Case Study U.S. Stroller: Lean

Clem Hawkins, director of manufacturing for U.S. Stroller, leaned back in his chair as he thought about the events of the past two weeks. The president of the company, Judy Hawkins, Clem's sister, had just returned from a conference on Lean manufacturing at the University of North Carolina. After the conference, she commented to Clem,

> We have got to do something about the high inventories, poor customer service, and high costs. I think that a Lean approach would work fine for our manufacturing plant. At the conference in North Carolina we heard of many companies that have used Lean as a way to reduce cycle time, improve quality, and ultimately reduce inventory and cost. In our industry, the competition is looking for our business, and unless we do something now, we may lose our market share and margins. Clem, I want you to take a close look at the plant and get back to me on how we can go about implementing a Lean approach.

BACKGROUND

U.S. Stroller is a leader in the production and sales of baby strollers in the United States. It has historically made very high quality strollers that sell at a premium price. The company is known for its innovative designs and its good distribution system. U.S. Strollers are sold through major department stores, discount stores, and baby equipment stores. Altogether, 2,000 different sites in the United States distribute the company's products.

U.S. Stroller has been a market leader for over 50 years. At the present time it has 40 percent of the U.S. market, a competitor Graco has 20 percent of the market, and Kolcraft has 10 percent of the market. Various other companies, each with less than a 10 percent share, have the remainder of the market, including two Chinese companies that have entered the U.S. market. The Chinese companies seem to be selling a low-price stroller that could take market share away.

U.S. Stroller started its business in 1934 with the introduction of the regular model that it still makes. While the regular model has been updated over the years for differences in fabric and style, the basic design is still the same. The regular model folds easily for storage or transportation and sells for $49 retail.

In 1955, the company introduced a deluxe model that sells for a premium price and is oriented to the upscale market. This model features a design that permits the stroller to be converted to a baby carriage as well as folding for storage or transporting. It also has an adjustable footrest, a storage basket, and locking dual front-swivel wheels. This deluxe model sells for $99 retail (see Exhibit 1 for an illustration).

In 1974, the company introduced its shopping center stroller. This model is very heavy duty, it does not fold, and it stands up well to the abuse that strollers take in shopping centers. The shopping center model sells for $149 and has been extensively marketed in the United States.

Currently, the company is selling 106,000 units per year of the three types of strollers. The amount of each type sold is shown in Exhibit 2. These amounts are divided by 52 to arrive at an average weekly usage. Sales are, of course, irregular and can vary by 25 percent from the average weekly volumes shown in Exhibit 2. Production is leveled, to the extent possible, to attain a level workforce.

The financial statements for U.S. Stroller are shown in Exhibit 3. Sales are approximately $4.5 million per year. The gross profit is 25 percent of sales, and the net profit, after tax, for the fiscal year 2014 was a disappointing 2 percent of sales. Profits have been dropping over the past two years because of price decreases and the inability to maintain margins. The balance sheet in Exhibit 3 shows that inventories are turning very slowly, at a rate of 2.4 times per year. The plant is fairly automated and includes up-to-date equipment. On an after-tax basis the company has earned 3 percent on net assets and 8 percent on owner's equity. U.S. Stroller is a privately held company.

PLANT DESCRIPTION

Strollers made by the company consist of from 20 to 30 different parts. The frame is made out of chrome-plated tubing. The tubing is bought in standard lengths and then cut to size, bent to the proper shape, and drilled with holes for assembly. Each stroller has about 10 pieces of tubing that are assembled into the final frame. Wheels for the strollers are bought from an outside vendor and attached to the tube frames. The padded seats and backs are also purchased from outside. The strollers have a plywood insert inside the seat and in the back to give added strength. These plywood pieces are cut from large 4 × 8 foot sheets by the company and then inserted into the purchased fabric pieces. U.S. Stroller also buys other parts needed to make a stroller, including plastic parts, bolts, fasteners, wire baskets, and so forth. Altogether, about 50 percent of the cost of a stroller consists of materials that are purchased from outside.

This case was prepared as a basis for class discussion, not to illustrate either effective or ineffective handling of an administrative situation.

EXHIBIT 1 U.S. Stroller products.

EXHIBIT 2 Sales volumes.

	Annual Sales	Average Weekly Sales
Regular	54,000	1,040
Deluxe	24,960	480
Shopping center	27,040	520
Total	106,000	2,040

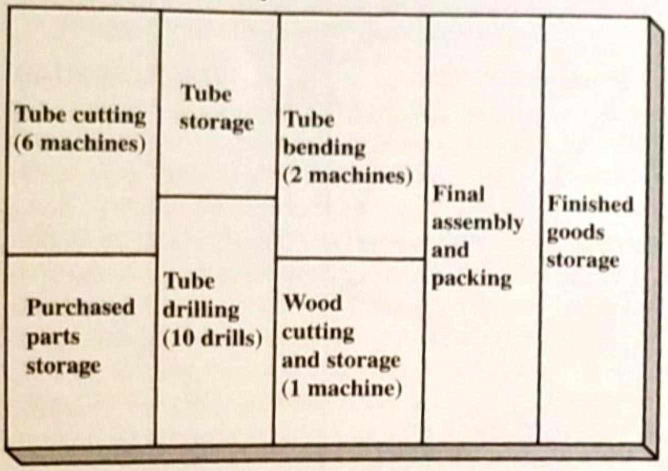
The plant layout has several work centers, shown in Exhibit 4. These work centers include a tube-cutting department with six nearly identical tube-cutting machines. After the tubes are cut, they are placed in tube inventory until they are needed by the tube-bending work center or the drilling work center. Tubes that require special shapes are bent by the two presses in the bending department. Bent tubes and straight tubes are taken to the drilling department and drilled with the proper holes. Jigs are used to speed up the process and to ensure that the holes are located in the right places. The drilled tubes are then put back into inventory until they are needed by final assembly. There are a total of 10 different drilling machines in the drilling work center.

Final assembly consists of one assembly line used for all three types of strollers. This assembly line is changed over from one model to the next according to the final assembly schedule. The woodworking department consists of one large saw that is used to cut seat and back inserts from large plywood sheets. These seats and

EXHIBIT 3 Financial statements ($000)—fiscal year ended July 1, 2014.

Income Statement		**Balance Sheet**	
Sales	$4,558	Assets	
		Cash	$ 106
Cost of goods		Accounts rec.	480
Materials	$1,682	Inventory	1,424
Labor	894	Net plant	987
Overhead	842	Total assets	$2,997
Total	$3,418	Liabilities	
		Notes payable	$1,200
Gross profit	$1,140	Long-term debt	697
Sales expense	$ 462	Owner's equity	1,100
G&A expenses	493	Total L&OE	$2,997
Subtotal	$ 955		
Profit before tax	$ 185		
Profit after tax	91		

EXHIBIT 4 Plant layout.



backs are put into inventory until they are needed by final assembly. When final assembly is begun, all parts are in inventory or are expedited in order to make the required batch of finished product. Expediting is done both inside the plant, to get the missing parts, and with outside suppliers. This expediting is started one week ahead of when the material is needed in order to get all the material in-house to support the assembly schedule for the next week.

An MRP system is used to plan and control inventories. A master production schedule is prepared on a weekly basis for eight weeks into the future. The master schedule is then frozen for four weeks to allow time to fabricate the parts required and to get the parts in from outside suppliers. Any parts that are not there when needed are expedited during the last week, as described above. New orders are only placed in week 5 or later in the master schedule.

The lot sizes for each of the strollers have been developed by use of the EOQ formula. This is done by considering the setup time of equipment and the carrying costs of inventory. The plant is scheduled on a lot-for-lot basis. For example, a lot in the master production schedule of 1,000 regular strollers is translated directly into the parts needed to produce it. This would include 1,000 stroller handles less any inventory on hand or on order. Due to lot-for-lot planning, a setup on the final assembly line also directly induces setups throughout the plant in tube cutting, drilling, bending, and seat cutting. The total cost of a changeover at final assembly is thus the cost of changing over the final assembly line itself, plus the cost of changing over all the other production equipment affected by the lot-for-lot calculations. As shown in Exhibit 5, for the regular model, the total setup time amounts to about 11 labor hours. The shop rate is currently $15 per hour, fully loaded. Therefore, a setup for final assembly of the regular model costs $165. Similarly, the cost of changeover for the deluxe model is $185, and for the shopping center model it is $170.

Setup time includes not only changing the machine over, but also bringing in new materials and taking out

EXHIBIT 5 Setup time for regular models.

Work Center	Setup Time (hours)
Tube cutting	4.2
Drilling	2.4
Tube bending	1.6
Wood saw	.5
Final assembly	2.3
Total	11.0

EXHIBIT 6 Economic order quantities.

Model	D Annual Sales	C Mfg. Cost	S Setup Cost	P Prod. Rate*	D Weekly Usage	1 − D/P	EOQ†
Regular	54,000	$21	$165	2,500	1,040	.584	2,400
Deluxe	24,960	$37	$185	2,000	480	.760	1,150
Shopping	27,040	$56	$170	1,800	520	.711	960

*This is the maximum weekly production rate for a single product being produced.

†$EOQ = \sqrt{\dfrac{2SD}{Ic(1 - D/P)}}$

the old, then making a pilot run to be sure the machine is making good parts. While there are minor setups when making different parts for the same stroller, the major setup is associated with changing over from one stroller model to another.

The EOQ calculations are shown in Exhibit 6. These calculations assume a holding charge of 25 percent per year. Note that the resulting EOQ for the regular model is 2,400 units, which is approximately one week of production, since the line can produce 2,500 regular units per week when the entire line is devoted to the regular model. Likewise, the deluxe model and the shopping center model will each require about .5 week of time to produce an EOQ.

Exhibit 7 shows a typical master production schedule calculated using the EOQs. This master schedule is constructed as follows. Suppose the regular model is put into production first. Then a batch of 2,400 units of regular strollers is scheduled in week 1. But 2,500 units can be produced in one week, and so with five days of production per week, the lot of 2,400 units will take 4.8 days (2,400/2,500 × 5). It will then take an average of two hours per machine to change over the line to the next stroller (time that results in lost capacity). As a result, the rest of the first week is devoted to changeover. Next, the deluxe model is scheduled in week 2, which requires 2.9 days of production (1,150/2,000 × 5 days) for the EOQ to be produced. Then two hours per machine are required to change over to the shopping center model. This process of scheduling is continued, resulting in the master schedule in Exhibit 7.

Inventory is maintained in finished goods ($765,000), work in process ($322,000), and raw materials ($337,000). The finished-goods inventory is distributed through three warehouses located around the country. An average of 80 days of supply is carried at each warehouse. It takes four weeks to reorder from the factory and one week for transit. Some inventory is held in safety stock. Likewise, four weeks of in-process inventory is held to provide high machine utilization and to facilitate scheduling. The company also holds 12 weeks of purchased parts in order to facilitate scheduling with vendors and to prevent line stoppages.

OPTION 1: A PULL SYSTEM

In thinking about Lean, Clem Hawkins was considering two options. Option 1 involved going to a pull system of inventory control. Under this option, three separate final assembly lines would be set up, one for each finished product. This would eliminate changeovers at final assembly. Clem was also considering mixed-model assembly, which would have a similar effect. But this could be more complicated and would require development of some tooling for instantaneous changeover of the line from one model to the next. Of course, setting up three assembly lines, instead of the present one line, would require additional investment (about $200,000) for jigs, fixtures, and assembly tables.

If three assembly lines were used, the master schedule would be drastically changed to the one shown in Exhibit 8. Each week the same amount is scheduled to meet the forecast, thereby putting a uniform load on

EXHIBIT 7 Master schedule for July 2014.

Model	Week 1	2	3	4
Regular	2,400		2,000	400
Deluxe		1,150		1,150
Shopping		684	276	324

EXHIBIT 8 Revised schedule—pull system.

Model	Week 1	2	3	4
Regular	1,040	1,040	1,040	1,040
Deluxe	480	480	480	480
Shopping	520	520	520	520

the plant. This loading is, of course, required for a pull system to work. Clem thought he could also reduce the length of time that the master schedule is frozen to two weeks. This will make it possible to drastically reduce inventories at the field warehouses, to about a 15- to 30-day supply. He would like to achieve the guideline that what is ordered from the warehouses this week is scheduled to be produced next week.

Setting up permanent final assembly lines with a pull system makes it also possible to dedicate certain equipment in the plant to each of the product lines (see Exhibit 9). For example, there are six tube-cutting machines. Since about one-half of the capacity is devoted to regular strollers, three of the tube cutters could be set up permanently for regular strollers. Clem would also need 1.5 tube cutters for deluxe models and 1.5 cutters for shopping models. This presents a problem: either one machine could be dedicated to each model, or two machines could be. If one tube cutter were dedicated to each model, then one machine would be kept to change over as needed between the various models. If two machines were dedicated to each model, an additional machine would need to be purchased. Also, in this case there would be little flexibility with all dedicated machines. In a similar way, some drills and tube benders could be dedicated to each model. But the saw presents a problem since there is only one saw. Either smaller equipment must be purchased and dedicated to models, or the saw could continue to be changed over for each product.

Using the pull system, Kanban containers will be used to move inventory from one work center to the next. When the containers are full at a work center, all machines at the supplying work centers will be shut off, thereby limiting the maximum inventory to the number of full Kanban containers provided. The tube storage room will be eliminated, and all inventory will be held in Kanban containers on the shop floor.

A smaller storage room for purchased parts will be needed, but Clem did not think that he could supply all purchased parts directly to final assembly, at least not initially. But purchased inventories could be greatly reduced once the suppliers are also on the Kanban system. Purchased parts could be supplied on the basis of daily, or certainly weekly, deliveries for all A items and less frequently for B and C items.

OPTION 2: MANUFACTURING CELLS

In this option, a manufacturing cell would be provided for each model. The layout would look roughly like Exhibit 10. Each product would be made in a U-shaped cell. In the regular model cell, there would be three tube-cutting machines, one bending press, five drills, and the final assembly line. This arrangement would have dedicated equipment located in close proximity to each other. Material would flow into one end of the cell and finished product out of the other end. Purchased parts would be delivered to the cell directly by the supplier or in kits from a central storage and kitting room. A kit would contain all the purchased parts needed to assemble one unit of the final product.

Two more cells would also be established: one for the deluxe model and one for the shopping center model. This would require two tube cutters, one press, and three drills in each of these cells in order to maintain the present capacity. Thus, Clem would need to purchase additional equipment (one drill, one press, and one tube cutter) at a cost of about $150,000.

There are several advantages to the use of cells. As things are moved closer together, visual control of each cell can be maintained. Any quality or maintenance problem would be readily evident. Also, the people working in the cell would gain an identity with the particular product produced. The cell takes less space and provides the advantage of fast feedback, since everything is in close proximity. Of course, a Kanban system would also be used to pull parts through each of the cells.

EXHIBIT 9 Pull system layout, dedicated equipment.

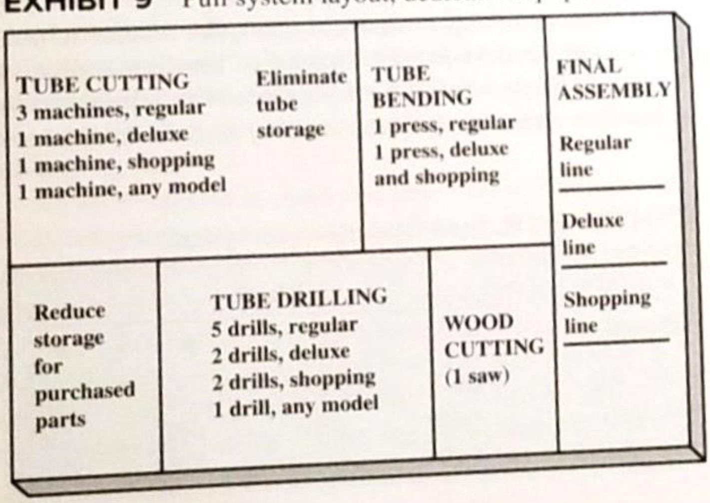
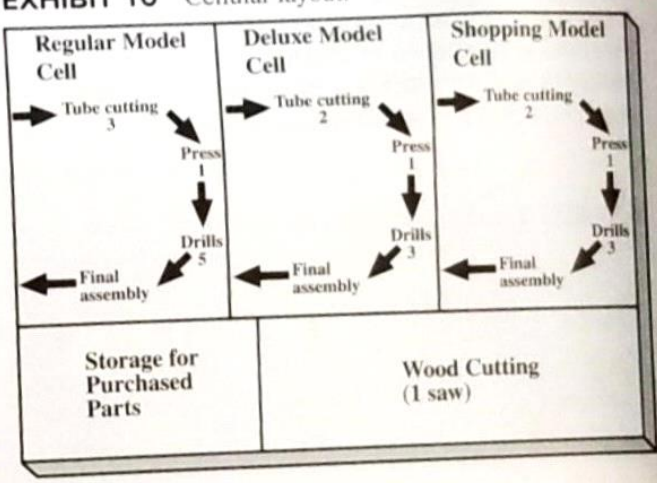


EXHIBIT 10 Cellular layout.



Many of the inventory reduction advantages described above would also be gained by the use of cells. As a matter of fact, the throughput from a cell might even be faster than the Kanban system described in option 1. As a result, less inventory would be required by a cell. On the other hand, a cell gives less flexibility to demand changes, since all equipment is dedicated to that particular product line.

SUNDAY AFTERNOON

During halftime of the Vikings and Bears football game, Clem could not help thinking about the options available for Lean manufacturing. He wondered how much each of these options would save in production costs and inventories. He also considered whether these options would have the same product quality: Would the cell produce a higher-quality product because of its close visual control? Clem decided that he would request a study of these options by his assistant, Joan Hankins. Joan had recently received her M.B.A. from UCLA and was a whiz at analyzing options such as these.

Discussion Questions

1. How would you describe the current situation facing U.S. Stroller?
2. What are the pros and cons of the options presented in the case?
3. What will be the impact of these options on the MRP system currently in use?
4. What option do you recommend and why?