Where in the World Is Timbuk2?
Outsourcing, Offshoring, and Mass Customization[1]

Teaching Note

This case illustrates a successful implementation of mass customization but then asks if this is the only strategy the firm should pursue. In particular, the main focus of the case is whether or not the firm should begin production in China. A key insight from the case is that the labor cost advantage of China are too strong to ignore – it clearly dominate the additional transportation cost of shipping finished goods from China to the U.S., and it likely to be more significant than the demand-supply mismatch costs that would arise. However, there are important issues with moving production to China, including brand image, shift from make-to-order to make-to-stock production and the resulting inventory increase, necessity to forecast demand and the likely decrease in the utilization of the San Francisco factory.

Only minimal numerical analysis is required to motivate a discussion with this case (the cost comparison between manufacturing in San Francisco vs China). However, there is enough information in the case to form the base for a more complex analytical analysis (which is described in this teaching note). If an instructor wanted to pursue the more in-depth analysis, then some additional information could be provided to students.

This case was taught in 2008 to 12 sections of the Wharton daytime MBA program and 4 sections of the Wharton executive MBA program. The response from students and professors has been positive.

This teaching note is based on the Aug 2008 version of the case.

Potential Discussion Questions:

1. What channels does Timbuk2 sell through and which one is the most profitable? What are some of the pros and cons of Timbuk2's "Build your own" channel (i.e., its e-commerce channel)?
2. How should Timbuk2 go about deciding which options to offer customers in the e-commerce channel? In other words, what general principles or analysis could be used to deepen their understanding of the appropriate choices? You may want to consider several of the options mentioned (an added handle, different color logos, different size panels, etc.)

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[1] This teaching note was written by Professors Gérard Cachon (The Wharton School, University of Pennsylvania), Kyle Cattani (Kelley School of Business, Indiana University), and Serguei Netessine (The Wharton School, University of Pennsylvania) as the basis for class discussion rather than to illustrate effective or ineffective handling of an administrative situation. Some numbers in this case were adjusted to simplify the case analysis and to protect confidential business information. The authors are grateful to Brennan Mulligan for his assistance in writing this case.

3. Estimate the cost of manufacturing a bag in San Francisco and the cost of producing a bag in China.
4. Should Timbuk2 pursue the option of manufacturing in China? If so, what challenges are they likely to face and what changes will they need to make? In particular, think about the utilization of the San Francisco factory before and after outsourcing as well as about inventory needs.

Pros and cons of mass customization

Labor costs are higher with mass customization than what they would be with a traditional manufacturing process that emphasized large batches and smooth production. (We'll also use the term "make-to-stock" manufacturing to refer to "traditional manufacturing".) The case suggests about 10% higher, which is not dramatic. Mass customization is probably able to achieve nearly the best efficiency because Timbuk2 uses orders from the traditional channels to smooth the production flow. (More on that point later.)

Is the cost increase significant for mass customization? To put this in perspective, consider the additional margins of customized bags – from Table 1 an e-commerce bag generates revenue of $96.75 whereas the domestic/wholesale channel yields only $37.91 per bag. Granted, the e-commerce channel needs to support the cost of the website, but the additional $60 of margin should go a long way to help justify those costs. Mass customization is also likely to operate with far less finished good inventory, so markdowns should not be an issue. Overall, it is remarkable that Timbuk2 has been able to achieve mass customization with only a limited increase in production cost.

So if mass-customization doesn't cost too much more and it enjoys a very large margin, why doesn't the firm focus exclusively on the e-commerce channel? For one, that channel isn't the entire market. The wholesale channels generate considerable revenue and potentially could generate more. Next, there are some downsides to mass customization. For example, it is difficult for a mass customization system to cope with highly seasonal demand because it cannot build inventory in anticipation of a peak season. As already mentioned, combining the traditional channels with the e-commerce channel allows Timbuk2 to operate with a high utilization and also achieve the fast lead times demanded in the e-commerce channel. In other words, mass customization may be as efficient as it is in large part because it is paired up with the wholesale channel. For more on this idea, see Cattani, K., E. Dahan, and G. Schmidt. 2007. Spackling: Smoothing Make-to-Order Production of Mass-Customized Products with Make-to-Stock Production of Standard Items. Under review at POM.

Finally, it should be noted that it is unlikely that mass-customization can be this efficient in all industries. The National Bicycle case suggests that labor content is at least twice as high with a mass-customized bike relative to a make-to-stock bike, possibly because they could not operate with high utilization. (They did not attempt to integrate the MTS and customized products on the same line.)

Designing mass customization

The case allows students to explore and define some guiding principles regarding mass customization. To open the discussion, it can be useful to ask students how many different kinds of bags Timbuk2 currently offers through their customized distribution channel. For fun it is possible to go the Timbuk2 website (www.timbuk2.com) and start the "build-your-own" process in class.

Most students will respond with a "1,000s" or "10,000s", but let's consider a sample of the variety they offer, just for their messenger bag (they have other product categories as well, such as backpacks and laptop bags): 5 (sizes) * 2 (fabrics) * 26 (colors for panel 1) *26 (colors for panel 2) * 26 (colors for panel 3) * 5 (liners) * 12 (logos) * 2 (strap) * 2 (insert) * 2 (center divider) *2 (reflectors) * 2 (left/right) *2 (pad) * 2 (accessory) * 2 (cell phone) *2 (holster) = 5.4 Billions of combinations.. The conclusion here is that even a limited set of choices across several options can lead to a considerable amount of potential variety. It is also a very good idea to bring a Timbuk2 bag to class and show it to students while highlighting customized options.

It can next be useful to discuss what makes a cell manufacturing system efficient. Here is a quick list: (1) handoffs must be easy (no setups); (2) the workers must be cross trained (which means that tasks cannot be too complex); (3) the physical layout should be compact so that workers need not walk far to reach for parts and tools.

Now discuss what criteria a firm should use for selecting which options to offer. At the highest level, an option should be offered if it creates perceived value for the consumer and it doesn't cost too much to manufacturer. Of course, that is too high level and not very useful from a practical perspective. So let's first consider some more specific causes for how an option can increase costs:

1. Is a distinct setup of the manufacturing process required to make the component?
2. Will it be difficult to deliver the component to the manufacturing process?
3. Does it integrate into the current manufacturing process, or will it require a change to the process?

For example, consider a new buckle, say a white buckle instead of the typical black one. It will be procured "fully assembled" so there is no need to make components – setups are not an issue. However, now there will need to be two bins of buckles available to the line worker rather than one. This requires some additional space – maybe not much, but a cell manufacturing structure is generally quite tight (again, so that workers do not need to walk a long distance between stations), so every additional component that demands space runs the risk of making the cell structure bigger and therefore less efficient. Finally, changing an object's color without changing its shape generally means that it doesn't change the assembly process, with the exception that now a worker needs to think about which bin to grab a buckle from – a thought process that requires a small amount of extra time.

In contrast to the buckle, consider changing the size of a panel. With standard sizes, a layer of 50 or more sheets is placed on a table so that many panels can be cut at once. With custom sizes, only one sheet of fabric can be cut at a time, which greatly increases the labor cost and setup times. (For example, it does not take 50 times longer to roll out 50 sheets to be cut relative to rolling out a single sheet.) To avoid some of those costs, sophisticated cutting tools can be purchased, but they are very expensive. Furthermore, panels can still only be cut one layer at a

time. Next, consider the delivery of the component to the manufacturing process. With the current system, the worker has access to stacks of panels of each color. The sequence of items in each stack doesn't matter – any panel in a stack of red panels can be used to satisfy the demand for a red panel. But with custom sized panels, now sequence matters. That means that all the components need to be sequenced in the order they will be produced, an additional step and a complex one that is prone to errors. This becomes particularly problematic when two different customized components need to be matched. For example, suppose the customer chooses a non-standard size for a red panel and a blue panel. Somehow those two components need to find each other on the production process at the same time. Finally, changing the size of components often means changing the physical process of assembly, which can add to labor content, sometimes significantly. A totally different aspect is eliciting custom panel sizes from the customer. Since different panels need to be stitched together, there is a need in designing web interface that ensures feasibility of customer choices while offering simple ways to visualize the final product to ensure that customers understand what they buy. This will likely involve additional costs.

To summarize, it may not be too costly to offer the option to customize the color of a component without changing its physical dimensions, but it is a much more costly proposition to offer the option to change the size of a component. The cost increase is likely to be large especially when changing size creates a situation in which each component is unique and therefore components need to be delivered to the production process in a particular sequence.

There are a few other cost issues:

1. Complexity generally leads to lower quality (e.g., the wrong buckle is sewn on the bag, etc.) This creates rework if the error is caught in the factory, and even higher costs if the error is discovered by the customer.
2. Although this is not a major issue with custom bags, feasibility of design can be an issue with customized products. Allowing customers to choose from among many options may cause them to choose an option that is either not feasible to produce or not functional. It is important that the system be designed to account for those issues.

Now consider the issue of added value – does the option add value to the customer. This is probably harder to quantify or to outline more detailed guidelines. In general, there are declining returns to customization. Customers value having the ability to choose the color for the three panels in their bag relative to having a bag with just one color. But would they value having the choice of four panels? Customers may enjoy choosing the color for the logo, but is it important to choose the location of the logo as well? In short, it is quite possible to imagine that customers can be given too many choices. Anyone who has built a custom home or redesigned a kitchen can relate to this. At first you are excited that you will be able to build your dream kitchen. You start making choices for your kitchen: the appliances, the flooring materials, the plumbing fixtures, the paint color, the counter material, etc. By the time you get to choose from the hundreds of possible knobs for the cabinets, you are exhausted from all of these decisions and all of the fun has disappeared from the process.

At certain points in the discussion of mass customization it may be useful to mention other mass customization companies. Dell is probably the most well known. Compare the process of

manufacturing a desk top to a laptop. Desktops are rather large and assembly of the components is “simple”. Laptops are more compact and require more nimble hands to manufacturer. Consequently, the labor content in a laptop is higher and Dell chooses to manufacturer laptops in countries with lower labor costs (such as Mexico). From the auto industry, the Mini Cooper is another example of a customized product. Customers are allowed to choose the color of the roof panel separately from the body color. If you look carefully, the roof panel is separated from the body panels by four black “posts”, so the roof panel attaches to the body of the vehicle in a very modular way. For example, most cars have doors that entirely frame the window, but the windows in a Mini Cooper are not framed. This higher degree of modularity allows them to offer this choice, which gives the sense that the Mini is customized – other vehicles on the road come in one color, so adding only one additional option creates this value. Next, to ensure that you don’t see too many Minis that look exactly alike, they change the color options relatively frequently - at any one time they have 5-7 color options, but over time they have offered many more colors. Another interesting contrast can be made with the National Bicycle case in which customization resulted in 3-fold labor cost increase relative to mass-production.

Cost comparisons

Table 4 quickly reveals the cost comparison between mass-customized production in San Francisco and make-to-stock production in China:

	San Francisco	China	Difference
Direct labor	7.29	0.94	-6.35
Manufacturing overhead	2.92	0.38	-2.54
Materials	13.00	13.00	0.00
Other expenses	1.50	0.75	-0.75
Shipping to SFO	0.00	1.00	1.00
Shipping to customers	3.00	3.00	0.00
Total	27.71	19.06	-8.65
Revenue per unit (Table 1)	45.00	45.00	
Margin	17.29	25.94	

There are several striking features in this analysis. First, labor costs in China are dramatically lower than in San Francisco. Second, although production in China requires shipping finished goods to the U.S., shipping costs are nearly an order of magnitude lower than the labor cost savings. Third, air freight is expensive – it makes no sense to produce in China if the plan is to also use air freight. Given the long lead times from China via ocean shipping, China is not an option for the e-commerce channel.

Produce in China?

Although the cost savings going to China are substantial, there are additional considerations. The e-commerce channel is likely to stay in San Francisco while at least a portion of the

traditional channels would move to China. Hence, China would probably operate in a make-to-stock fashion.

Make-to-stock production involves mismatch costs – lost sales and excess inventory that needs to be salvaged. From the newsvendor model it is possible to evaluate these mismatch costs as a percentage of the product's gross margin given the coefficient of variation in demand and the product's critical ratio. For example, with a newsvendor model the mismatch cost is 30% of the gross margin when the critical ratio is 0.8 and the coefficient of variation is 0.85.

	Critical ratio					
Coefficient of variation	0.4	0.5	0.6	0.7	0.8	0.9
0.10	10%	8%	6%	5%	3%	2%
0.25	24%	20%	16%	12%	9%	5%
0.40	39%	32%	26%	20%	14%	8%
0.55	53%	44%	35%	27%	19%	11%
0.70	68%	56%	45%	35%	24%	14%
0.85	82%	68%	55%	42%	30%	17%
1.00	97%	80%	64%	50%	35%	19%

China saves about $8.65 in costs and the margin in China is $45.00 - $19.06 = $25.94. Hence, if mismatch costs with China production are greater than 33% of the gross margin ($8.65 / $25.94 = 0.33), then all of the labor savings in China are "used up" by the added mismatch cost of production in China. Based on the table above it would seem that it is possible that the mismatch cost could be greater than 33% of the gross margin. But that assumes that the newsvendor model is the correct model. It is likely that they don't face quite that much risk.

There are other approaches to address the question of how costly will it be to produce in China. With a 2-3 month lead time and shipping times of over 1 month, it is not difficult to imagine that there will be at least 2 months of finished goods inventory in the channel and maybe even 3 months. Say you have 3 months of finished good inventory. If markdown costs each year are ½ of average inventory, then they would equal 1.5 month of inventory, which is about 1.5/12 = 12.5% of cost-of-goods (COGs). 12.5% of COGs is 0.125*19.06 = $2.38. This is a significant cost, it is less than the cost savings of $8.65. (In fact, it is only about 10% of the gross margin, comfortably under the 33% of the gross margin that we needed to break even.)

Alternatively, one could construct an order upto model to provide an estimate for how much inventory will be needed. Based on the case, say orders are placed monthly and the lead time is 3 months. However, customers place orders in the wholesale channel and do not expect delivery immediately. Say you need to deliver within a month. The effective lead time is then about 2 months. (The fact that the customer's lead time can be subtracted from the production lead time to yield an effective lead time is not at all obvious. Therefore, if a problem like this is given to the students, either this issue should be ignored - just tell them that the lead time is 2 months - or this insight should be explained.) We don't know what demand is for an individual item, but it is likely to be quite volatile given that aggregate demand is volatile. Say an item has mean demand of 100 per month with a standard deviation of 60. If the target fill rate is 99%, then the order

upto level should be about 457, and the resulting on-hand inventory is about 160 units. Pipeline inventory is 200, yielding about 3.6 months of finished good inventory in the supply chain, which is in the ball park of our estimate of 3 months used above.

It is probably easy to get bogged down in the numerical estimates regarding what the demand supply mismatch costs will be. It is important to remember that the big picture here is that China is likely to provide significant cost savings and these savings are likely to be larger than the additional demand/supply mismatch costs. That said, there are some additional issues that should factor into this decision.

Recall that we argued that the traditional channels actually provide a nice complement to the e-commerce channel – they allow a smoother workflow on the line, which allows a high utilization on the line. If all demand from the traditional channels is moved to China, then this benefit goes away. An option is to retain some of the traditional channel demand in San Francisco to provide demand smoothing for that production facility. (A more radical option is to move all production to China, but as we suggested above, that would increase costs significantly for the e-commerce channel.)

Our analysis of make-to-stock assumes that Timbuk2 will be able to do a reasonable job forecasting demand. This is not a skill they have and it is likely that they will not be very good at it at first. One can imagine that the cost of poor forecasting are likely to be high in the beginning and may even start to approach or exceed the labor cost savings offered by China. They can help themselves out by offering a limited amount of variety in the make-to-stock channel. However, given the company's mindset of offering customers choices, they are likely to offer too many choices in the make-to-stock channel, thereby making their forecasting task more difficult than it need be.

Finally, moving to China has some branding implications – can Timbuk2 still claim to be a domestic producer? Does this really add value to the brand? It is instructive to look at how Timbuk2 handled this issue. Their website is almost apologetic about the use of offshore production, but the primary emphasis is that the custom orders are still done domestically. The brand is protected (hopefully) by maintaining production in San Francisco, acknowledging offshore production, but emphasizing continued use of a San Francisco factory.

To summarize, establishing make-to-stock production in China appears to be an attractive option. They need to be careful to put considerable effort into forecasting demand for those products and they probably should err on the side of offering too few options so that the forecasting task isn't too difficult. Furthermore, they may actually need to mix some wholesale demand between China and San Francisco so that the workflow in San Francisco is reasonably smooth.