MASS CUSTOMIZATION IN HIGHER EDUCATION: PATHWAYS TO EFFECTIVENESS

Samir Barman,
Price College of Business
University of Oklahoma
307 W. Brooks; 1E Adams Hall
Norman, OK 73019-4001
sbarman@ou.edu
405.325.5717

Mark D. Hanna
College of Business Administration
Georgia Southern University
621 COBA Drive
Statesboro, GA 30458
hannamd@georgiasouthern.edu
912.478.5511

ABSTRACT

Three elements of mass customization (MC) strategies (elicitation, process flexibility, and infrastructural logistics), four approaches to MC (collaborative, adaptive, cosmetic, and transparent), and examples of mass customization in diverse industries, are used in this paper to draw inferences regarding the mass customization of courses and programs in higher education.

Keywords: mass customization, academic programs, academic administration

DEFINING MASS CUSTOMIZATION

Mass Customization (MC) involves the use of flexible, computer-aided manufacturing or service delivery systems to produce variable outputs with the efficiencies derived from high volume operations. The term is derived from its main purpose, which is to combine the low unit costs of mass production with the individual customization of flexible operations. It often allows customers to interact directly with producers during production and/or design activities, which allows the provider to satisfy customers' specific needs in ways that may not be feasible with a standard product at costs that might not be attainable through traditional unit manufacturing systems such as job shops.

The term MC may seem contradictory because it includes two opposing concepts: mass production and customization. While mass production implies uniform products, customization involves diverse outputs tailored to individual needs (Zipkin, 2001). In order to better understand the concept, it is important to consider the definition of each of the two terms involved.

Mass production is a business strategy that focuses on taking advantage of the economies of scale by offering standardized goods and services. Mass producers can offer low prices because production costs can be lowered by producing homogeneous goods in a large scale. It is considered to be a capital intensive business strategy because it necessitates expensive machinery and therefore, high fixed and low variable costs. However, customization is derived from the idea of trying to best satisfy customers' needs, without a deliberate emphasis on low prices. Therefore, the term 'mass' implies a relatively high volume of products produced for a large market, while the word 'customization' means that products are designed to fit specific customers' needs (McCarthy, 2004). Instead of producing one standard product, mass customization aims to satisfy each customer's unique requirements. Such a strategy is then "a synthesis of two long competing systems of management: the mass production of individually customized goods and services" (Boynton, Victor and Pine; 1993).

MC is the result of fundamental changes in the business environment that occurred during recent decades and in the development of new manufacturing technologies and strategies. According to McCarthy (2004), some of the motives that drove companies to develop this new business strategy included:

- The change in customers' expectations from relatively homogeneous to very heterogeneous market requirements.
- The increasing speed at which customers' needs change and the consequent shorter of product life-cycles.
- The development of new manufacturing strategies like assemble to order and the construction of product families, which allow offering customers a greater variety while maintaining low costs and high quality.
- The understanding of specific customer's needs and the subsequent development of products that meet these needs leads companies to align their strategies in order to satisfy customers' wants in the long run.
- The increasing number of channels to communicate with customers has improved manufacturers ability to determine customers' needs, and also understand market opportunities and forecast market trends more accurately.

Based on all these fundamental factors concerning the need for mass customization, McCarthy (2004) defines the term as "the capability to manufacture a relatively high volume of product options for a relatively large market (or collection of niche markets) that demands customization, without tradeoffs in cost, delivery and quality".

On the one hand, there are many different kinds of companies and not all of them are going through the same changes at the same rate; which implies that not all of them need to lower costs and increase variety in the same way. Therefore, "even though the essence of mass customization is relatively fixed, at an operational level it will often mean different things to different groups of firms" (McCarthy, 2004). As a result, a variety of approaches to mass

customization have been developed by different companies in order to fulfill their specific needs over time.

On the other hand, no matter the kind of company, mass customization is a strategy that cannot be successfully implemented in isolation. In order to archive customization, along with low costs, high quality, and high customer satisfaction, mass customization has to be applied in combination with some relatively new manufacturing concepts, such as Just-In-Time, lean manufacturing, time-based competition. As Pine (1993a) states, just-in-time reduces inventory; lean manufacturing eliminates waste, increases process flexibility and responsiveness while also lowering expenses; and made-to-order provides valuable information for customization and also lowers holding costs. These techniques have "increased flexibility and responsiveness and therefore the ability to increase variety and customization without parallel increases in cost" (Pine, 1993a). All the benefits derived from the appropriate implementation of these strategies are essential in achieving truly low production costs while customizing the product or service at the same time.

MC, applied in collaboration with all these management techniques, is then a business strategy that "bids return to an axiom frequently ignored in the homogenized world of Mass Production: *Each customer is unique*, and all deserve to have exactly what they want at a price they are willing to pay" (Pine and Gilmore, 1999).

MASS PRODUCTION SYSTEMS

This mass production system, a direct extension to the factory system of manufacturing originally developed during the Industrial Revolution, was mostly based on the following four principles: interchangeable parts, specialized machines, process focus, and the division of labor. In addition, Pine (1993b) identified the following principles that could be attributed to mass production systems:

- Continuous flow of work
- Focus on low costs and low prices
- Economies of scale
- Product standardization
- Degree of specialization
- Focus on operational efficiency
- Hierarchical organization with professional managers
- Vertical integration

The manufacturing system derived from the application of the eight principles presented above was also called *Fordism*, after the production system implemented by Henry Ford to manufacture automobiles. The production of the first Ford's Model T in 1913 represented "the culmination of a century's experience with mass production" (Piore and Sabel, 1984).
Ford was the first to use a continuous assembly line, a continuous *flow* of work from one worker to the next. The assembly line was necessary to increase worker and machine productivity, which helped achieve the main objective of *Fordism*: to focus on low costs and low prices. Low costs and the invention of the assembly line led to the use of *economies of scale*. With lower prices,

products had a higher demand, which led to a cycle of even lower prices. In order to continue with this cycle, *standardized products* were required "because any complexities or custom work would upset the production process and result in much higher costs" (Pine, 1993b). Also, in order to take advantage of the economies of scale an even higher level of *degree of specialization* was necessary to sustain an increasing rate of worker and machine productivity.

This constant focus on increasing productivity led to the next principle of mass production, the *focus on operational efficiency*, which was achieved by constantly increasing the throughput rate of workers, machines and the factory in general. The continuous control and measurement resulted in the need of a *hierarchical organization* with *professional managers* whose responsibility was to accurately measure productivity and efficiency, and set policies to help increase them both. The last principle, *vertical integration*, was necessary to ensure that the production line had the required supplies to remain busy during most of the production time.

EXAMPLES OF MASS CUSTOMIZATION

Key to recognizing an application of mass customization is that the organization must be seeking to gain the aforementioned benefits of scale using mass production techniques, while simultaneously seeking to provide opportunities to individually determine the exact configuration of their purchase. Since the introduction of the concept, it has been recognized in various industries and sectors to the point that numerous examples are now extant in the literature. It has been used as a strategy to tailor products, like clothing and automobiles, and services, like restaurants and hotels, to satisfy customer desires and preferences. In the manufacturing sector, Kotha (1996) studied the application of mass customization in one of Japan's largest bicycle manufacturing facilities, the National Bicycle Industrial Company (NBIC). The author suggests that mass production and mass customization can be applied in conjunction and that it doesn't have to be one or the other. NBIC has two factories: one for mass production and a smaller one for the fabrication of mass customized products. Company's workers rotate from one to the other, which has led to the development of a "knowledge-creating system" (Kotha, 1996). The main conclusion of the study is that "the interaction between mass-production and mass-customization leads to knowledge creation and organizational learning" (Kotha, 1996). The application of mass-production and mass-customization in NBIC has led to the creation useful knowledge because highly skilled workers are continuously trained in two different environments, which has lead to the development of a very flexible and responsive manufacturing system.

Mass customization applications are also evident in the apparel industry. Lee and Chen (1999) explored the new technologies and strategies that have been applied in the apparel industry. They explain "how apparel industries practice mass customization and what dynamics of the industry are changed by the impact of mass customization" (Lee and Chen, 1999). They cite three different manufacturers: Custom Foot Inc., Levi Strauss and Second Skin Swimwear, as examples of firms that have applied this approach.

Custom Foot Inc., located in Florence, Italy, manufactures customized shoes for their customers. They use a computer scanner that registers information about the customer's feet, and then the customer selects the specific style, material and color from 160 different models. The shoes are manufactured in seven different factories with an estimated delivery time of three to four weeks from the time an order is placed.

Levi Strauss developed a program called "Personal Pair" and its main objective is to manufacture custom-fitted jeans for women. In the store a sales person would take four initial measures and enter them into a computer system. The system would suggest some initial "prototype test garment" that the customer would try on and based on the fit the customer would decide on the needed adjustment, such as shorter, longer, tighter or looser, for example.

Second Skin Swimwear developed a mass customization strategy where customers had to first try on some sample suits from which then he or she had to choose the one that he or she liked the most. A digital camera would then scan the customer's body. Finally, the customer would select the fabric from a broad range of options. All the information would then be entered into a computer and sent to the manufacturing facility. The manufacturing and delivery time is less than two weeks.

All three examples show how some apparel manufacturers have used new technology in developing new tools that have helped them customize clothing. These companies have used scanners, digital images and the internet, among many others, in order to get more accurate information about their customers. And then, based on that information, the final product is designed, manufactured and delivered.

Another application of mass customization is studied by Chen and Hao (2007), which emphasized that nowadays there's lack of information regarding how to apply mass customization. They studied the case of a Chinese restaurant chain with three outlets and 300 different items on their menu. The high variety of products with the main objective being meeting customers' need best, plus the application of a traditional production system where everything needs to be processed from the very beginning stage, made business operations quite complex. Since its offerings include a high variety of items, the company decided to make some strategic and operational changes. First, it chose to outsource most of the primary handling and some of semi-processing which had been previously conducted inside the kitchen (Chen and Hao, 2007). Second, it decided to outsource the seafood inventory in order to improve efficiency and reduce inventory risk. The outsourcing of non-core processes "simplified the operational complexity caused by mass customization and helped the company focus on the core competence: innovation in final cooking and better dinning services" (Chen and Hao, 2007).

Netflix is also a good example of the application of mass customization. The company developed a business model that revolutionized the traditional way of renting movies. Netflix lets their customers browse a huge selection of movies and other DVDs that wouldn't be available in a normal rental store, which results in customers getting exactly the title they want. In addition, it has also managed to keep costs low by targeting a mass market. The success of Netflix stems from the advances in technology and the wide access that people have to internet and computers, which has greatly increased in recent years. This wouldn't have been possible twenty years ago and therefore serves to illustrate that technology is a very useful tool for the application of mass customization.

Another application of MC can be found in the cell phone industry (Sigala 2006). A number of approaches exist from the customer's viewpoint. For example, in addition to the basic services that every customers need, services such as various ringtones, voice mail services, text

messaging, access to the internets, etc., might be made available for customers to customize their cell phone services. Monk et. al. (2000) explains how MC can be effectively applied in the hospitality industry, which caters to a wide range of customers of varying needs. The customers include those on business trips, pleasure travelers, honeymooners, vacationing couples with children, all with unique needs. The services can be customized to satisfy their needs with options such as wake-up calls, flexible check-in, various in-room entertainments via the television or video games, internet connections, in-room mini-bar, etc. (See Da Silveira et. al. (2001) for additional examples of applications of mass customization in both manufacturing and service operations.)

KEY ELEMENTS OF MASS CUSTOMIZATION

Successful implementation of MC requires three key elements: elicitation, process flexibility and logistics (Zipkin, 2001).

Elicitation

One of the biggest challenges manufacturers face when implementing a mass customization strategy is the process of finding out what their customers want or need. This task is usually very difficult because, in many cases, customers are uncertain about their own needs. The elicitation process, defined as "a mechanism for interacting with the customer and obtaining specific information" (Zipkin, 2001), is aimed to determining specific customers' needs regarding a particular product or service. It plays a major role in mass customization because it enables manufacturers to correctly determine what their needs are. As Zipkin (2001) stated "… any elicitation process is an artful means of leading customers through the process of identifying exactly what they want".

However, in the development of every product or service the elicitation process does not take the same amount of time. Depending on the type of customization and the specific product or service, the process of obtaining the required information to customize it takes varying degrees of time and effort. For example, the process of customizing an iPod by engraving a personal message or a name takes only one question; while the whole mechanism necessary to create a special industrial soap for a specific factory takes a lot of different studies, analyses and trials.

Process Flexibility

In order to better fulfill specific customers' needs, the manufacturing process needs to be flexible. Otherwise, the final product will be uniform(standard), with little possibilities for customization. This basic characteristic of mass customization is derived from the craft production system which is completely ignored by the mass production system. In fact, the best example is the famous phrase coined by Henry Ford: "Any customer can have a car painted any color he wants so long as it is black". Mass Customization calls for an opposite view, which is based on constantly looking for better ways to meet customers' needs while keeping costs low. Flexibility is a key requirement for such strategy.

Some of the most common strategies used to increase flexibility are modular design, lean manufacturing and CAD/CAM systems. One common way to assess the flexibility of a process is to "determine how many spatial dimensions are involved in each step" (Zipkin, 2001). The fewer the number of dimensions involved in a process, the higher the potential for mass customization.

Logistics

Managing all the resources in an efficient way is very important when applying a mass customization strategy. *Logistics* involves all the processes required to ensure the adequate supply of raw materials and their storage needs; the flow of information through the whole production process; and packaging, storage and delivery of manufactured products.

Mass customization requires efficient logistics in order to maintain the availability of necessary raw materials to manufacture the product and also to deliver the right product at the right time to the right customer. It is also responsible for lowering inventory, warehousing and transportation costs in order to keep prices low. As Rautenstrauch, Seelmann-Eggbert and Turowski (2002)stated,

> "Logistics systems have to be redesigned in order to face the new challenges. Long transport times have to be reduced within and between production lines. Lot size 1 in the machine does not imply lot size 1 in transport. Both information and goods have to be controlled and steered in order to be at the right place at the right time. Logistics therefore plays an essential role in mass customization".

Obviously, logistics plays a major role in, and is a key determinant of, the successful implementation of the mass customization strategy.

FOUR APPROACHES TO MASS CUSTOMIZATION

Mass customization can be applied at the design, production, or the delivery stage of any product or service. However, it is the management's responsibility to determine the stage at which it could be most effectively applied in order to better satisfy customer needs while keeping costs at a competitive level. According to Gilmore and Pine (1997), there are four main approaches to mass customization: collaborative, adaptive, transparent and cosmetic. They can be applied individually or in any combination of some or all, depending on the production and market requirements.

Collaborative Approach

When dealing with mass customization, customers could feel overwhelmed by the sheer number of options available for a specific product or service. The collaborative approach deals with this issue by helping the customers decide on what they need (Pine and Gilmore,1999).

The main objective of the collaborative approach is to communicate with the customers to determine what their true needs are and to identify the specific product or service characteristics needed to fulfill those needs.(Gilmore and Pine, 1997). Furthermore, for such an approach, the customer may take part in the design process, but manufacturing and assembly processes may be standard while distribution could be customized (Rautenstrauch, Seelmann-Eggebert andTurowski; 2002).

One well known application is Dell's approach to configuring personal computers, where "customers work with Dell to identify what components they want configured into their personal computer, which the company then develops exclusively for them" (Cohen and Pine,2007). With the widespread use of the Internet as a direct distribution channel, this approach has been adopted and implemented effectively by other computer manufacturers, such as Sony, Toshiba and Hewlett-Packard. Another example of collaborative mass customization is Paris Miki, the largest Japanese eyewear retailer that allows customers to design their frames and lenses based on a picture (Gilmore and Pine, 1997). Specifically, the system takes a digital picture of the customer, along with his or her preferences, and recommends lenses, frames, nose bridges, arms, and hinges. The customer continues to work with the system until a satisfactory choice is obtained. The approach is also used by Andersen Windows, a window and door manufacturer, that lets its customers design windows that fit their homes and needs by trying out different styles, shapes, sizes, and colors.

In each of the above examples of the collaborative approach, the elicitation of customer preferences is facilitated by interactive, web-based, ordering systems and customer involvement. Simultaneously, process flexibility is gained through modular design and postponement strategies. Finally, a modern ERP based logistical system for scheduling and delivery is used.

Adaptive Approach

In some cases companies provide a great variety of final products from which customers may fulfill their needs. In such cases, it could become difficult for customers to identify the ideal or the best product because it may not include all of their desired features. Consequently, much like many car buyers who don't see the car they want at the local dealers lot, they end up purchasing a product that may not meet their actual needs as well as one that is available – perhaps in some other location. The adaptive approach, by contrast, offers customers a product that they can customize depending on how they want it to perform under a specific situation.

In this adaptive approach all processes are typically standard (Rautenstrauch, Seelmann-Eggebert and Turowski, 2002), but the customer can modify the final product according to their needs; "neither the product itself nor the representation of the product is changed for the individual customer; rather the customer customizes the good or service as desired using customizable functionality embedded into the offering" (Pine and Gilmore, 1999).

One example of adaptive customization is the 'sleep number bed'. Each customer buys the same bed but adjusts the firmness of the mattress to meet his or her preference. Also, online learning programs such as Blackboard's Vista® or the Desire to Learn® system are good examples of adaptive customization because they provide an adaptable platform that teachers modify to suit

the structure of their particular course, yet without changing the programs' capability (Cohen and Pine, 2007). Indeed, any modular or reconfigurable software is an excellent example of this approach because individual users may choose to use the features they need and disregard those they don't (Rautenstrauch, Seelmann-EggebertandTurowski; 2002). Another example of this approach is the lighting systems manufactured by Lutron Electronics Company. The system allows the customer to program the lighting system for different effects without having to experiment with different lights and separate switches to create those effects.

Manufacturers of tangible products could use a collaborative approach to offer products with different options and features through process flexibilities and logistics, so a customer can choose the one with desired functionality or fits individual preferences (Gilmore and Pine, 1997). Especially, with advanced technology and lean manufacturing, businesses may cost-effectively provide a wide set of desirable features in any one product in a set of packages (such as preferred configurations used by auto manufacturers) consistent with the adaptive customization approach. The elicitation of customer preferences, then, would largely occur in design studies and the market behavior of customers and *not* interactively during production.

Cosmetic Approach

As the name implies, in a cosmetic customization approach "customers use the product in same way but they want it to be presented in a different way" (Rautenstrauch, Seelmann-Eggebert, and Turowski; 2002). In other words, a standard product is offered in different ways to different customers using special packaging, marketing or advertising. Instead of changing the product or service to meet the needs and desire of different customers, "the standard product is packed specially for each customer" (Gilmore and Pine, 1997).

The way Hertz treats its golden customers is an application of this kind of customization. Hertz Gold members bypass the check-in counter and go directly to the bus instead. The bus driver informs that the customer is on his way and when he gets to the parking lot an electronic billboard directs him to the car. "It's the same car everyone else in your product class gets, but the delivery of the car is customized" (Cohen and Pine, 2007). The way most soft drink manufacturers market their products exemplifies this approach also. The same product is sold in different containers - aluminum can, plastic or glass bottles, and in different sizes - 12-ounce cans, 20-ounce bottles, 2-liter bottles, etc.

Oftentimes manufacturers "… postpone many activities in order to perform them before the observant eye of the customer, who feels that the performance is being staged just for him" (Pine and Gilmore, 1999). As an example, there are many manufacturers who customize their products by placing the customer's name, company's name or logo, or a personal message on each item of a standard product. Need for process flexibility is not great with this approach. Similarly, very limited elicitation combined with changes in timing of key logistical decisions, provide a sense of customization.

Transparent Approach

The final type is called transparent customization. It occurs when the manufacturers or service providers observe the customers' needs without having a direct communication with them but provide the customers the products or services with the specific features they want or need. The customer does not necessarily know that the product or service has been specifically designed for him or her. In effect, "… transparent customization is the exact opposite of cosmetic customization, which has standard content but a customized package" (Pine and Gilmore, 1999).The transparent approach works best when individual preferences are easily understood and predicted.

An example of this approach is ChemStation, a soap manufacturer that develops the right mixture of soap for each specific customer after carefully analyzing their needs. They conduct a lengthy analysis to determine what soap composition works best for a given customer and in what quantity will be required by that customer. The customers don't know the type of soap they are using or how much is left of it, they only care about the fact that it works and that it is available when needed (Gilmore and Pine, 1997).The Ritz-Carlton hotels also apply the principles of transparent customization by keeping a record of their customers' personal preferences so they can customize their needs during their future trips. For example, "… if a guest requests extra pillows, then extra pillows will be provided at every Ritz Carlton hotel the guest visits" (Ho and Tang, 1998). This approach results in an ever more comfortable experience for the customer because "the more frequently someone stays in Ritz-Carlton hotels, the more the company learns, and the more customized goods and services it fits into the standard Ritz-Carlton room, thereby increasing the guest's preference for that hotel over others" (Pine and Gilmore, 1999).

Keeping records and analyzing customer preferences obviates the need for customizers to ask repeated questions, which could annoy customers and adversely affect their overall experience. Therefore, this kind of approach is really useful in situations where customers don't want to state their needs repeatedly. However, it is important note that transparent customization can be applied only when customer needs can be accurately predicted. In essence, for results of an earlier elicitation to apply to a repeat customer in an alternative setting, service alternative, process conditions, and logistical options must be relatively consistent.

MASS CUSTOMIZATION IN HIGHER EDUCATION

In this section we discuss the advent of mass customization in higher education, areas where mass customizations may be applied and key issues in implementing a mass customization strategy in each of these areas.

Forces leading to mass customization in higher education

For the past ten centuries the primary model for higher education has been the university. Universities typically provide greater efficiencies through economies of scale that are offered by enrolling large volumes of students through providing degrees in numerous disciplines. The administrative fixed costs of running the university are thereby spread across many individuals; profit centers may be developed in the requisite campus student services such as housing, bookstores, and dining facilities; and variable costs such as faculty salaries may be kept low on a

per credit hour basis. Such universities are oriented primarily to the production of one output – graduates with a given set of initial career qualifications. Much of the perceived quality difference between institutions has resulted from careful and ongoing branding. For example, Ivy League institutions are able to attract students with higher aptitude due to their brands. In a positive cycle of reinforcement, their higher aptitude students are attractive to both potential top-tier faculty members and employers. As a consequence, alumni of such institutions experience disproportionate levels of career performance by comparison to many other universities, and populate positions of leadership, privilege and power around the globe. Based on this difference in outcome for their graduates, these premier institutions continue to enhance their perceived brand and attract more applications from ever more talented students. Indeed, the historic university system and its competitive characteristics are essentially the same as any other mass production system.

In contrast to the typical large-scale university, and partly due to the inability of the vertically integrated model to satisfy lifelong learning needs of career professionals, corporate and for-profit "universities" have now emerged (Poon, 2006). These institutions provide highly customized solutions to the education and training needs of very specific niche markets. For example, Motorola developed the Six Sigma methodology and provided world class training in Six Sigma long before this was available in a traditional university. Indeed, it is unlikely that any superior training in this one topic area has since been developed. Similarly, for profit institutions have selected high demand topical areas and invested heavily in providing a custom solution to students (or corporations) interested in that specific area of study. As early as 2001, for example, Cardean University was investing an average of one million dollars per course and utilizing world renowned individuals such as Nobel prize winners in both course design and delivery. (Lippert, 2001).

Information technologies and methods used for mass customization in other industries are also relevant to the higher education industry. As a consequence of web-based instructional delivery systems, high quality customized materials can now be provided to extremely large-scale audiences. While the process may have begun in executive education – where corporations were able and willing to pay for the development of specialized training – it is now beginning to impact education in traditional degree programs. Indeed, due to the scalability of web-based instruction, and the simplicity with which it can be marketed and discovered using search tools, it need not be the case any longer that the best of the best instruction is available through a branded university. Indeed, higher education appears to be in the beginning stages of a tectonic shift toward mass customization that reduces the traditional advantages held by the large, branded vertically integrated delivery systems of the past centuries.

Application of mass customization in higher education

In addition to executive education, we feel that two significant opportunities for mass customization exist in the traditional university: 1) core classes with large annual enrollments and, 2) high demand degree programs in large universities.

Mass customizing the core course

Large universities historically built large lecture halls in order to provide economies of scale in delivery of core classes through large enrollment sections – perhaps with low cost graduate student administered break-out sessions or labs. Today, they may be more likely to put the class, or at least the lecture portion of it, on-line. Just going on-line, however, does not inherently provide mass-customization. To mass-customize large core classes the aspects of elicitation, process flexibility, and logistics need to receive fresh consideration.

From an elicitation perspective, mass customizers of core classes need to consider the requirements of multiple stakeholders: the student, faculty in courses for which the core course is a prerequisite, faculty in majors that require the core course, and potentially employers. Student input is likely to be important in determining the characteristics of the technologies and software used, and to lesser extent the dimensions of course structure and instructor availability. Other faculty and possibly employers are likely to be influential determinants of course learning objectives and hence content and skill development aspects of the course.

From a process flexibility perspective, mass customizers of core classes may utilize a variety of strategies to provide some mix of content flexibility, schedule flexibility, and course length flexibility (Wilson, 2011). Among these are automated content delivery, virtual office hours, asynchronous communication interfaces, automated problem files, online homework and assessment, flexible online office hours - all customized based on the individual student's requirement profile. It is worth noting that much of this need for process flexibility has been anticipated and is well supported by the traditional publishers of academic texts (Millson and Wilemon, 2008; Wilson, 2011). Specifically, these publishers currently provide both the ability to sell customized texts – in print or online – and they provide platforms for interactive automating homework and assessment activities.

The logistical system to support the mass-customized core class requires more flexibility than logistical systems typically used in today's universities. For example, an instructor of a core statistics class might be responsible for teaching three undergraduate sections in a given semester. Students enroll in just one of a number of theoretically identical course sections that have a fixed beginning and ending date based on the university's calendar which is set in stone. When the term is over, the instructor is evaluated by student feedback only once. Student grades and performance are no longer assessed for the material covered. Typically, students sell their books, and retain little ownership over materials used in the course. Consider the logistical differences required if a core course is mass customized to provide content, schedule and course-length flexibility. Students would in some fashion need to register for the specific options in the course that are required for their major, employment preferences, and other personal learning preferences. The course need not be limited to a semester. Indeed, a module in the course might be sufficient for enrollment in a subsequent course. Furthermore, rather than months or years in advance, the prerequisite material could be delivered in a future semester at the beginning of the subsequent course. Instructor evaluation could be ongoing utilizing online evaluation and feedback tools, rather than based on a once a semester standardized instrument. Student performance could also be evaluated in more of an ongoing fashion, rather than based on end of term summative grades. In the context of subjects where cross-functional or multi-disciplinary learning objectives exist, logistical changes that provide for contributions from multiple faculty

in a given course – rather than the one section one teacher model that is currently so prevalent – would also be beneficial.

Elements of all four approaches (collaborative, adaptive, cosmetic, and transparent) may be useful in mass-customizing core classes. From a collaborative perspective, a modular course structure provides ample opportunity for student input in the specific design of their course requirements, schedule requirements and completion timing. In fact, inference engines utilizing artificial intelligence may be built into an online course such that semantic web descriptors are used by intelligent agents to search digital libraries and suggest content choices to students based on their cognitive, social, and affective characteristics. (Woolf and Eliot, 2005) From an adaptive perspective, it is not difficult to anticipate that core course customizers may mirror the standardized large-lecture with variable break-out sections model that is currently in place in some setting. The mass-customized course could easily begin with customized material based on student characteristics to prepare them for core materials required of all students and then move toward diverse materials required on the basis of individual student needs or preferences. A cosmetic approach might be particularly useful in contexts where students have been sold on a brand. For example, Ivy League institutions may choose to use the best available material which is used by multiple institutions, even though its development was not in-house. It is likely, they would seek to make cosmetic changes to the content and delivery platform in order to identify it with their premium brand. Finally, in situations where an institution seeks to mass customize multiple core courses, the transparent approach may be used. Many of the individuals' preference could be recorded during the completion of modules in any course, and these preferences could be honored in the delivery of future modules in any course.

Mass customizing programs of study

It has not been uncommon for faculty to seek to differentiate their programs by providing students with opportunities to adapt and customize a major to their own preferences through providing menus with some required and some optional courses. While this approach has provided students with a degree of choice, it does not fully implement the concept of mass customization in that it provides static choices and does not provide options based on results of preference elicitation. Furthermore, the choices do not fully draw upon the flexible and scalable web-based instructional strategies that are currently available and require little change to the logistical approach provided by the mass production systems for course scheduling in academic institutions. A truly mass customized program might provide for variable mixes course delivery approaches, content flexibility up to and including self-defined programs, scheduling flexibility ranging from lockstep cohorts on a fixed semester calendar to self-selected timing program start and finish dates, and course length flexibility that would allow an individual to progress at the pace which they prefer.

Consistent with the current climate in regard to program accreditation, it seems that any effort toward mass customization of programs would need to establish a set of potential learning outcomes, classified as mandatory and elective, that an individual student program would be expected to create. On the basis of this set of outcomes, divisions and/or departments would be able to create learning modules which would be comprised of a set of courses which would deliver content aligned with some subset of the program's outcomes. Any student designed

program that satisfied all learning outcomes, could be considered an appropriate configuration of the program. For example, a business program with a major in marketing might not enumerate all of the possible combinations of course choices that could be used to satisfy requirements. Rather, it might create a set of desired student outcomes in areas such as analysis and research, customers and behavior, cultures and diversity, leadership, sustainability and communication. Once course modules across the university have been established, students would be able to plug in their to satisfy each objective. For instance, a sequence of courses in graphic design might serve the communication requirement just as easily as a series of oral communication courses or a writing sequence. Similarly, cultures and diversity outcomes might be satisfied by some combination of language courses, foreign exchanges, study abroad, women's and gender studies, black studies, or world civilization courses. Thus, while each student could design a completely customized program, modularization provides a mechanism to assure that all students are expected to attain all learning outcomes. The modular approach, a cornerstone of mass customization, is utilized to provide great latitude in program design while simultaneously assuring program quality.

The authors are not currently aware of any truly mass-customized programs of study. On the one hand, it may be that the logistical infrastructure required for such a programs to be available on a large scale is so radically different that it could not be implemented in the context of the existing university model. On the other hand, as universities begin to pursue mass customization of their core courses and develop infrastructure to support this, they may take the next evolutionary move to mass customization of the entire core and in a yet further state of evolution seek mass customization of entire programs.

CONCLUSION

This paper has provided an overview of mass customization as a business strategy that, when implemented in the effectively, may result in significant competitive benefits for modern companies and improved outcomes for their many diverse customers. The development of a continuous elicitation process involving the customers, a flexible system for delivery of value, and a congruent logistics system are the basic characteristics mass customization strategies. (Zipkin, 2001). Mass customization efforts utilize some combination of collaborative, adaptive, cosmetic and transparent approaches (Gilmore and Pine, 1997). Mass customization has been effectively used in many industries and is a viable strategy in higher education as well.

Companies that want to implement all the principles must study very carefully their customers, their processes, and their environment in order to determine the best way to put into practice the key elements of mass customization. In addition, it is very important that companies pursuing mass customization take into account their previous experiences of incorporating this strategy. This is no less true for the implementation of mass customization in higher education. Hence, we have provided conceptual (admittedly provisional) suggestions regarding the elements and structure of mass customization when applied to core courses in the traditional university setting.

There are many, as yet unexplored, potential applications of mass customization that have not yet been explored. Technology has played an important role in the application of mass customization in many business environments and will continue to do so in the future. Advances

in technology as well as the ever changing customers' needs and market competition will compel organizations to find innovative ways of adding value to their products and services. Mass customization of entire programs of study may be an attractive future alternative for institutions of higher education.

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