

**FROM MASS PRODUCTION TO MASS CUSTOMIZATION**

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ABSTRACT

With the advent of the industrial revolution and interchangeable parts, manufacturing moved from the craft era to the mass production era. Today there is a new era emerging and it is called Mass Customization. Mass Customization takes the best of the craft era, when customers had products built to their specifications but only the elite could afford them, with the best of the mass production era, when everybody could get the same product because it was affordable. This presentation will highlight the development of Mass Customization and how the sewn products industry is positioned to capitalize on it. As progressive companies trade their traditional production concepts and practices for powerful mass customization techniques, this presentation will provide insight into the integration of information technology, mechanization, and team-based flexible manufacturing. Emerging technologies for mass customization such as three-dimensional non-contact body measurement and digital printing will also be discussed.

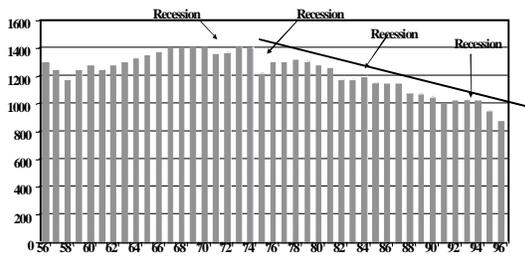
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Introduction:

Sometimes we get signals that it is time to change long before we respond to those signals. In fact, we have been getting signals in the United States that it is time to do something different, and we have been betting those signals for a long time. For example, a study of U.S. apparel employment over the last twenty years would indicate that there has been a steady decline from a peak of about 1.4 million workers to less than 800,000. (Figure 1) Likewise the textile and apparel trade deficit over the past ten years has grown tremendously. In fact, it has more than doubled in the past ten years (Figure 2).

Another very interesting signal that merits some attention is that of the growth in worldwide population. If world population were separated into developed countries versus developing or undeveloped countries, it would show that there is a significantly greater growth rate in developing countries. In fact, the projections for the next ten years indicate that world population is expected to grow from 6.3 billion to 7.3 billion people. Ninety percent of this growth is expected in developing countries (Figure 3).

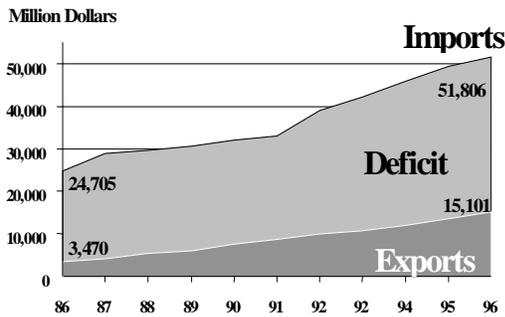
U.S. Apparel Employment (Thousands)



Source: AAMA

Figure 1.
U.S. Apparel Employment Statistics

U. S. Textile and Apparel Trade



Source: AAMA

Figure 2.
U.S. Textile and Apparel Trade Deficit

World Population In Billions

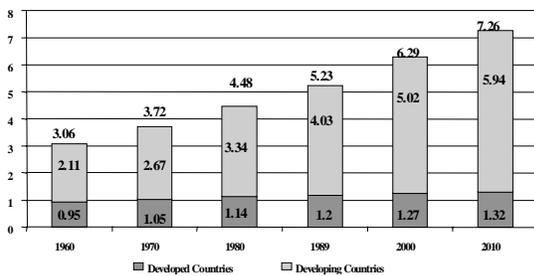


Figure 3.
World Population in Billions

This has significant implications for industries such as the apparel industry. So I ask, “Where is all of the growth taking

place?” It is in developing countries! “Where do you think the competition for jobs will be?” It will be in developing countries!

A closer study of the changes taking place and the trends that exist in consumer behavior reinforce the need for manufacturing companies to rethink their business strategies. These strategies should include the way supply chains are managed and products are manufactured. Industry today is confronted by a new set of requirements. The days of long runs of like products are gone – they are rapidly being replaced by the next generation of manufacturing principles. It is being called the era of *Mass Customization*.

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2. SIGNALS FOR CHANGE

There are some key indicators in the United States that it is past time for change. The first is that service expectations are higher than they have ever been. Consumers used to tolerate substandard service, but today, they do not have time for it. People are no longer willing to stand in lines and be ignored by bank tellers, hotel receptionists or other service providers. They want immediate and personalized service.

Second, consumers want more variety. If you do not believe it, investigate some of the consumer products and the options that are available today. To buy shampoo, for example, a consumer must make multiple decisions about his or her individual preferences before selecting the appropriate brand. Do they have oily hair, dry hair or normal hair? Is it permed, dyed or tinted? Is it thick, thin, or gone? Do they like strawberry, apple, or banana fragrance?

The same is true with other consumer goods. For those that have small children and wish to purchase disposable diapers, consumers must not only know the sex of the child, but it’s age to the nearest week, and the particular time of day that the diapers will be

worn, in order to make an accurate decision regarding the type of diaper to purchase.

To make this relative to the apparel industry, I would suggest that you look around the room at any meeting and locate another individual who is wearing the same “outfit” that you are wearing. The fact is that we really do not want this to happen unless we are wearing apparel that represents a team. The fact is that **we all want more variety!**

The third reason it is past time for change is that consumers no longer want to order goods and services and have to wait for their delivery. Ten years ago if a catalog order was placed, the expected delivery was four to six weeks. Today, after two or three days, consumers begin to wonder where and why their merchandise is being delayed.

The textile and apparel industries are not the only industries impacted by these signals. Other industries are also experiencing the kinds of changes that are causing a breakdown in mass production concepts. It is happening in the automotive industry. It is happening in telecommunications. It is happening in the banking industry. It is happening in the insurance industry. Everywhere one looks, there is a shift towards more personalized products and services.

3. THE ERA OF MASS CUSTOMIZATION

So what does this mean for U.S. businesses? Better yet, what does this mean for business in general? It means that it is time to change the way in which manufacturing organizations and service organizations operate. Just as the craft era was replaced by the era of mass production, mass production is being replaced by the era of *Mass Customization*.

Prior to the industrial revolution manufacturing was considered a craft. Products were typically custom made to meet the needs of a particular individual. No two products were exactly alike and

parts from one product could not necessarily be interchanged with the similar parts on another product. Since products tended to be relatively expensive, access was limited primarily to the upper class or aristocracy. With the advent of the industrial revolution and the concept of interchangeable parts, like products began to be produced in large quantities and were made available to the middle class. Because of the large production quantities of like products, the costs were low enough that they became affordable for most people.

Mass Customization has emerged as a practice that combines the best of the craft era with the best of the mass production era. Not to be confused with custom-made, mass customized products may still be manufactured in relatively large quantities; however, each item might be slightly different based on the needs and desires of the individual end customer. Joe Pine refers to the goal of Mass Customization to be to provide enough variety so that the wants of the consumer are satisfied; whereas the goal of Mass Production was to produce at sufficiently low cost so that everyone could have one.

The ability for manufacturers to offer mass customization is limited by their ability to get consumer information to the “workplace” doing the customization. Mass Customization is also limited by the extent to which production workers have been cross-trained and empowered to accept responsibility for the manufacturing and “customization” process, so that they can accurately respond to those needs. In addition, manufacturers are constrained by the lack of available technology that can be reconfigured quickly, easily, and cost effectively to meet consumer needs.

During the era of Mass Customization, product development cycles will be extremely short and product life cycles will also be extremely short relative to the era of mass production. Large homogeneous markets will be replaced by heterogeneous

niches with fragmented demand. Large numbers of similar products will continue to be manufactured; however, each consumer will be able to alter products based on their individual needs and the capabilities of the producer.

On the other hand, Mass Customization, does not mean that everything about a product is customizable. This may have been true in the craft era, and may still be true for some products, but it is not true for Mass Customization. Pine says that “variety in and of itself is not customization – and it can be dangerously expensive.” Customizable features must include only those things the customer determines are important and the customized products should not necessarily cost any more, other than the initial investment in the technology required to provide those features.

Information technology and automation play a key role in mass customization in that they create the linkage between a customer’s preferences and the ability of a manufacturing team to construct products based on those preferences. Customization will be limited by the availability of technology to make the customization seamless. It will also be limited by the ability of business systems to provide information about product features and customer requirements to the individuals who are able to respond to those requests. It is expected that the order-to-delivery process will be less than one week, including the manufacturing.

There are currently some limitations to mass customization in the apparel industry. These include garment fit and color selection. Fortunately, a tremendous amount of development work has been completed that will improve the opportunity for future consumers to have more garment customization available.

4. BODY SCANNING

For some apparel manufacturers, the term *mass customization* means manufacturing clothes that have been pre-altered to fit an individual’s body. A potential enabling technology for this method of creating individualized products is body scanning. Through body scanning, a three-dimensional image of person’s body is captured electronically. Critical measurements are then extracted from the digital image and downloaded to a pattern alteration system. The altered patterns are placed in a marker, cut, and assembled.

In October 1998, [TC]² unveiled its first commercial version of a three-dimensional, non-contact body measurement system. This system is capable of collecting over 400,000 data points during the eight-second cycle time of the scanner. The light level can be automatically adjusted for both light and dark skinned subjects. From the scanned data, a large number of exact measurements can be extracted.

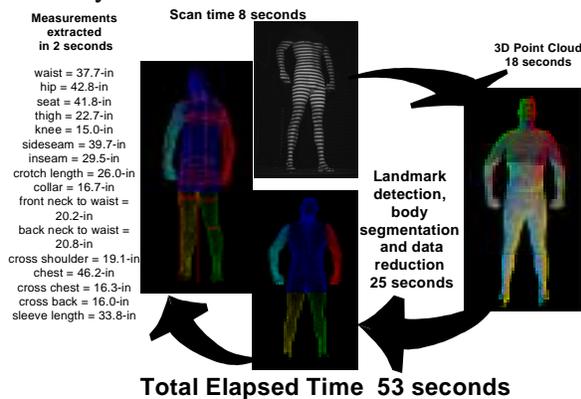
Each measurement must have a measurement extraction rule that details the way in which a measurement is to be captured. For example, the waist could be measured as the smallest horizontal point of circumference between the hips and the bust, or it could be the smallest circumference at any angle. Likewise, the hip measurement could be defined as the circumference at the widest point below the waist as viewed from the front. Or it could be the maximum circumference below the waist. For each measurement that is desired, a definition of that measurement must be created. This measurement information can then be used to drive pattern alterations.

The total cycle time for a scan is about fifty-three seconds. This includes eight seconds of scan time, eighteen seconds to create the 3D point cloud, and twenty-five seconds to reduce the data and detect key body landmarks. The measurement extraction

requires only two seconds to complete (Figure 4).

The objectives over the next twelve months are to reduce the cost of the scanner by 50% and to reduce the floor space required. The first prototype required 200 square feet and the current model requires 180 square feet. In addition plans are to implement digital projectors and color scans.

Figure 4.
Body Measurement Process



5. DIGITAL PRINTING

The selection of fabric color at the individual garment level (which includes fabric print specification) is another area that currently offers little opportunity for mass customization. The primary reason is that to do so requires the production of 1 to 1 ½ yards of individualized fabric. This requirement is dramatically different from the way in which current textile production technologies have been developed.

Sewn products manufacturers typically commit to fabric purchases months in advance of their receipt at the production plant and they are required to make yardage commitments and issue purchase orders for fabric by color and/or print design. It is also a common practice for textile producers and fabric finishers to require minimum purchase quantities of one thousand yards or more because heretofore it has not been

economical to dye or print small lots of fabric.

Fabric is traditionally colored at different points in the supply chain depending on the end product. About five percent of garments are made with yarn-dyed fabric. Color is applied either at the polymer level or the fiber level, or the yarn is dyed after spinning. About seventy percent of fabrics are dyed after knitting or weaving. Approximately twenty percent are printed and the remaining five percent are produced white and are either screen-printed or garment dyed.

About sixty-five percent of printed fabrics use rotary screen technology. This has been the dominant form of fabric printing for many years. The current shift from analog technology to digital technology is impacting the fabric printing process as well. It is expected that the initial application of digital print technology will be as a substitute for traditional print technologies.

The most promising digital printing technology for the apparel industry is ink jet printing. This is because it is a non-contact printing technology and is less sensitive to variations in the substrate. Ink jet printing refers to the creation of individual drops of ink that are deposited in a precisely controlled manner onto a substrate to create an image.

The study of ink jet technology quickly leads to a new language. Terms such as continuous stream, binary system, drop on demand, raster scan, thermal, bubble jet, and electrostatic can be very confusing. Fortunately, all of the terminology can be simplified because there are two primary categories of ink jet printers. One is called continuous stream ink jet printing because the machine creates a continuous stream of drops that are either deposited on the substrate or deposited in a gutter to be recycled. The other method, called “drop on demand”, creates individual drops of ink

only when they are needed at the substrate. As with most technologies, there are multiple ways of creating a continuous stream or of creating individual drops and each of these has its own cost, productivity, quality tradeoffs, and terminology.

The primary components in the technology of ink jet printing are (1) the creation of individual drops, (2) the control of the individual drops to their final location on the substrate, (3) the method used to impact the resolution of a printed image, and (4) the application of a color to a given image.

A number of vendors are developing ink jet technology for application in the textile and apparel industries. One of the greatest challenges will be to marry a print image with its respective pattern part after the markers have been produced. This will allow garments to contain engineered designs that are continuous across the entire product. The design challenges include the inserting of darts and pleats without distorting the print image. In addition, the ability to cross seams without losing the continuity of the design will allow new families of products to be developed.

6. CONCLUSIONS

In order to predict the needs of the soft goods industry, it is necessary to understand the expectations of the various customers that make up the supply chain. Some of their expectations are a result of characteristics of consumer behavior that have changed over time. By analyzing these changes it is possible to more accurately forecast future expectations.

For example, one merely has to study the trends in consumer expectations that relate to product differentiation and individualized product. In the past consumers were accustomed to selecting merchandise from whatever inventory was available. It was also common for consumers to have had little or no direct input into the choices and/or product features that were offered,

without expecting to pay a substantial premium for that privilege. Retailers were required to make commitments for this available inventory as much as six months or more in advance of their availability at the retail market.

Today's consumer wants more variety and more direct input into the options that are available. They want retailers to cater to them. According to KSA, 66% of consumers are comfortable having their body scanned, 59% say they will use body scanning, and 18% will pay more for customized products. In the next 10 years customized products will account for 20-30% of products sold. As a result, retailers prefer to make commitments that are only weeks, and sometimes days in advance of their availability for consumer delivery.

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Many companies question whether they need to be concerned about mass customization. For many, a review of Joe Pine's book on the subject is warranted. A review of the turbulence that exists within an industry, its marketplace and its products, can be used to establish an individual company's need to adopt mass customization principles.

Everywhere one turns, the message is the same. Since it was coined in the book *Future Perfect* in 1987, mass customization has become an industrial household name and can now be found in almost every article written on the subjects of innovation, technology management, product development, or supply chain management. Davis and Meyer, in their book titled *Blur*, state that the rate of change today is so rapid that it is only a blur. They make the following claim: "It used to be one size fits all. Now Porsche says it never makes the same car twice. Whatever you offer, you must tailor it each and every time, with the needs of the individual buyer or user in mind. Cheeseburgers, hotel rooms, pants, software programs, office chairs, retirement plans, skis, kitchen appliances... Today,

every offer, no matter its nature, can be customized, along many dimensions.”

It is a known fact that analog technologies are being replaced by digital technologies; from digital recording to digital telephones to digital cameras to digital garment design. Body scanning, digital printing and mass customization will have major implications for the soft goods industry and new markets will be created as a result of coupling these technologies with next generation business strategies.

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Employing mass customization, firms can produce enough variety in products and/or services so that nearly everyone finds exactly what he or she wants at a reasonable price (Pine, 1993). According to Kotler (1989) the concept of 'mass market' is dead and market segmentation has now progressed to the era of mass customization. The growing interest in mass customization has led researchers to suggest that firms that shift from mass production to the emerging paradigm of mass customization will gain a competitive advantage. Emerging literature on the topic suggests that mass production and mass customization are fundamentally different and incompatible paradigms. Pine et al.