maintain lower inventory levels throughout the supply chain helps in improved profits by means of reduced markdowns and interest costs, improved cash flows, effective space utilization, etc. Customers are motivated to buy customized products at a higher price because primarily it is customized and the product needs no modifications such as alterations after purchase. The continuous and direct dialogue between the mass customizer and customer help to provide the right product to the consumer. As an added advantage, this information can be used to develop new mass products for customer preferences (Berman, 2002).

Cost and Economic Advantage of Mass-Customization

The economic advantage of MP is to produce the homogenous products in a serial way. The other hand, the economic advantage of MC is the driving factor in a successful MC business. Anderson (2003) addresses the concept of cost of variety, which is a closer look at the current attempt to practice manufacturing variety of a single product. He refers to this cost of variety which is applicable to many companies today as the "sum of all the costs of attempting to offer customers variety with inflexible products that are produced in inflexible factories and sold through inflexible channels". As he discusses the costs that must be considered in identifying the manufacturing variety are, customizing and configuring product costs, setup costs, costs of excessive parts, procedures and processes and excessive operations costs caused by meeting variety from inflexible systems.

A different approach for obtaining this cost is to compare the company's current operating budget under the idealistic situation of producing a single product

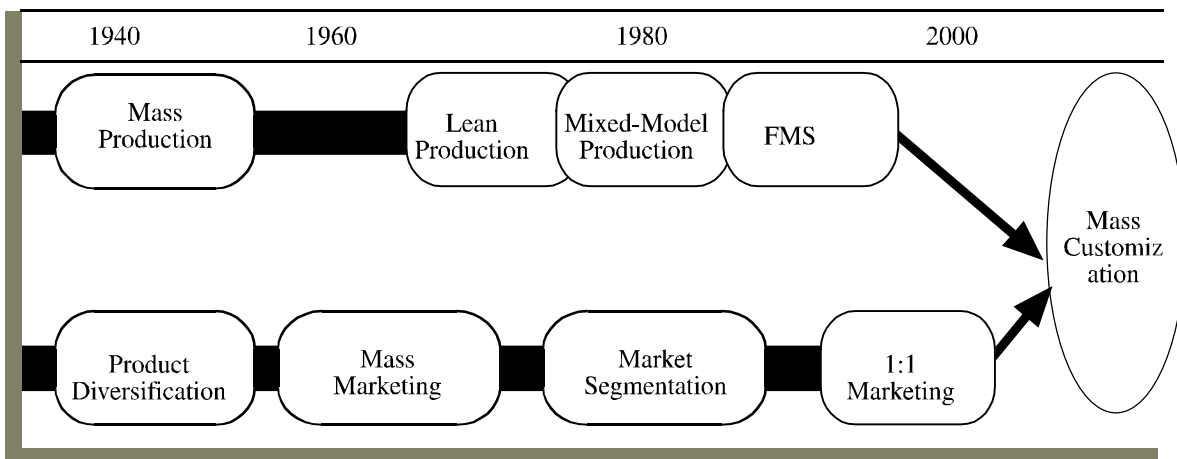


Figure 2: From the book, “Build to order & Mass customization” by Anderson (2004) shows a pictorial representation of the concept of market variety and cost of variety.

with no variety to a mass-customized product with similar volume using a similar manufacturing process. The difference between the current operation cost and the single product scenario calculates the variety cost. Figure 1. from the book, "Build to order & Mass customization" by Anderson (2004) shows a pictorial representation of the concept of market variety and cost of variety. Increasing market variety causes the variety cost of MP to increase exponentially because of the cumulative effects of inefficiencies faced by MP manufacturing practices. Similarly, Figure 2 shows how response difficulty changes with market volatility in case of MP and MC. The response difficulty for MP rises exponentially with increasing market volatility. Considering apparel MP and MC, this representation shows a practice of MP in a market environment with changing demands for manufacturing variety of styles. As Anderson (2004) shows the MC practice will be able to overcome both the variety cost and response difficulty issue because of eliminating setup, reducing batch size, eliminating or reducing WIP, improving customer loyalty, etc. It should be noted that these graphs are qualitative rather than quantitative.

The advantage of Product Customization In Terms of Cost, Quality, Delivery, and Flexibility

Mass customization is a new paradigm for industries to provide products and services that best serve customer needs while maintaining near-mass production efficiency. To understand the impact of product customization we must point out the importance of the Cost, Quality, Delivery, and Flexibility.

Building flexibility to respond quickly to changing market needs has been regarded as one of the major challenges in operations management over recent years (Bordoloi et al., 1999 and Barnes-Schuster et al., 2002). Industrial markets have been increasingly subject to frequent changes regarding product variety and demand volumes (Bayus and Putsis, 1999 and Jack and Raturi, 2002). In most cases, however, customers do not accept paying higher prices or waiting longer for products fitting to new demands. For many operations, the challenge is how to build flexibility at no expense to cost, quality, or delivery performance (Boynton et al., 1993 and Suarez et al., 1996). Over the last decade, a great deal of research has aimed at tackling such flexibility challenge (De Toni and Tonchia, 1998). Most authors focused on either exploring the relationship between flexibility and performance, or building conceptual typologies or taxonomies (Narasimhan and Das, 1999). Flexibility of a system has been defined as its ability to adapt to environmental change (Sethi and Sethi, 1990 and Gupta and Goyal, 1989). It entails modifying processes and product configurations with little penalty in time or cost to deal with changing circumstances (Slack, 1987, Upton, 1994 and Van Dijk, 1995). According to Bordoloi et al. (1999) and Barnes-Schuster et al. (2002), flexibility has grown in priority due to pressures to respond to changing market needs and shortening product life cycles.

Figure 3 illustrates the economic implications of mass customization (Tseng and Jiao 1996). Traditionally, mass production demonstrates an advantage in high-volume production, where the actual volume can defray the costs of huge investments in equipment, tooling, engineering, and training. On the other hand, satisfying each individual customer's need can

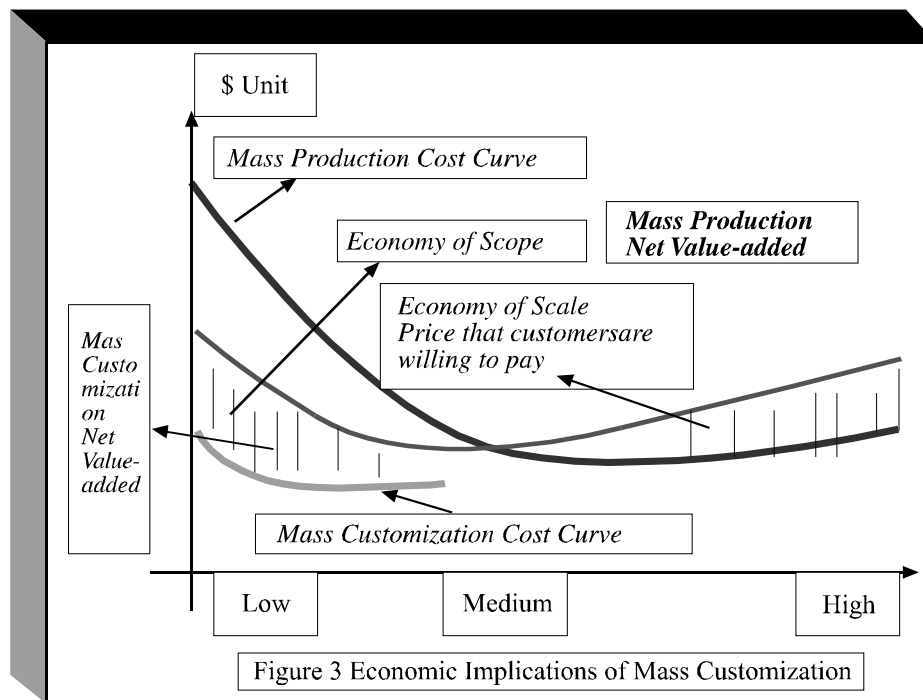


Figure 3: Adopted from "3rd Edition Handbook of Industrial Engineering Edited by Gavriel Salvendy Published by Wiley-Interscience In cooperation with Institute of Industrial Engineering"

often be translated into higher value, in which, however, low production volume is unavoidable and thus may lend itself to becoming economically not viable. In the same time, mass customization provides movability advantages to firms in terms of low inventory, retaining of customers, profit potential. Accommodating companies to garner economy of scale through repetitions, mass customization is therefore capable of reducing costs and lead time. As a result, mass customization can achieve higher margins and thus be more advantageous. With the increasing flexibility built into modern manufacturing systems and programmability in computing and communication technologies, companies with low to medium production volumes can gain an edge over competitors by implementing mass customization

In reality, customers are often willing to pay premium price for their unique requirements being satisfied, thus giving companies bonus profits (Roberts and Meyer 1991). From an economic perspective, mass customization enables a better match between the producers' capabilities and customer needs. This is accomplished through either developing the company's portfolio, which includes products, services, equipment, and skills, in response to market demands, or leading customers to the total capability of the company so that customers are better served. The end results are conducive to improvement in resources utilization. Mass customization also has several significant

ramifications in business. It can potentially develop customer loyalty, propel company growth, and increase market share by widening the product range (Pine 1993). Besides, quality is the an other important factor in terms of the mass customization. Quality is defined by the customer. A quality product or service is one that meets customer equirements. Not all customers have the same requirements so two contrasting products may both be seen as quality products by their users. For example, one house-owner may be happy with a standard light bulb - they would see this as a quality product. Another customer may want an energy efficient light bulb with a longer life expectancy - this would be their view of quality. Quality can therefore be defined as being fit for the customer's purpose. There are three main ways in which a business can create quality

Qualitative research
Quantitative research

Working to best practice standards is another way an organization can create quality. BSI works with industry specialists to create these standards. For example, it delivers the confidence of customers in a business through BS 7799. This is the standard for a company's management of information security. BSI developed this standard in 1995 to establish best practice for capturing, storing and handling data. This British Standard became the basis for the International

Standard ISO/IEC17799. Today companies worldwide are seeking certification for their security management systems.

CASE STUDY

Textile Industry is generating 1/10 of the whole added value that is created in Turkey and has 1/3 share of the total export. It is estimated that 10 Million people are employed in textile industry in Turkey.

Aydin Textile (AT) Company is founded in 1979 as a small family owned company. Over time, it has become the largest upholstery fabric manufacturer in Europe with 1,200 employees and over 100,000 square meter production area. AT is manufacturing nearly 24,000,000 meter upholstery fabric annually and markets all over the world. AT is a pioneer company that sold upholstery fabric first to many countries such as the USA, Australia, New Zealand as Turkish company.

AT has its own yarn manufacturing facilities, dying facilities, warp facilities, weaving facilities and finishing facilities. Therefore, AT would be considered as a large factory consisting of sub factories. In yarn manufacturing facilities, AT purchases fiber bales and processes them into fancy, chenille yarn cones. Dying facilities are used to process yarn cones to be fashionable colors. Weaving facilities receive yarns from yarn and dying facilities, in addition to warp from warp facilities. Then these yarns weaved into, colorful, upholstery fabric rolls. After that, these fabric rolls are processed to be ready for shipment in finishing facilities.

Before MC was adopted at AT, orders were received,

and checked for warp and weft first. After, if any of the yarn in warp or weft was not sufficient, then planning department set an order for manufacturing necessary yarn to yarn department. For every single SKU, one or more, if necessary, warps were prepared. If any order coming from customers was not sufficient for a full warp, usually between 1500 mt to 3000 mt, then the order was rejected.

The competition became more intense because every market became easier to reach for suppliers and consumers have more alternatives than ever. Therefore, in order to survive and grow over time, companies should listen to their consumers carefully and provide them exactly what they want. This severe competition from all over the world forced AT to change as a global company. AT's managers have decided that their production policy should shift from mass production to mass customization.

However, it was very difficult to meet all customers' needs in the form of exactly they wanted. There were some constraints limiting AT to manufacture fabric amounting less than warp size. It costs more to manufacture smaller amounts of fabric due to long set up times and diminished productivity rates. Even though it takes almost the same time to prepare 100 mt of warp and 3000 mt of warp, the profit generated from each of them is extremely different. AT was able to make 1/30 of profit by preparing 100 mt of warp in stead of 3000 mt of warp. For this reason, AT was not accepting orders less than 1,500 meters per color. As a result, it was losing orders and market share against its rivals.

AT's managers believed that AT would be able to accept those orders less than 1,500 meters for every

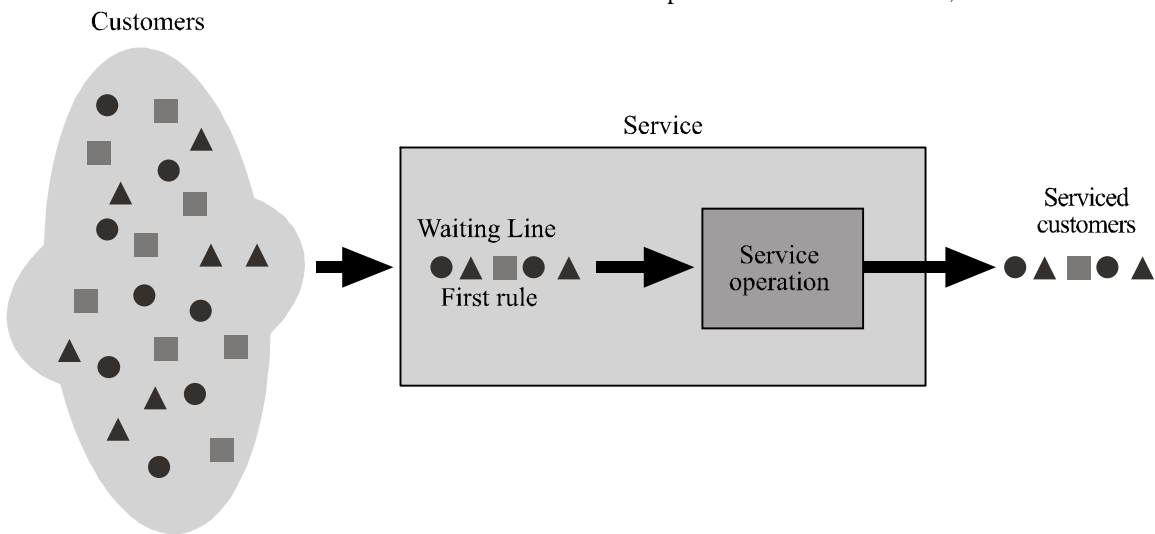


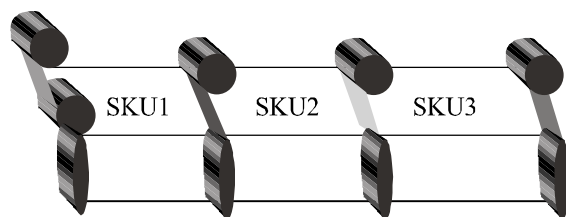
Figure 4: The Sequence of Answering Different Demands According to Mass Customization

stock keeping unit (SKU) by adopting mass customization as manufacturing strategy. This would result that AT may meet its customers' demand and needs, and increase its market share.

In order to adopt mass customization in AT, first warp types were reviewed. It was realized that there were similar warp types that developed over time. After carefully studying the warp list, it was realized that some of the warp types were very similar to each other and therefore would be eliminated from the list. After working on warp list, weft yarn colors and types were studied. It was realized that also there exist some really similar colors in weft list and some of them would be eliminated.

Elimination of similar yarns made AT to carry less yarn stocks to keep its ongoing operations. After elimination of similar warps and weft yarns, order receiving and accepting process examined. It was suggested that in stead of rejecting smaller, and more profitable, orders, these orders should be kept in a queue until AT receive one or more SKU orders with the same warp.

Even if the SKUs are not the same, their warp would be the same. It was known that there were so many SKUs possible to weave on the same warp, and only their weft yarns and designs were different. Therefore, it has become possible to accept orders less than 1500 mt for each SKU. Planning department takes the smaller SKU orders, and prepares a virtual warp to list these smaller orders on this virtual warp. After smaller SKU orders on the same warp reach the minimum required amount, warp was manufactured and then the small SKU orders were weaved on appropriate loom. In practice, operators set the loom for the first SKU and loom stops after weaving the set amount. Meanwhile, operator prepares weft yarns be ready for use for second SKU. After that, operator simply changes the design diskette and sets the loom for the second SKU order. This would continue until planned SKUs on that particular warp were finished.



Shape 1: Stock Keeping Unit

In shape 1 (stock keeping unit), 3 different SKUs on the same warp were illustrated. Before adopting mass customization approach, AT was not able to accept and weave these small SKU orders and the orders like these. Since similar warp types and weft yarns are eliminated, it has become possible to weave much more SKUs on the same warp. Due to this change, AT started to accept smaller orders.

As a result, AT became a more consumer oriented company that is able to accept smaller amount of orders and it didn't cost anything. In contrast, AT used the very same warps and weaved more SKUs with the same warps. This helped AT to keep up with its rivals and its market share in addition to decreasing its yarn stock cost.

CONCLUSION

The economic advantage of MP is to produce the homogeneous products in a serial way. On the other hand, the economic advantage of MC is the driving factor in a successful MC business. The driving force in MC is the potential benefits of MC compared to the existing system of mass production. Improved fit with each customer's unique needs will help to satisfy the customers and increase customer loyalty. The continuous and direct dialogue between the mass customizer and customer help to provide the right product to the consumer. At the same time, mass customization provides mobility advantages to firms in terms of low inventory, retaining of customers, profit potential. The reasons of using Mass Customization instead of Mass Production can be identified as an adaptive behavior of the business. As the consumer preferences are always changing, and are becoming more diverse and unpredictable, gaining advantages among competitors need to be achieved by acknowledging customer needs and reacting accordingly. Accommodating companies to garner economy of scale through repetitions, mass customization is therefore capable of reducing costs and lead time. As a result, mass customization can achieve higher margins and thus be more advantageous. With the increasing flexibility built into modern manufacturing systems and programmability in computing and communication technologies, companies with low to medium production volumes can gain an edge over competitors by implementing mass customization.

Case study showed that adopting MC helped AT to reduce its inventory carrying cost. Before MC was adopted, AT developed so many different warp types over time and it had to carry certain amount of yarn

for each warp. AT had to carry different yarn types for every warp and weft, because time was very critical issue in customer satisfaction in upholstery fabric business. If you deliver your customers' orders later than 4 weeks after receiving, it is very likely that, customers will not prefer AT on next time. This resulted AT to invest its capital on so many types of yarns, which AT might never use. This financial cost was contributing AT's overall cost and increasing its prices. Therefore AT was losing its competitiveness.

Adoption of MC also helped AT to improve its service quality. Previously AT was not able to accept smaller orders, and its customers went somewhere else to get its smaller orders done. This was resulting AT to lose money, customer and credibility against its rivals. However, by adopting MC, AT has become more consumer oriented, and satisfied its customers by meeting their needs and wants.

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