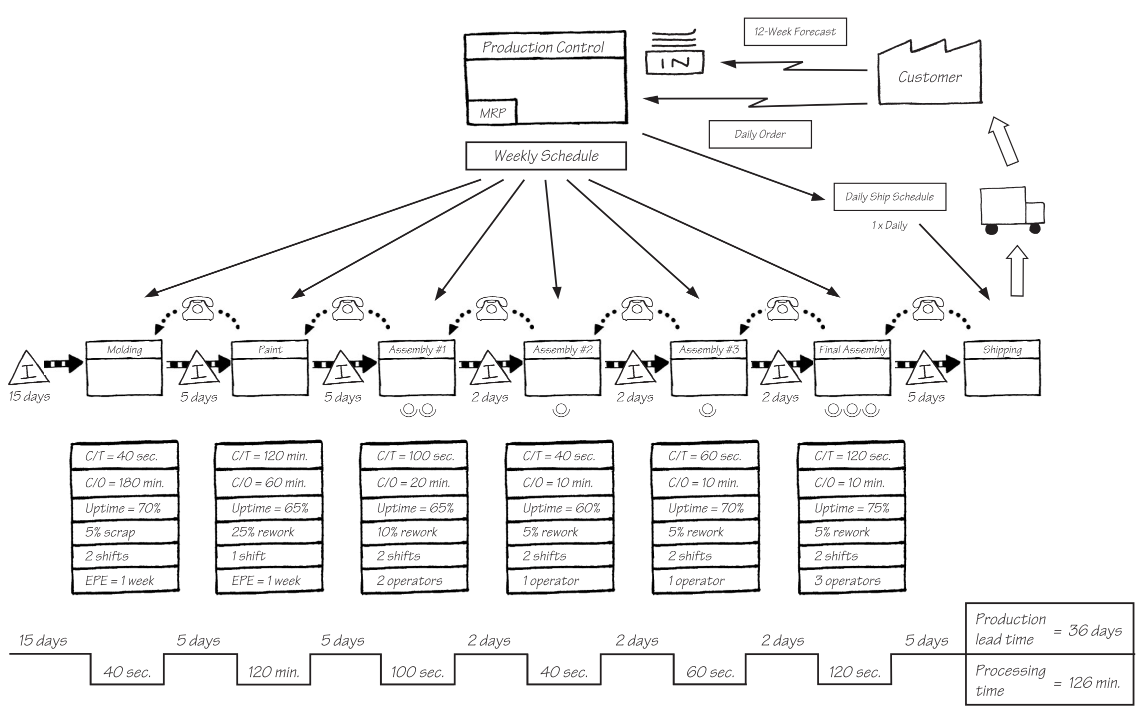
Welcome to Apogee Mirror

Apogee Mirror is a typical discrete parts manufacturer, making exterior mirrors, interior mirrors, and door handles for the automotive industry. Several years ago, Apogee responded to pressure from its customers for lower prices, higher quality, more frequent deliveries exactly on time, and more rapid response to changing market demand by taking a hard look at its manufacturing operations.

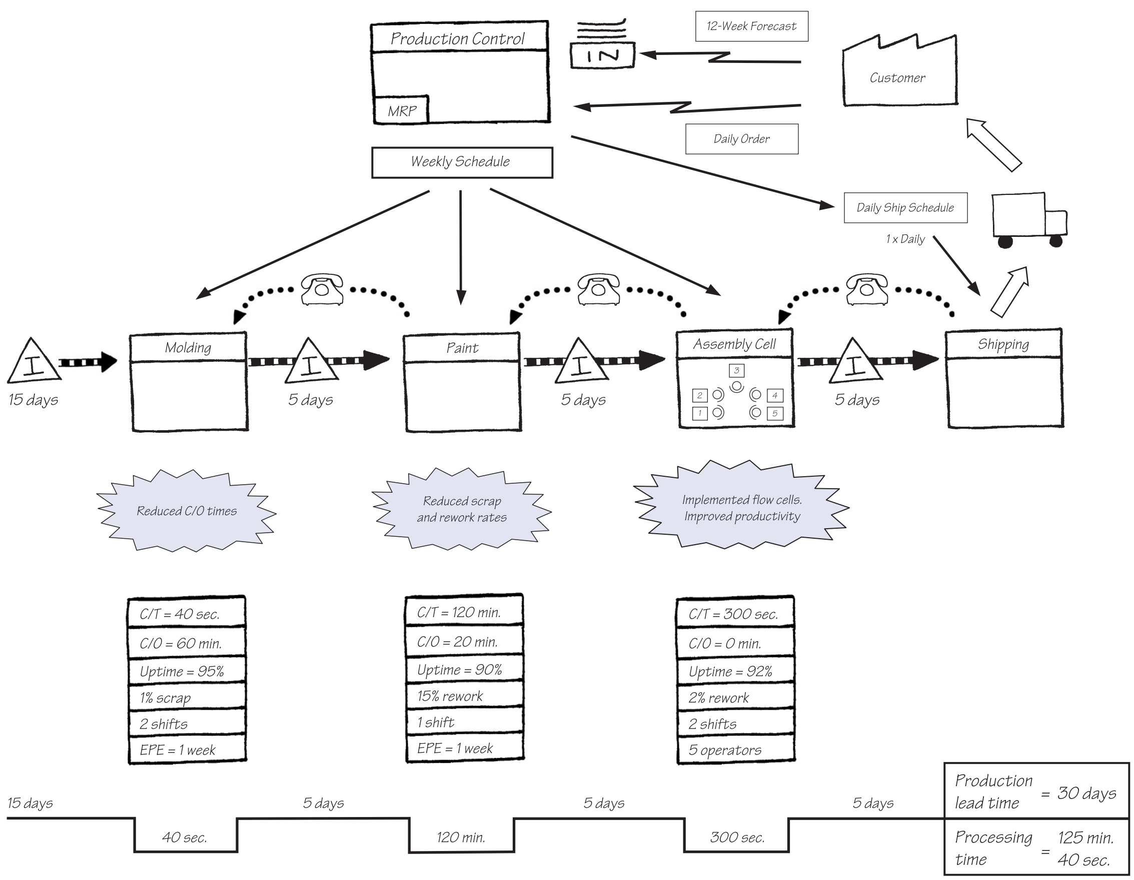
Apogee managers took a value-stream walk to follow the manufacturing paths of its three main product families. They drew value-stream maps for each product family—one of which is illustrated below by the map for the exterior-mirror product family. They soon were able to see wastes of many sorts: long set-up times on molding machines; poor uptime in the paint booth; many disconnected operations for assembling the product; and long throughput times with large inventories between every step in the process.

Original-State Value-Stream Map for Exterior Mirrors



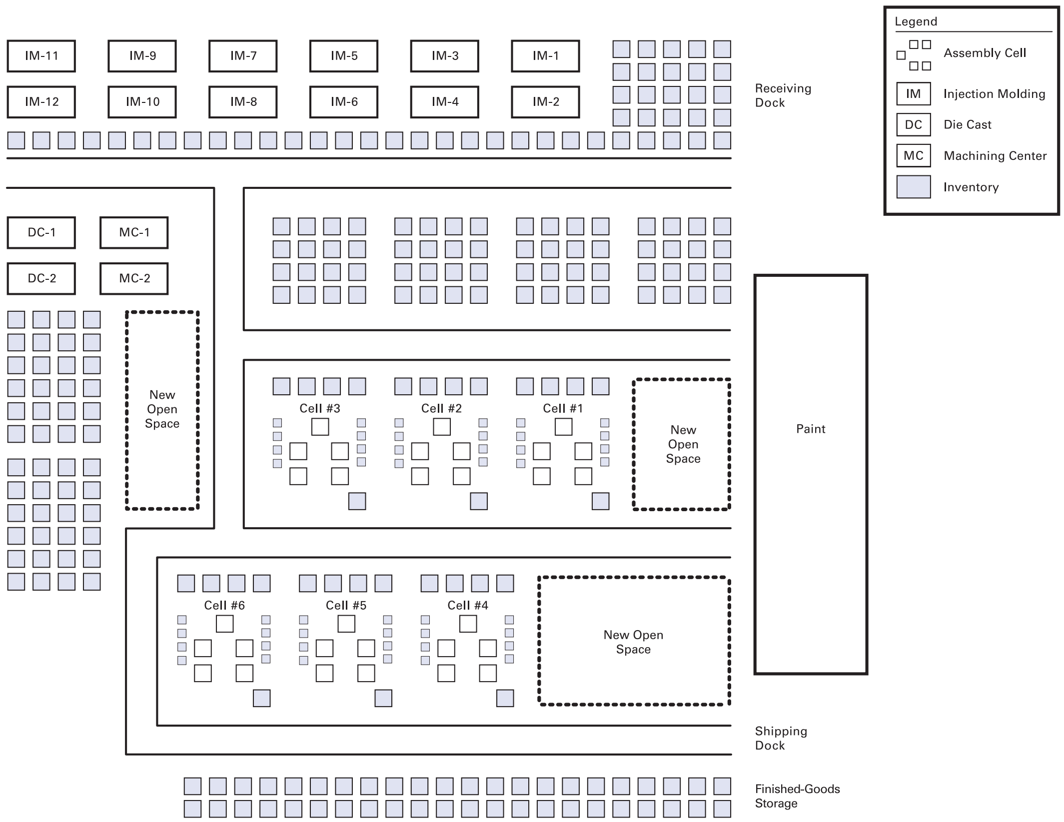
By energetically pursuing both point and flow kaizen along the three value streams, Apogee management and employees soon were able to achieve much better performance for all three product families, as shown by their current-state map for the exterior-mirror product family.

Current-State Value-Stream Map for Exterior Mirrors



Apogee reduced changeover times in all of the processes, improved uptime in paint through point kaizen, and created compact continuous-flow assembly cells through flow kaizen. Because of this, Apogee managers were able to shrink throughput time and inventories while reducing effort and cost. They also were able to reduce the amount of manufacturing space required (*see Apogee Overhead Layout*).

Apogee Overhead Layout



Like many companies today, Apogee avoided taking any action to more tightly link and control the flow of information between the production departments—molding, die casting, paint, assembly, and shipping. Apogee managers judged that modifying the information management system linking these areas—which pushes products ahead to the next processing step with the help of material handlers who respond as needed—would be complicated because the necessary systems would affect every value stream in the plant. In addition, many managers wondered if this leap really was necessary. They thought that sufficient improvements could be wrung from point kaizen and flow kaizen.

The Continuing Challenges of Delivery and Cost

Initially, Apogee's managers were delighted with their achievements as a result of point and flow kaizen. Morale in the facility was higher as a 5S program brightened work areas and employees participated in the kaizen activities. And direct-labor costs significantly declined.

Many dimensions of performance, however, did not improve as hoped. In particular, the facility still needed considerable overtime and expediting of shipments to meet customer requirements. And while total inventories had been lowered, they still were high. Equally troubling, the reduction in direct-labor costs had not been matched by any change in indirect labor. Managers still were spending large amounts of time revising production schedules as customer requirements changed. Meanwhile, an army of material handlers raced through the plant to get the right materials to the right place to meet changing customer requirements.

Even more troubling, performance in some areas seemed to be deteriorating as the initial excitement of the kaizen initiative wore off. In particular, the paint, assembly, and shipping departments often reported that they could not provide what their customers wanted because of a lack of materials in the right place at the right time. This trend is shown in the box score.

Box Score—Exterior-Mirror Value Stream*

	Original state	After basic stability	After cell flow kaizen	Current state
Productivity				
Direct labor (pieces per person per hr.)	9.0	10.0	11.5	11.0
Material handlers supporting value stream	3	3	3	4
Quality				
Scrap	5%	4%	3%	2%
Rework**	25%	20%	15%	15%
External (ppm)	500	250	125	105
Downtime***				
Assembly (min. per shift)	40 min.	30 min.	10 min.	20 min.
Paint (min. per shift)	30 min.	20 min.	15 min.	15 min.
Molding (min. per shift)	50 min.	25 min.	25 min.	10 min.
Inventory turns				
Total	8	11	14	12
On-time delivery				
To assembly	65%	68%	80%	75%
To shipping	80%	92%	95%	85%
To customer	100%	100%	100%	100%
Door-to-door lead time				
Processing time (min.)	126.0	126.0	125.7	125.7
Production time (days)	36	34	28	30
Costs				
Overtime costs per week	$6,000	$5,000	$4,000	$5,000
Expedite costs per week	$2,000	$1,500	$1,500	$2,000

* No major change in demand or product mix over this time.

** Rework is due to persistent inclusion problems.

*** Downtime is separate from changeover time and reflects only lost time in production due to mechanical problems or material availability per shift.

The pattern of visible improvements at many points but limited progress in the facility as a whole, along with ominous backsliding in some improved areas, seemed to suggest that something was wrong with the total production system, not just the individual parts. Apogee managers therefore decided to take another walk to focus on the flow of information and materials between production areas and to look at the entire production system involving all three product families. What they saw was quite startling.

Traditional Scheduling in a 'Lean' Facility

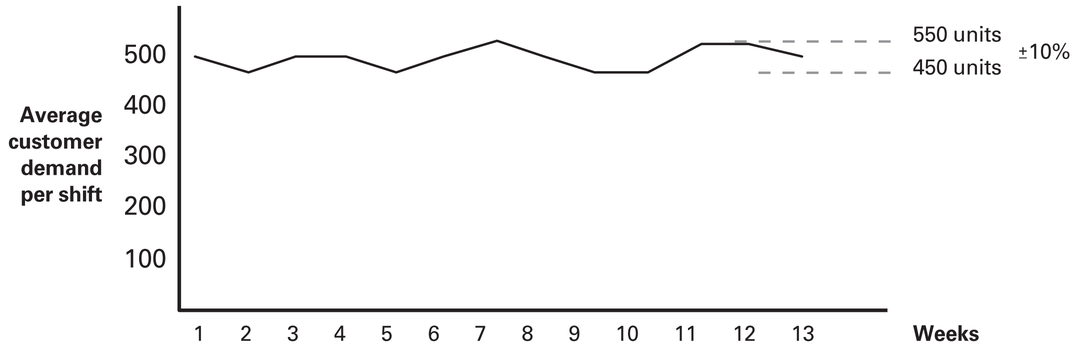
The management team started its walk in the shipping area, following the value stream for exterior mirrors. It quickly learned from the Production Control manager that customer schedules were forecast well in advance and formed the basis for the weekly schedules sent to each production area by the computerized Material Requirements Planning (MRP) system. However, the weekly schedules bore only limited resemblance to the daily releases from customers that determined what was actually shipped. Because the throughput time in the plant from raw materials to finished goods was still several weeks, the frequent change in customer orders, as reflected in the daily releases, often meant:

- The wrong items—too many and too early—were being produced far upstream.
- Downstream processes, such as assembly, lacked the correct parts despite holding large inventories of many parts.
- Downstream processes had no effective mechanism to let upstream processes know what parts they needed next, short of supervisor intervention.

To deal with these problems, Production Control spent most of its time revising schedules and expediting parts within the plant. Yet during a normal shift only 75% of orders were ready to assemble on time, and only 85% were ready to ship on time. Because no automotive supplier can risk stopping its customer's assembly plant, Apogee dealt with the problem of products arriving late at the shipping dock by running large amounts of overtime every day (to get the product out of the plant that night) and by using expensive air freight. Senior managers also discovered on their walk that production capacity for each process was greater than the average demand. This meant that expensive overtime mostly was caused by scheduling problems rather than capacity constraints.

To illustrate the production-control problem Apogee was facing, the management team drew a simple graph (*see Apogee Demand Variation for Exterior Mirrors on page 6*) in which the variation in orders for exterior mirrors was plotted. The solid line shows the actual variation in weekly demand for units from the end customer over the most recent 13-week period for one of the two assembly cells in this value stream. (The two cells were identical. One produced right-side mirrors and the other produced left-side mirrors.)

Apogee Demand Variation for Exterior Mirrors

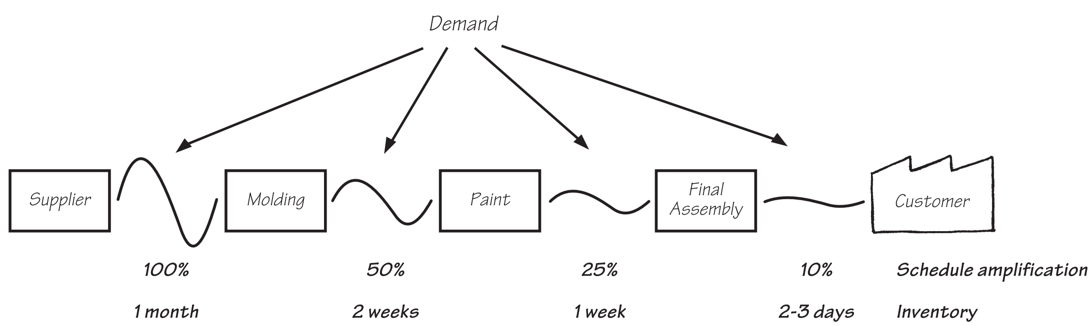


The chart reflects only variation in the total number of mirrors demanded from the left-side exterior-mirror cell. The situation became more interesting when mix variation for mirrors by colors and configurations was included for the same 13-week interval. A sampling of the top 10 part numbers that ran through the same assembly cell in the exterior-mirror value stream generated the chart below (*see Apogee Demand and Mix Variation*). The obvious conclusion was that total demand varied only slightly, but mix varied substantially.

Apogee Demand and Mix Variation

More surprising, however, was the realization that variation in both total demand and mix got progressively worse through the plant. By collecting data on actual production orders at each process step, the Apogee team soon was able to see that the variation in daily release amounts was less than the variation in actual orders sent to the two assembly cells for exterior mirrors, and this variation was less than that experienced by the most upstream production step for this product family (molding). In short, Apogee faced a modest challenge from erratic customer demand—one no worse than what most facilities face—but its internal practices made the problem much worse than it needed to be.

Demand Transmission and Amplification



The Need to Switch from Erratic Push to Level Pull

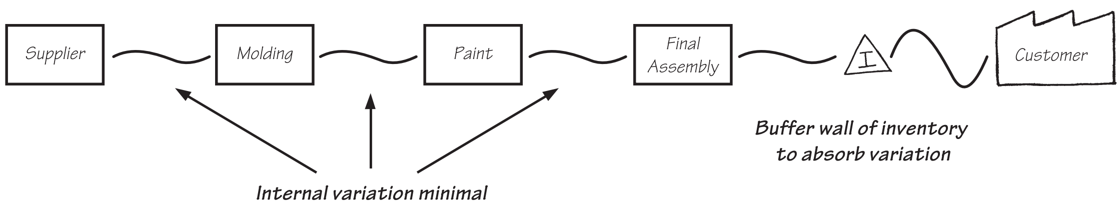
As the Apogee managers reflected on their walk, they suddenly understood some simple ideas they had read about but never really grasped. They had discovered that their customers were only modestly erratic with their orders, but Apogee's internal scheduling practices were making the situation much worse by transmitting customer variation to every step in the production process and then increasing the variation. They also realized that the centralized production-control methods, which attempt to schedule every point in the production process, were pushing products ahead to the next production area on the basis of the forecast rather than the actual needs of the next process. This was causing inventories to pile up ahead of every step.

The team realized Apogee had a *cognitive* scheduling system that pulled all information up to a centralized point for decision making when they really needed a *reflexive* production-control system permitting each production point to signal its needs to the previous production operation. In biological terms, Apogee was transmitting all information to its brain for processing when it really needed to let its reflexes take over. When we put our finger on a hot stove, we don't methodically review the situation and propose the best course of action. Instead, our reflexes do the right thing by pulling our finger away. This is the simplest way to think about the difference between push and pull.

Similarly, the team could see that their facility was exposed to the full brunt of customer orders, as if built on an unprotected coastline and exposed to storm waves. Yet humans always have sought to locate important sea-related activities in safe harbors rather than on unprotected coasts. The purpose of the harbor and its breakwater is to prevent disruptive waves from reaching the docks, even though the level of water still rises and falls over time in the harbor to match the average level of the ocean. Apogee's location on an unprotected coast was allowing waves of customer demand and mix fluctuations to flood through the plant unchecked, becoming even more turbulent as they passed from department to department.

What Apogee needed was a way to level and smooth external customer orders to protect the activities within the plant from chaos while still serving the customer and while letting every production activity pull the materials it needed next from the previous process. They needed to *create level pull*!

Level and Pull to Smooth Demand Amplification



As we soon will learn, there are many places to locate strategic buffers that protect operations from demand waves while serving the customer better *and* improving operational performance. Indeed, much of this workbook will be devoted to locating and precisely sizing the appropriate buffers. The key point now grasped by the Apogee team was that inventories at the right points could greatly improve productivity and customer response.

Do You Have Sufficient Stability to Embrace Level Pull?

An important question for you to ask at this point is whether you have sufficient stability in your operations to move forward with a pull production-control system. In general, if individual processes have uptimes of 75-80%, as they did at Apogee, you can move forward on pull. However, if the output in many of your processes is less stable and predictable, lead times internally will vary tremendously and pull production will be very hard to implement. In these cases you probably will do better to spend a bit more time on point and flow kaizen to improve stability before attempting to make the leap to level pull.

At the end of their value-stream walk, Apogee managers resolved to install a truly lean production-control system for every value stream in their facility. This workbook will show how they did it, describing the questions they asked, the actions they took, the performance targets they set (*as shown in the chart below*), and the timeline adopted for the initiative.

Box Score—All Value Streams

	Original state	Current state	Target state
Productivity			
Direct labor (pieces per person per hr.)	7.8	10.2	12.5
Material handlers per shift	24	25	15
Quality*			
Scrap	5%	2%	<1%
Rework	25%	15%	<5%
External (ppm)	500	105	<50
Downtime			
Assembly (min. per shift)	40	30	<5
Paint (min. per shift)	30	15	<10
Molding (min. per shift)	20	20	<10
Inventory turns			
Total	8	10	30
On-time delivery			
To assembly	60%	75%	98%
To shipping	85%	85%	100%
To customer	100%	100%	100%
Door-to-door lead time			
Processing time (min.)	126.0	125.7	125.7
Production lead time (days)	36	30	12
Other			
Overtime costs per week	$30,000	$25,000	$0
Expedite costs per week	$12,000	$9,000	$0

* Quality issues will not be directly addressed in this implementation effort. These targets represent long-term goals for the value stream.

Implementation Approaches

I often encounter debates about which implementation path to take—narrow or broad, fast or slow—and I always say, "It depends." It depends specifically on:

- Your level of knowledge and experience as you start;
- The level of acceptance of the concept within your implementation team;
- Your need for quick results as opposed to the need to get it right the first time while educating a larger number of individuals;
- The nature of your production assets; and
- Your tolerance for making mistakes.

Firms with limited knowledge and experience, ambivalent managers in some key positions, and limited tolerance for errors will do better to follow the incremental path described in this workbook. Other firms with more knowledge (perhaps including an experienced external sensei), more buy-in, and lots of courage may follow the all-at-once path and will gain the full benefits of the transformation sooner. However, the end objective and the methods to employ are the same. With the information provided in this workbook, you can successfully follow either path or some path in between that best fits your circumstances.

As Apogee set out to create level pull, it needed much more than performance targets and the right questions. With a little experience you will find that setting reasonable targets is the easy part, and the questions to answer are always similar among facilities. *Apogee's most critical needs were the correct management team to spur the transition, a clear plan to guide everyone's actions, and a reasonable scope and timing for their efforts.*

The Transition Team

Apogee knew it was important for everyone in the facility to be involved, and created a special team for the transition. The team was led by a dedicated leader from Production Control, the organization that will operate the system over the long term. The team included one manager from every area of the operation—shipping, final assembly, paint, molding, die casting and machining, receiving, materials handling, industrial engineering, and human resources. The detailed implementation work then was done by a small staff, which worked full time on the project and reported frequently to the team.

Apogee set a six-month timetable to get the job done, which is reasonable in all but the largest facilities. The timetable listed every task to accomplish, established times to start and complete each task, and assigned clear responsibility for each task to a specific member of the team.

The Scope and Timing

Apogee could have started with the whole facility, done lots of planning, and switched from erratic push to level pull on a given Monday morning. (And some facilities actually can do this. Yours may be one.) However, Apogee was attempting this conversion with no prior experience operating a level pull system. In addition, Apogee had limited resources—they could devote only a few full-time staff to the project. The area managers on the team needed to perform their normal tasks in their areas and could devote only a few hours each week.

Apogee decided to proceed in stages: They started with only one product family—exterior mirrors—and began their implementation at the shipping dock for this one product. They then worked backward to the two assembly cells for exterior mirrors, then to the paint booth, and finally to injection molding. At the end of the first two-month phase they had created a level pull system for only this product family. It was not very efficient from a total plant performance point of view because the rest of the facility, including a fraction of each shared process (paint and molding), was still operating on the old production-control system. But it worked and it demonstrated the concept. Based on their learning and the growing acceptance of the concept among formerly ambivalent managers, Apogee then transitioned the rest of the plant in a disciplined manner over four months.

Apogee faced a considerable challenge in tackling system kaizen to complement previous initiatives with point and flow kaizen. But the benefits were enormous. So, let's get started and follow their progress.