Welcome to Apex Tube

Apex Tube Company is a typical discrete parts manufacturer, making fuel lines for cars, trucks, and heavy equipment. Several years ago, Apex responded to pressure from its customers for lower prices, higher quality, more frequent deliveries, and more rapid response to changing demands by taking a hard look at its manufacturing operations.

One facility — the example used in *Creating Continuous Flow* — took a dramatic leap to embrace lean production on a plant-wide basis by creating high-performance cells. It also introduced a lean production-control system using kanban to connect a finished-parts market with the pacemaker cells and the pacemaker cells with a purchased-parts market near the receiving dock.

However, a second Apex facility — which we use for our example in *Making Materials Flow* — took a more gradual approach to improvement that seems to be typical of current practice in many companies. This facility, which made similar products although for different customers, started by constructing a product family matrix as shown here.

Its managers then drew a current-state map for the circled product family, light trucks.

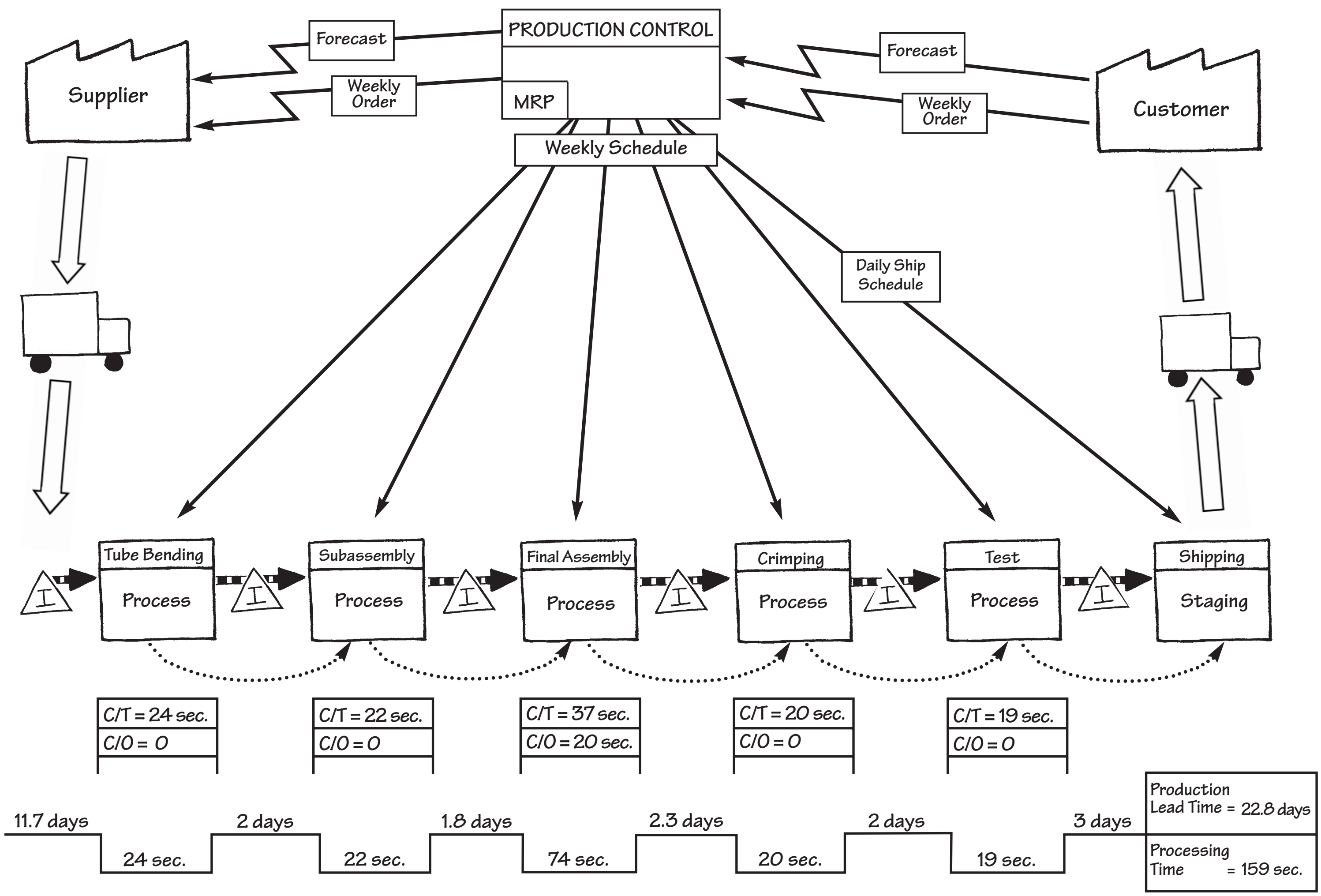
Apex's Product Family Matrix

		Assembly Steps and Machines							
		end form	pierce	braze	bend	sub-assembly	final assembly	crimp	test
PRODUCTS	automotive	X				X	X	X	X
	truck S	X			X	X	X	X	X
	truck [illegible]	X			X	X	X	X	X
	truck A	X			X	X	X	X	X
	heavy truck		X	X	X				X
	heavy equipment	X	X	X	X		X		X

Note:

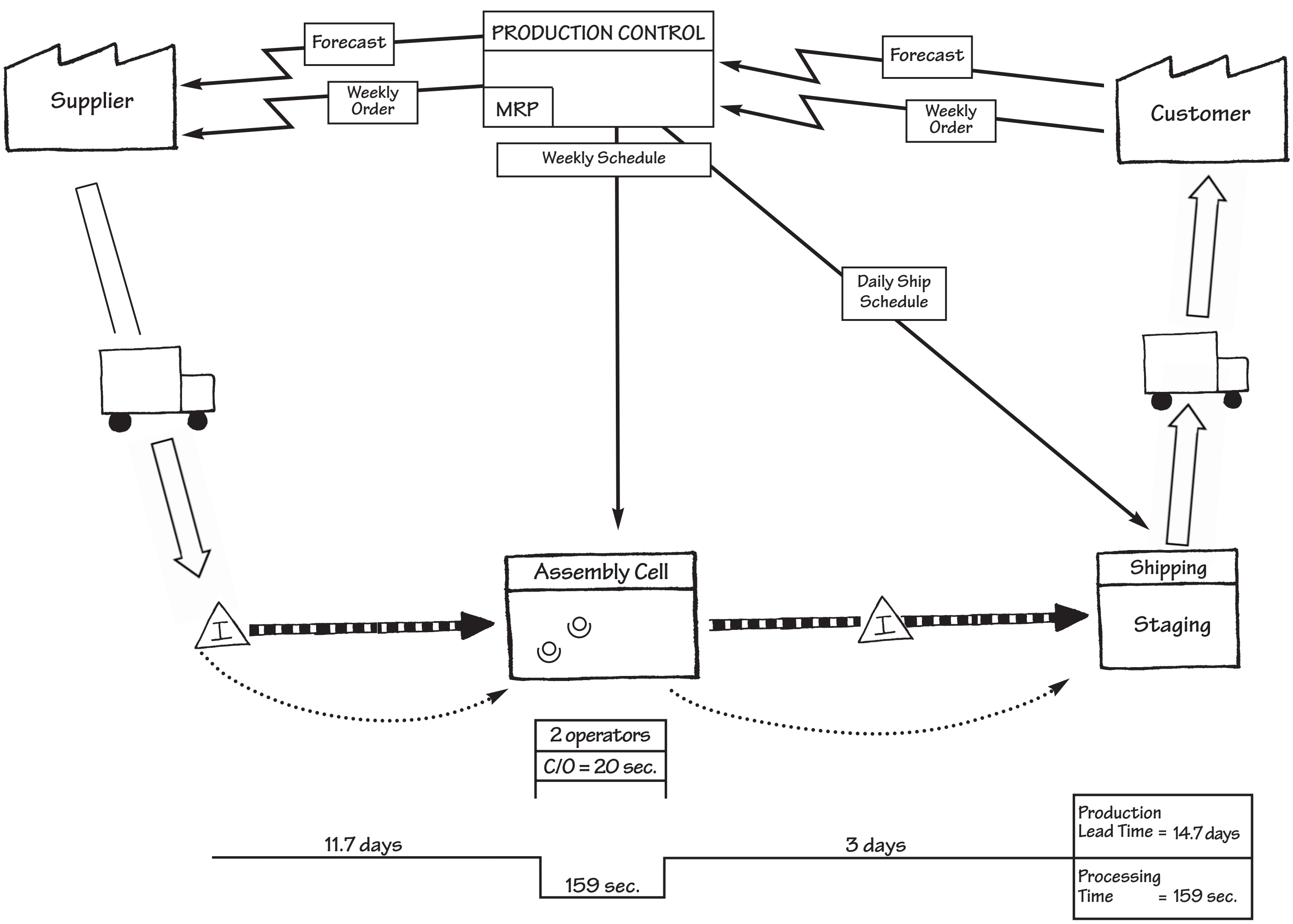
Readers familiar with the current-state map in *Creating Continuous Flow* will observe that this Apex sister plant performs only five processing operations to manufacture fuel lines. Tube extrusion and end-forming activities are performed at the Apex headquarters facility, which supplies tube parts to the Apex plant in our example.

Apex Light-Truck Fuel-Lines Current-State Map



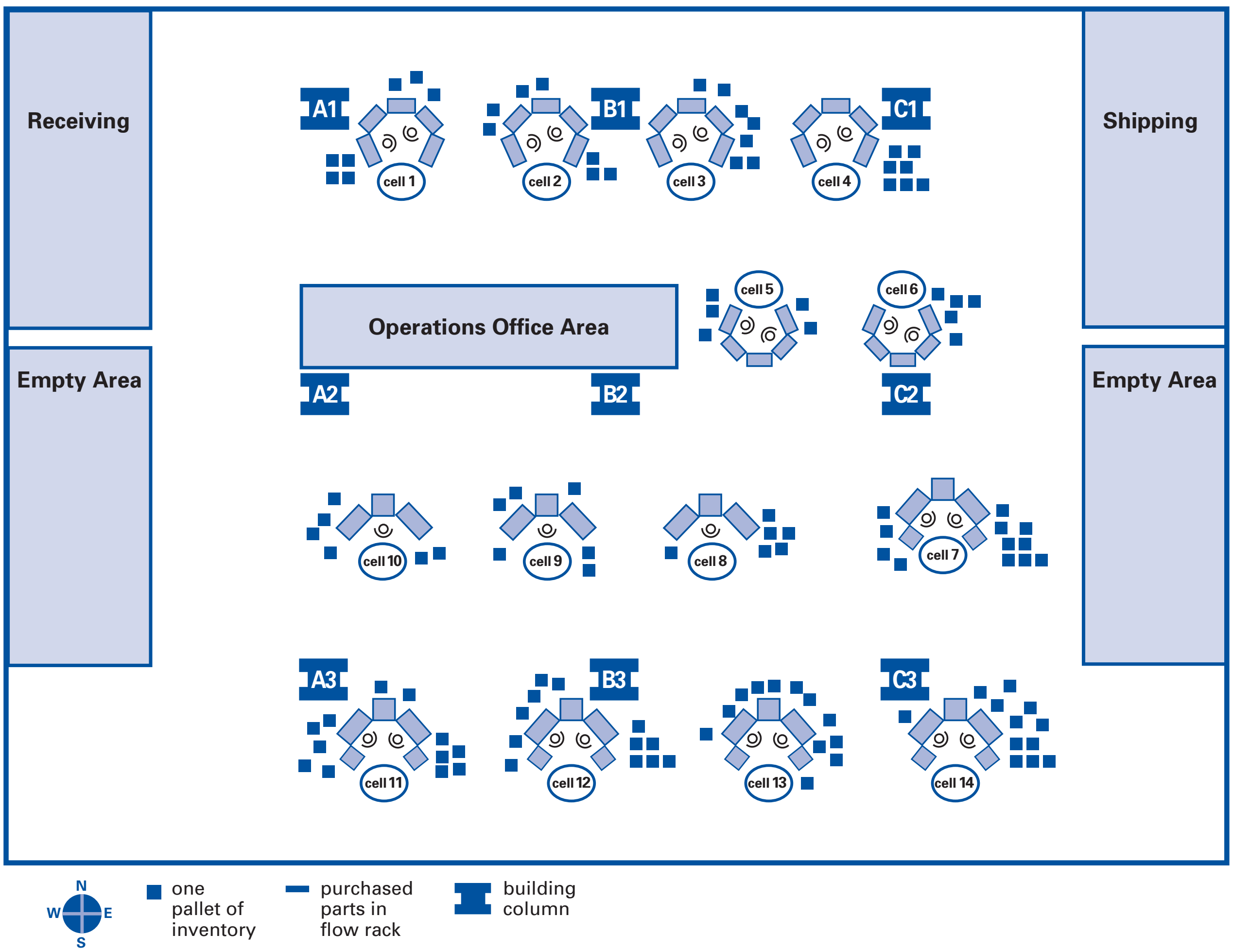
Apex managers understood the advantages of starting with a pull production-control system from a finished-goods market to the pacemaker cells, created by moving and combining the five process steps. But they were cautious. As a first step, they decided to create the cells but maintain their traditional MRP production control system and their traditional material-handling system, which brought parts to the cells in whole pallet loads as they arrived from suppliers.

Apex Light-Truck Fuel-Lines First Future-State Map



As all of the product families were converted to cellular operations — with five cells for the light-truck family, three for the auto family, four for the heavy-truck family, and two for the heavy-equipment family, for a total of 14 — a new layout for the Apex plant was created (*shown below*). Note that a considerable amount of space was freed in transitioning from the traditional process-village layout to a cellular configuration.

Apex Overhead Layout



Inventory is delivered from the dock to the cells on a pallet.

Continuous-Flow Cells That Don't Flow Continuously

Apex managers initially were elated with their accomplishments. For example, in the first cell converted (for light-truck fuel lines) they cut the space required by 75% from the amount needed under the original process-village layout. At the same time, when everything was operating perfectly, they reduced production lead time by 35% and more than doubled productivity, as measured as pieces per production associate per hour. Similar leaps in performance occasionally were achieved in every cell.

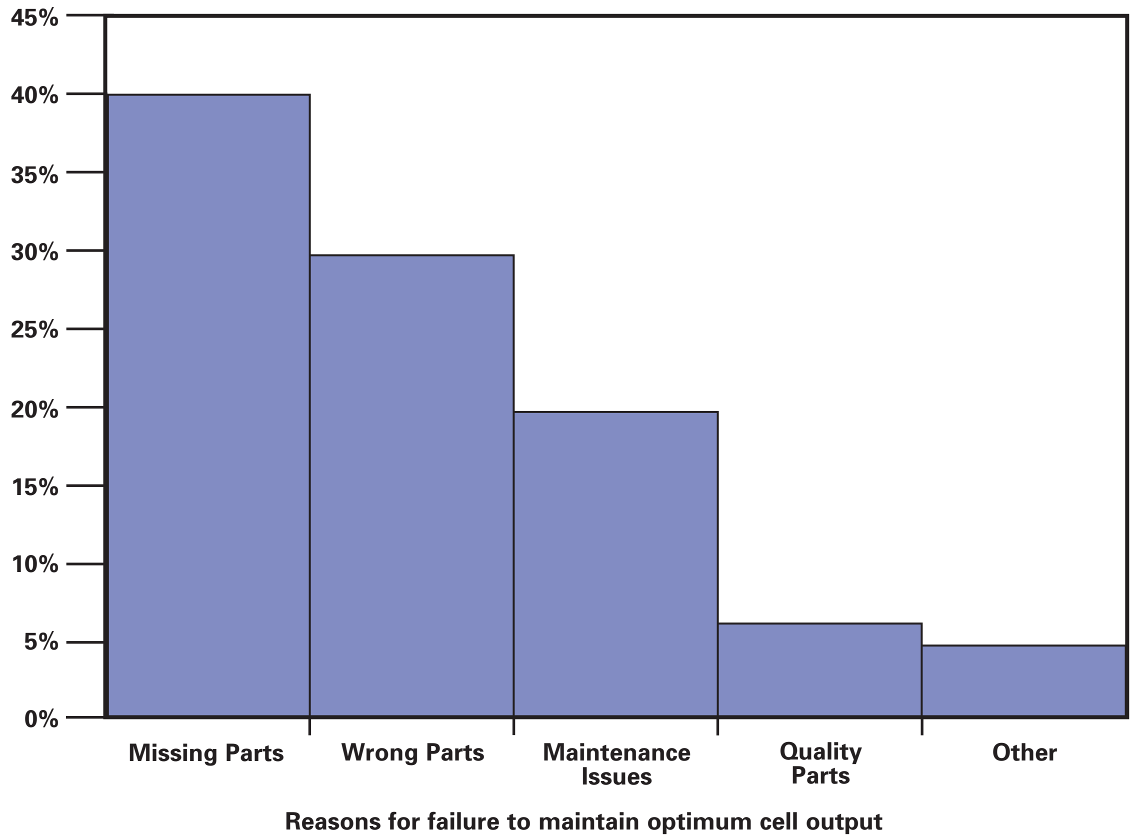
However, these levels of performance were achieved only when the cells flowed continuously. Unfortunately, it soon was apparent that this normally was not the case. For example, what should have been a steady output of 90 fuel lines per hour in the light-truck cell began to fall short as the novelty of the new system wore off and management attention shifted to other issues. Indeed, shortfalls of 20% soon became the norm, necessitating expensive daily overtime. Even worse, these shortfalls were erratic and unpredictable from hour to hour and day to day, making it difficult for production managers to plan.

Fortunately, Apex had installed and faithfully used a *production analysis board* (also called a *problem-solving board*) next to every cell. After a few weeks of erratic production in the new cells, the most important causes of production stoppages were easy to see and summarize.

Production Analysis Chart

Line Fuel-Line Cell			**Team Leader** Barb Smith	
Quantity Required 690			**Takt Time** 40 sec.	
Time	**Plan/Actual (hourly)**	**Plan/Actual (cumulative)**	**Problems/Causes**	**Sign-off**
6-7	90 / 90	90 / 90		
7-8	90 / 79	180 / 169	missing parts	
8-9	90 / 82	270 / 251	missing parts	
9^{10}-10^{10}	90 / 71	360 / 322	wrong parts	
10^{10}-11^{10}	90 / 90	450 / 322		
11^{40}-12^{40}	90 / 84	540 / 406	wrong parts	
12^{40}-1^{40}	90 / 86	630 / 494	missing parts	
1^{40}-2^{30}	60 / 60	690 / 552		
O.T.	138	690 / 690	(2 hr. 35 min.)	

Apex Pareto Analysis



By aggregating the results of the production analysis charts from all 14 cells, Apex managers were able to construct a Pareto analysis for the entire facility that showed the leading causes of production halts throughout the plant.

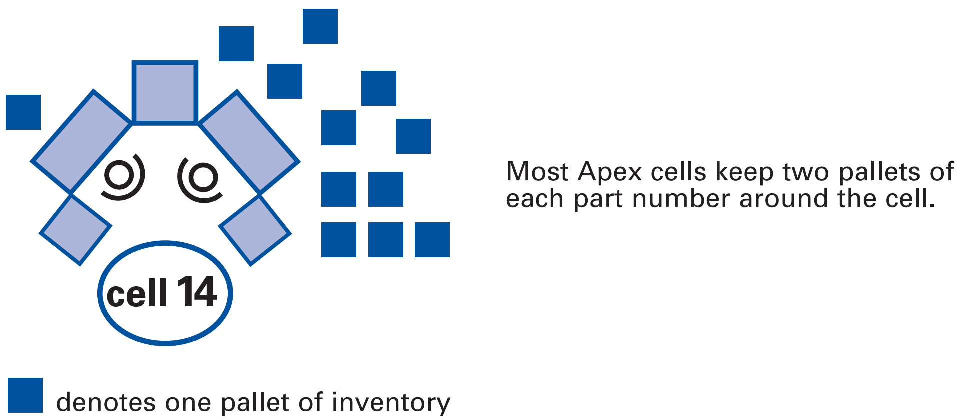
The message of the Pareto analysis was clear: The root cause of the most serious production interruptions was unreliable supply of the right number of good parts to each cell. When materials consistently were available to the cells, the production associates often were able to meet their production requirement without overtime.

This finding set Apex managers to thinking. In the spirit of going to the *gemba* (the shop floor or, literally translated, the *actual place*), they decided to take a walk through the plant to understand the actual flow of materials from the receiving dock to the cells. As they did this, they calculated the amount of inventory in the plant compared with what they had expected to find based on their success with creating cells. Apex managers then had a second realization: The amount of inventory on hand had not fallen nearly as much as they had expected.

A bit of reflection showed the reason: Although the amount of work-in-process inventory *within* the cells between machines had been dramatically reduced, indeed down to zero in some cases, large amounts of inventory still were piled up beside the cells. And this was the problem.

An examination of an area around a typical cell showed two pallets of most part numbers were being kept near the cell, one to supply current production and one as a backup. Most managers did not trust the current Apex material-handling system and had insisted on large buffers of purchased parts in an effort to ensure steady production for their areas. (Yet, ironically, the mountains of parts still were not ensuring steady output.)

Excessive Inventory Around Cells



As the team continued its walk, it was soon apparent that the performance of the material-handling system was actually even worse than it first appeared. The Apex managers knew that the same part numbers were used by a number of cells, but they soon realized that pallets of parts of the same part number were stored beside every cell that used the part. This greatly increased the amount of parts in the plant and made it difficult to determine the true level of inventory for each part. As a result of the inability to track materials — the final discovery of the team's walk — parts were frequently being expedited from suppliers at high cost when they were actually available in adequate quantity *somewhere* in the plant.

Redundant Inventory at Cells

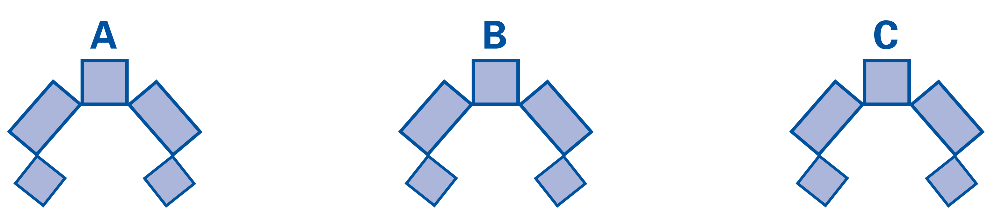
As a result of their walk, Apex managers suddenly could see that they had created lean production within their cells but had retained an expensive and undependable mass production material-handling system to supply the cells.

This produced many undesirable consequences:

- Production operators and supervisors were spending valuable time looking for parts.
- The total inventory in the plant was far more than necessary.
- Many dangerous forklift movements were needed to supply the pallet loads of parts to the cells.
- The cost of expediting "missing" material (much of which was in the plant but impossible to locate) was more than a thousand dollars per week.
- Overtime to make up production shortfalls due to wrong or missing parts was a major plant expense.

To use a biological analogy, the individual cells now were healthy, but the circulatory system was causing the whole organism to feel sick.

Redundant Inventory at Cells



A		B		C	
Part #99009	3 weeks	Part #99009	2 weeks	Part #99009	8 weeks
Part #99009 Backup Pallet	3 weeks	Part #99009 Backup Pallet	2 weeks	Part #99009 Backup Pallet	8 weeks

There are 26 weeks of part #99009 on the floor.

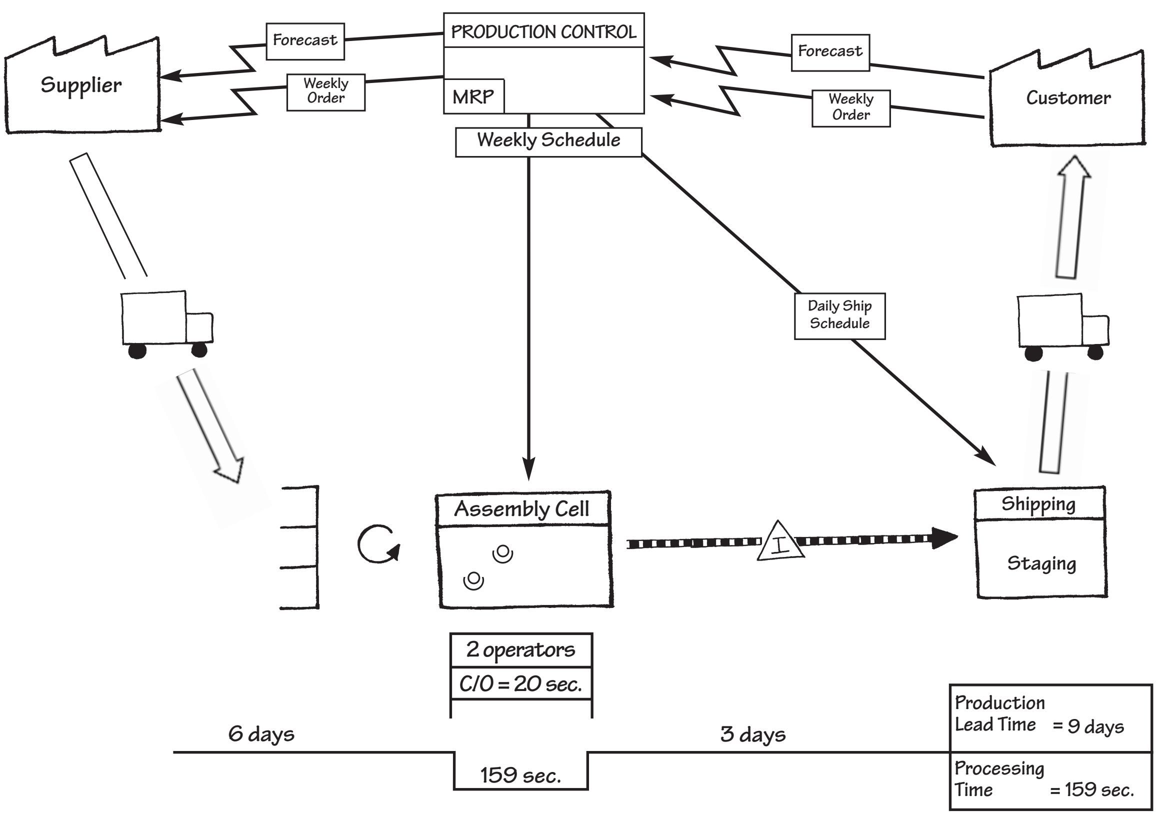
Targets for a Lean Material-Handling System

To create a leaner plant, Apex managers needed to introduce a lean material-handling system to *make materials flow* throughout the facility with much higher accuracy at much lower cost. Specifically, they needed:

- A process for describing with great precision how every part would be managed from the receiving dock to its point of use in the plant.
- A purchased-parts market near the receiving dock to hold and control the necessary parts.
- A precise delivery system to get the parts to the point of use.
- A precise signaling system that each production area would use to pull just the parts it needed from the purchased-parts market.

Apex managers then drew a new future-state map with the features indicated here. (Note that for the moment Apex will continue to order purchased parts through its MRP system. Further down the road it plans to extend its purchased-parts pull system directly out to suppliers and bypass the MRP. Similarly, on the other end of the value stream, the authorization for cells to produce goods eventually will be triggered by pull signals coming from the customer-end of the facility.)

Apex Light-Truck Fuel-Lines Second Future-State Map



Based on extensive experience with materials management, we can estimate reasonable targets for the performance of a lean material-handling system for the Apex facility in comparison with the current performance (*shown below*).

Apex Material-Handling System

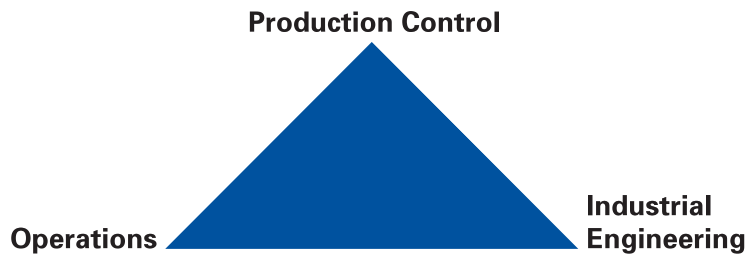
	Current-State Performance	Target Performance
Material handlers on production floor	14	5
Percent operator time retrieving parts	10-15%	0%
Percent of manufacturing space required to store parts inventory	20%	1%
Total plant inventory turns	8	15
Parts inventory at cells	2-3 days	2 hr.
Forklifts for parts delivery	7	0
Forklift recordable incidents per year	13	0
Average production per shift/target production per shift	552/690	690/690
Daily overtime per light-truck fuel-line cell	2 hr. 35 min.	0 min.
Cost of overtime, entire plant per week	$19,500	$0
All expedited delivery costs per week	$1,400	$0

The Key Role of the Production Control Department

It's one thing to desire a better material-handling system; it's quite another thing to achieve and sustain it. As always, management and organization are key. Apex therefore needed to focus on an often-neglected group in its organization — the *Production Control Department* — and give it center stage. While this group was called Production Control at Apex (and often is called *Logistics Control, Materials Control*, or *Inventory Control* in other companies) it actually didn't *control* anything. It planned the weekly schedule and then functioned as an expediter to chase missing parts and head off shutdowns due to lack of materials.

Apex decided to revitalize Production Control and make it a central figure in its facility. However, to be successful Production Control could not work alone. It needed to be one corner of a door-to-door *materials triangle* that includes the Operations Department and the Industrial Engineering Department. In your operation, of course, the names for these activities may be different. Regardless, someone must be tending to production control (including expediting), production operations, and layout planning. Apex needed to tightly coordinate the efforts of the three groups.

Door-to-Door Materials Triangle



As it moved ahead with implementing a lean material-handling system, Apex quickly learned that changes in the system needed to be discussed and agreed to by all three members of the materials triangle. Otherwise, serious problems were sure to arise. The proof of this principle came early in Apex's implementation of the new materials system when Production Control decided to create an aisle for a planned material-delivery route. Industrial Engineering designed the aisle and passed the project on to the Facilities Department. However, it turned out that the production operations in the area needed access to an immovable water line directly above the planned aisle. The problem was caught just before the start of construction, but all of the planning effort was wasted and implementation of new delivery routes was delayed.

As a result of this and other experiences, Apex managers instituted a decision-making rule that we urge you to copy. Proposals to alter *anything* affecting the management of materials within the facility now must be signed off by each member of the door-to-door materials triangle before implementation.

Getting Started

Once Apex had revitalized its Production Control Department with new leadership and clear responsibility for the door-to-door flow of materials and clarified this department's relations with the other key departments, it was ready to quickly implement a lean material-handling system.

This involved four simple but demanding steps:

1. Develop a *Plan for Every Part (PFEP)*, a database for every part number entering the plant that contains the part's specifications, supplier, location of supplier, storage points, point of use, rate of usage, and other important information.

2. Create a single *purchased-parts market* for all parts entering the plant and implement careful rules for its management.

3. Initiate *precise delivery routes* to move all materials within the plant, utilizing standard work.

4. Integrate the new *material-handling system* with the *information management system* through the use of *pull signals* to ensure that only the parts consumed by the cells will be replenished.

In the pages ahead we will provide you with all the information and methods you need to take these same steps. We'll do it by walking you through 10 simple questions, providing answers and examples. Because the rewards of taking these steps are abundant for any operation, let's get started right now.

Is Your Facility More Complicated?

We've chosen this Apex facility for our example in this workbook because it is relatively simple and makes a simple product. This makes it easy to illustrate the key principles involved in lean material-handling. However, your facility may be more complicated. For example, you may have fabrication areas working in batch mode that supply intermediate goods to your final assembly cells. Or you may have traditional assembly lines rather than cells. And your product families may have much lower volumes with wider variety than at Apex. As we proceed through this workbook, we will keep the Apex example in the foreground for ease of illustrating the key principles. In the Appendix we will discuss briefly how to deal with more complicated situations.