CHAPTER 2

Moving From Traditional to Modern Manufacturing Environments

REVIEW QUESTIONS:

2.1 The traditional manufacturing environment is a PUSH system in which a subassembly or partially completed product is pushed to an area designated for work-in-process storage. This type of environment is characterized by functional departments that produce large batches of components. Often quality control is performed at the end of the production process. The Widgets, Incorporated case exemplifies a traditional manufacturing process.

The world-class manufacturing environment is a culture of problem prevention, continuous improvement, efficiency and effectiveness, and manufacturing excellence. WIP inventories are minimized. With JITs, WIP is restricted to the size of kanban containers. Instead of functional departments, work is organized into quality circles and manufacturing cells that produce one product at a time. Quality control is performed by the cell workers as they perform each operation. Harley Davidson is an example of a WCM firm.

2.2 The partially completed product is pushed from one assembly location to another. Production volume within each department is not driven by demand, rather by the desire to maximize efficiency through producing large batches. The goal is to drive down the average per unit cost of production through maximizing volume.

2.3 The characteristics of traditional production processes are:

- Suboptimizing behavior between organizational areas. An example is not coordinating production between departments.
- Producing and maintaining large inventories. Standard Motor Products' old production process exemplifies this characteristic.
- Producing products of sub par quality. It appears that before they became WCMs, both Harley Davidson and Hewlett-Packard had quality problems.
- Striving for efficiency at the expense of effectiveness. Standard Motor Products demonstrated this characteristic before it converted to JIT production.

2.4 KAIZEN

2.5 Harley Davidson, General Electric, and Hewlett-Packard

2.6 There are seven major characteristics of WCM. These are:

• *High quality*	The product works as it is intended without defect or deficiencies.
• *Customer satisfaction*	Customer service factors are used to achieve complete customer satisfaction.
• *Low inventory*	Minimal amounts of inventory are ordered, processed, stored, and handled.
• *Flexibility*	The manufacturing process can adapt quickly to changes in demand.
• *Automation*	Self-acting and self-regulating technologies are used to perform a large variety of tasks.
• *Team concept*	Workers and managers work together in a cooperative manner for the overall success of the enterprise.
• *Integrated computer-based information system (ICBIS)*	A system in which various information technologies are used to connect all functions throughout the enterprise.

2.7 Exhibit 2-4 summarizes the reasons for high and low inventory levels. It is reproduced here:

Reasons for Having
<u>High Levels of Inventories</u>

- long delay between when raw materials are ordered and delivered
- vendor quality and delivery schedules force managers to order much more raw materials than are needed
- inventory records are not frequently updated or are inaccurate so managers order more/less than needed
- hedge against future price increases and/or to take advantage of quantity discounts
- ordering, receiving, inspection, and/or setup costs are high
- the conversion process requires a long time
- large production volumes are needed due to poor quality (e.g., make 1,000 parts to get 800 good ones)
- disruptions such as machine breakdowns or strikes are too frequent
- managers are rewarded for minimizing the average per unit production cost
- long delay times in delivering finished goods to customers
- customer demand is very uncertain

Reasons for Having
<u>Low Levels of Inventories</u>

- raw materials arrive just at the time they are needed
- vendors can be relied on to deliver quality materials in the right amount on time
- all inventory transactions are processed in real time and are accurate
- raw materials prices are stable due to long-term contracts with suppliers
- ordering, receiving, inspection, and setup costs are minimal
- products move through the process efficiently (high velocity production)
- high quality results in zero defects
- production is not subject to disruptions
- managers are rewarded for minimizing the total costs of production throughout the plant
- finished goods are delivered to customers overnight
- customer demand is known with a high degree of certainty

2.8 Inventories are evil because they hide quality problems in direct materials and WIP components. Inventories also incur large costs such as:

- Opportunity costs associated with the investment in warehousing, receiving, inspection, handling, and inventory control systems.
- Deterioration, damage, shrinkage, spoilage, and obsolescence.
- Operating costs associated with storage and handling.
- Insurance and taxes on the inventories.

2.9 The mushroom concept keeps processes and products standardized for as long as possible, creating a product structure that is diversified only at the final production stage. In this way, different styles of products still can be produced, maintaining the flexibility needed to satisfy changing market demands. Standardizing much of the production process reduces the costs associated with all preliminary production departments and activities.

2.10 Old style management creates walls between hierarchical levels in the company. Thus, there is a need for many formal lines of communication vertically and horizontally. The new style team concept has no walls as all employees work together to benefit the team. Many of the "trappings" that separate managers from workers are eliminated, such as: special parking, different lunch rooms or bathrooms, dress codes, salaries versus wages, special perquisites, and the like.

2.11 An ICBIS is composed of six components. Examples are in parentheses.
- Inputs (user friendly input coding displays at shop floor computer terminals).
- Processes (an Accounts Receivable program).
- Outputs (hardcopy reports, terminal displays).
- Database (magnetic disk storage, tapes).
- Controls (EDP internal controls, physical and data security measures).
- Technology platform (microcomputer-based LANs connected to WANs supported by minicomputers and/or mainframes).

2.12 Linking LANs together promotes communication across functional areas and geographic boundaries. The sharing of computing resources and information allows different organizational members to work together as a team.

2.13 Products are made in response to downstream needs. In this manner, work is pulled through the production process from its end (sales ordering) to its beginning (purchasing). Products are not made unless there is a need for them in terms of a sales order or minimum FGI kanban.

2.14 There are seven objectives of JIT:
- *Synchronized operations* — Inputs equal outputs through the grouping of machines in the sequence required to make the product.
- *Zero inventories* — No buffers of WIP, no large warehouses of RMI or FGI.
- *Zero setup time* — Reducing the time needed to retool to a minimum.
- *Zero lead time* — Reducing the time to produce a product to a minimum.
- *Zero defects* — No rejects or rework.
- *Visual factory* — Providing easily understood visual displays of production activities, progress, and problems.
- *Computer-Integrated Manufacturing* — The grouping and integrating of technologies controlled by an ICBIS.

2.15 Kanbans provide a means of controlling the size of buffers used to smooth production flow. Kanbans are orders to produce components or deliver direct materials only as they are needed. Production is not allowed unless there is a kanban from the next cell authorizing it. The amount of production is minimized through restricting it to the number of empty kanban containers. In this way, production is synchronized across operations.

2.16 Exhibit 2-10 illustrates a JIT flow while Exhibit 2-2 shows a traditional production process. JITs require smaller amounts of RMI, WIP, and FGI, as production is controlled through a PULL philosophy in which just enough products are made to keep kanban containers full. Thus, there are not large batches of WIP or large storage areas for RMI and FGI as seen in Exhibit 2-2.

2.17 Value-added time represents activities performed by machines and people who work directly on making a product or providing a service, such as the activities within a production cell.

Nonvalue-added time comes from activities performed by people and machines that do not work on the product, such as an inventory control clerk.

2.18 The lead time formula is:
Lead time = Process time + Move time + Wait time + Inspection time

2.19 An ideal LTE ratio is 1.0; nonvalue-added time is eliminated.

2.20 TQM focuses on preventing problems through:

- *Design of experiment* — Improve engineering's ability to create problem-free designs that meet customer requirements.
- *Total preventive maintenance* — Extending equipment life and maximizing its effectiveness throughout its useful life.
- *Statistical process control* — Statistical techniques such as random sampling and control charts to analyze a production process.
- *Jidoka* — Stop everything when something goes wrong; each person is responsible for his or her own errors.

2.21 The five S's are components of the visual factory. They are:

- *Seiri* — Organization to eliminate nonvalue-added activities.
- *Seiton* — Orderliness in the location of needed materials, tools, and equipment to eliminate nonvalue-added activities.
- *Shitsuke* — Discipline and instructions.
- *Seiso* — Cleanliness of tools, equipment, and the shop floor.
- *Seiketsu* — Standardization to promote efficiency.

2.22 The purpose of visual factory is management by sight. This is accomplished through the use of easy to understand displays of information. It is supported by the concept of andon; visual control systems. Andon employs the five S's discussed in question 21.

2.23 A Kanban is a visible signal, card or sign. Kanban containers are receptacles that hold material or parts for movement from one work center to another.

2.24 The users of an ICBIS include: stakeholders, office personnel, engineering, computer-aided manufacturing, and the manufacturing cells.

2.25 Cross training is important so that workers can perform a variety of tasks within the manufacturing cells. This can help eliminate bottlenecks caused by uneven production or absenteeism.

2.26 Advantages of U-shaped production cells include:

- Shorter lead times.
- Better response time.
- Less move time and material handling.
- Minimum work-in-process inventory.
- Less space.
- Better coordination.

Disadvantages include (although these have been disputed by proponents of JIT):

- The possibility of having to increase the total number of machines.
- A need for versatile personnel and cross training.

CHAPTER-SPECIFIC PROBLEMS:

2.27
- Push
- Pull
- Push
- Push
- Push
- Pull

2.28 Demand is the key criterion. If sufficient demand exists to pull 100,000 units through production, it is efficient and effective to produce this volume.

If demand is only 20,000 units, this volume should be pulled through the process. Producing more than this volume might be argued to be efficient by some traditional managers because this will reduce fixed costs *per unit*. This myopic focus on *production efficiency* ignores the other costs of making and holding surplus inventory. Other costs that should be considered in measuring both efficiency and effectiveness include:

- The extra variable production costs of the surplus inventory (direct materials, direct labor, VOH).
- The return this extra investment in inventory and associated fixed assets could have generated if used in some other productive manner.
- The costs of deterioration, damage, shrinkage, spoilage, and obsolescence.
- The extra operating costs of storage and handling including safe keeping.
- Taxes and insurance on the value of the surplus inventory.

Are there situations that can justify surplus production in *certain periods*? Some issues involved are discussed in the "Let's Talk" box on the next page.

Let's Talk

Are there situations in which surplus production *in one period* can be argued to be efficient and effective? You may wish to stimulate class discussion by asking the following **What If** questions:

What if demand is highly seasonal and there is a world-class commitment to keep people employed all year?

> For example, there is a company that created a JIT production cell for one of its assembly processes. Kanbans controlled its production volume, but the kanbans were based on building up FGI during the winter months because of highly seasonal sales during the summer. Even with JIT production, the management felt a need to smooth production throughout the year. Producing just for a period's demand would have been impossible because virtually all sales were made during the spring and summer only. Further, this company has a commitment to full-time employment of its workers. (This is the Ditch Witch case referenced in footnote 5 of the text.)

What if there are minimal storage and movement costs because of the size, weight, and/or other characteristics of the product?

> If these costs are not significant, then other goals (such as continuous employment) may be more important. This could justify building up surplus inventories in one period to smooth production throughout the year.

What if final products can be shipped on consignment to retailers?

> If retailers are willing to assume the costs of carrying surplus inventory, then can this justify surplus production? The need for a wide variety of styles may justify this.

2.29 Matthew Gilland's recommendation is based on the "mushroom concept." This design strategy reduces variability throughout the production process by delaying product variety until the last step. In the case of Kitchenhelper, variety is introduced only after the customer has received the product. The objective of the mushroom concept is to decrease total production costs through standardization of product design and its components.

Currently there is a $100,000 investment in the painting facility, and an $18.00 incremental cost per dishwasher from maintaining different colored doors in inventory. Matthew Gilland should ask the management accountant for help in preparing an analysis for his proposal. This analysis should seek to answer the following questions:

- Will the incremental costs of substituting colored plastic inserts with white doors be more or less than the current $18.00 cost?
- What new investment will be necessary to produce plastic inserts, assuming they are not outsourced?
- Can the current painting employees be retrained and reassigned, or used to produce the plastic inserts?
- What environmental issues should be addressed if painting is eliminated and replaced with a plastic insert production process?
- What type of vendor relationships exist with the painting department, or may exist if plastic inserts are produced?
- Will the ultimate quality of the product be diminished by such a change?
- Will the change cause any customer dissatisfaction or inconvenience?
- How will this change affect our competitiveness in the marketplace?

2.30 *Costs of using Vendor A:*

Raw materials cost	
($50 per unit x 1,000 units per day x 25 days per month)	$1,250,000
Late delivery costs ($40,000 per day x 10 days per month)	400,000
Total costs of Vendor A	$1,650,000

Costs of using Vendor B:

Raw materials cost	
($65 per unit x 1,000 units per day x 25 days per month)	$1,625,000
Cost savings per month from using Vendor B	$25,000

Other factors to be considered:

- Can the idle time created by late deliveries be used to do other activities such as machine maintenance or employee training? Will this result in any cost savings that should be measured?
- Is there any difference in raw materials quality between the two vendors? What is the cost of these quality differences?
- Is there, or can there be, a long-term purchasing commitment with either vendor?
- What is the cost associated with the customer ill will caused by not having the product available due to late deliveries?

2.31
- Output
- Database
- Input
- Technology platform (note: "transmission" is the key word. If the question had asked for displays of this information, for example through a visual factory display board, then the answer is output.)
- Controls
- Process

THINK-TANK PROBLEMS:

2.32 *What's wrong with the current system?*

This is a traditional process with quality control being performed after production is completed. It can be compared to "shutting the barn door after the cow is gone." Quality cannot be inspected into the products after they have been made. Further, it may be difficult, if not impossible, to determine where the problems causing the defects actually occurred. Without proper identification of the underlying sources and causes of defects, preventive controls may not be possible. Detective (also called inspection or appraisal controls) and corrective controls are usually much more costly than preventive controls at the source of production activities. This is a fundamental tenet of WCM and JIT.

Why can this system result in excessive scrap and rework?

- The discovery of defects after production is complete results in one of two costly events: either the product is scrapped, or it is reworked. If problems leading to defective products could be identified and corrected, or prevented altogether, at the various stages of production, then the costs of scrap and rework would be greatly reduced.
- In many production processes, after-the-fact quality control requires destructive sampling. This process results in the loss of the product inspected. This is equivalent to scrapping the product.
- Because the quality control system does not emphasize control at the source of the production problems, workers may not be motivated to build-in quality. Workers may just pass along defective components and subassemblies to the next departments. This will result in excessive scrap and rework in those departments.

Is there a more effective way to control quality?

Orico should consider WCM and JIT techniques. WCM emphasizes designing and building quality into the product. It is a philosophy of "doing it right the first time, every time," and is prevention oriented. The WCM emphasis on high quality and the JIT objective of zero defects leads to TQM (Chapter 12). Total quality management involves engineering error-free designs, maximizing equipment life through total preventive maintenance (TPM), analyzing the production process using statistical process control (SPC), and developing visual control systems.

Two key points stressed in TQM are:

- Preventive controls at the source.
- Quality can be increased while the total costs of quality decrease.

2.33 *Expected behaviors:*

If Ultrix is seeking high quality lenses, this reward system probably will backfire. Workers are motivated to produce large quantities, not to produce quality lenses. Likewise, shipping personnel are motivated to ship products as their rewards are based on the quantity of lenses shipped. For both groups of employees, the reward system should be modified so that it is based on the number of ***good*** lenses produced and shipped.

Let's Talk

Both for the previous problem and with this problem, you may wish to discuss the traditional emphasis on cost variance minimization within departments. Usually cost variances are only calculated for production quantity, not quality. This results in a "pounds-in-the-bucket" mentality. Workers are motivated to hit or exceed their production quotas. Traditionally, cost variance analysis has not included variances for rejects. Nor has traditional analysis attempted to link rejects discovered during some type of final inspection back to the underlying sources and causes of the production problems that occurred in previous departments.

There is the beginning of a movement towards world-class cost variance analysis that requires input coding of the sources and causes of production problems. This type of activity-based cost variance reporting system is described in Chapter 8.

Should inspection be in the shipping department?
There are at least two reasons why quality control inspection should not be the shipping department's responsibility:

- This is inspection after-the-fact. Quality cannot be inspected into an already manufactured product. See the discussion in the previous Think-Tank problem.
- The shipping personnel have a vested interest in maximizing the number of lenses shipped. This is in conflict with shipping only quality lenses.

Will the present system be beneficial to Ultrix?
After-the-fact inspection, and bonuses for the quantity produced and shipped, will not yield the desired results. The present plan should be modified to provide bonuses based on the good lenses produced and shipped. Possibly a joint, group reward system for both production and shipping would be consistent with the Total Quality Management (TQM) philosophy of JIT.

Consideration should also be given to the effects on market share and Ultrix's customers. Lenses are an extremely important product from the customers point of view. Even a few bad lenses can lead to a loss of consumer confidence, and eventually to the loss of Ultrix's entire market share.

2.34 *Financial analysis:*

Assume the following direct materials cost for a turkey sandwich:

Turkey	$0.15
Bread	0.10
Cheese	0.25
Tomato	0.20
Lettuce	0.18
Onion	0.12
Total direct materials cost	$1.00

Cost of turkey:

Wholesaler B (15% of $1.00 total direct materials cost)	$0.150
Wholesaler A (70% of $0.15)	<0.105>
Cost savings for Wholesaler A	$0.045

No doubt, this cost differential may be significant. This analysis, however, does not consider all the costs involved. There are other costs that can result from the following considerations.

Nonfinancial factors to consider:

- The quality of the turkey rolls.
- On-time delivery.
- Ability to order in JIT quantities to avoid spoilage, storage, and handling costs.
- The credit history and financial stability of the wholesalers.
- The ability to enter into long-run supply contracts which could affect the purchase price of turkey rolls.

2.35

Let's Talk

On the next page are two solutions for part a. The top solution represents a U-shaped JIT cell. The bottom solution illustrates how the plant could be redesigned to improve the product flow while maintaining the functional departments.

Both solutions have been presented by many students.

If you wish to use both solutions, they can be related by discussing how some companies may want to temporarily redesign the shop floor layout, maintaining functional departments (the bottom diagram). This is a transitionary design while team building exercises and productivity improvement programs are undertaken as a prelude to JIT. Ultimately, the goal is to undertake a more comprehensive redesign into a JIT with cellular manufacturing (the top diagram).

b. There are 7 characteristics of WCM, and 7 objectives for JIT:

Characteristics of WCM
- High quality
- Customer satisfaction
- Low inventory
- Flexibility
- Automation
- Team concept
- Integrated computer-based information system (ICBIS)

JIT Objectives
- Synchronized operations
- Zero inventories
- Zero setup time
- Zero lead time
- Zero defects
- Visual factory
- Computer-integrated manufacturing (CIM)

Tour De Frame needs extensive work to become a world-class manufacturer. The key to WCM is continuous improvement. The ability of workers to continuously improve their operations should begin with redesigning the production process into a JIT. Accomplishing this is no easy task, though. It must begin with fostering a *team concept and synchronizing operations.*

Let's Talk

There are a number of team-building methods that should be investigated, such as the Delphi method. There are also methods available to reduce *setup times*, such as the Single Minute Exchange of Die Method. Ditch Witch (reference footnote 5 in the text) used both of these methods in redesigning one of its manufacturing processes into a JIT.

Team building and zero defects require training programs so that workers want to work together cooperatively and control production activities at the source. These goals will not be realized, however, unless a congruent reward system is designed to promote these behaviors. *High quality* results from zero defects.

Customer satisfaction results from high quality and flexible operations. *Flexible operations* require *synchronized operations, low inventories, minimized lead times and setup times. Low inventories* will require JIT supply relationships and effective monitoring of customer needs. *Flexibility* often requires *automation* supported by *CIM and ICBISs. Synchronized operations* are supported through a *visual factory.*

c. Receiving and storage costs can be significantly reduced through developing long-run vendor JIT relationships. The use of an EDI system with certified vendors (discussed in Chapter 3) can support these relationships. In the proposed redesign shown in part a, the Test and Repair department has been eliminated because quality control will be done by the cell workers.

2.36 a. There are 7 JIT objectives:

- *Pursuing Synchronized Operations:*
  Synchronized operations exist when input equals output. This requires grouping a variety of machines in the sequence required to make the product, and flowing one product at a time through them. Cellular manufacturing, also called "group technology," is an often-used configuration usually conceptualized as a U-shaped loop (although it can take on any basic form). A main objective of cellular manufacturing is to minimize wait and move time.

- *Pursuing Zero Inventories:*
  In a traditional manufacturing process, large buffers of WIP inventories are often needed. JIT proponents believe that the philosophy of using inventories to overcome work stoppages or defects is a way of ignoring production problems. JIT reduces inventories in order to recouple sequential workcenters into cells, forcing workers to solve problems, such as defects, as they arise.

- *Pursuing Zero Setup Time:*
  Setup time is the amount of time required to adjust equipment and to retool for the production of a different product. The reduction or elimination of WIP inventories is dependent on reducing setup times.

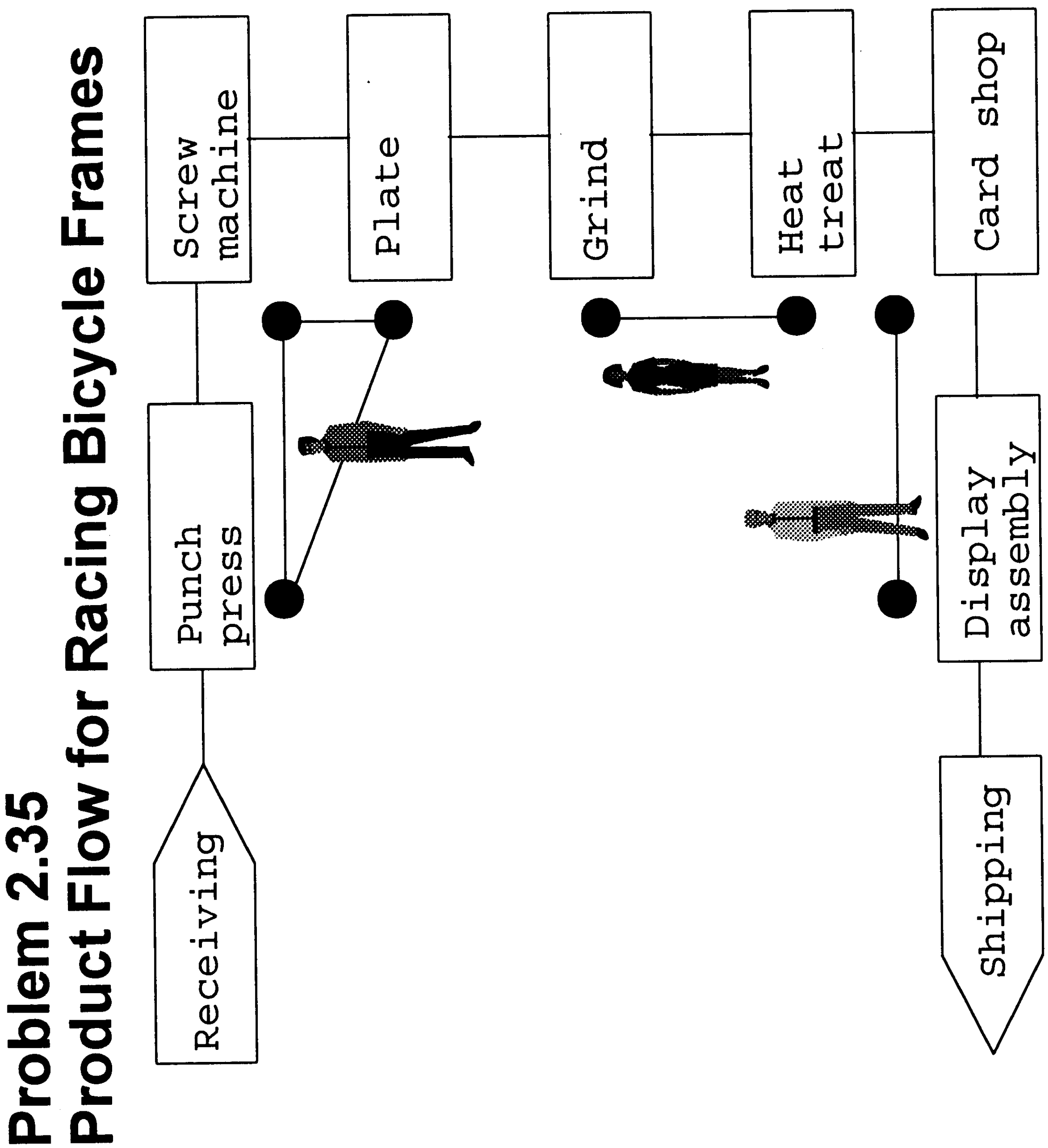
- *Pursuing Zero Lead Time:*
  Lead time, also called cycle time, is how long it takes to produce a product or provide a service from start to finish. Lead time is composed of value-added time that represents activities performed by machines and people who work directly on making a product or providing a service, and nonvalue-added time from activities performed by people and machines that do not work on the product (such as: move time, wait time, and final inspection time).

- *Pursuing Zero Defects:*
  Zero defects means that there are no rejected materials, parts, or finished products, and there is no rework. The journey toward zero defects is driven by TQM which focuses on prevention of problems and "getting it right the first time."

- *Developing the Visual Factory:*
  JIT production facilities usually incorporate a visual control system known in Japanese as "andon." The visual factory enables all to see the status of production by merely walking through the plant and observing the easy-to-understand displays of information. It is management by sight.

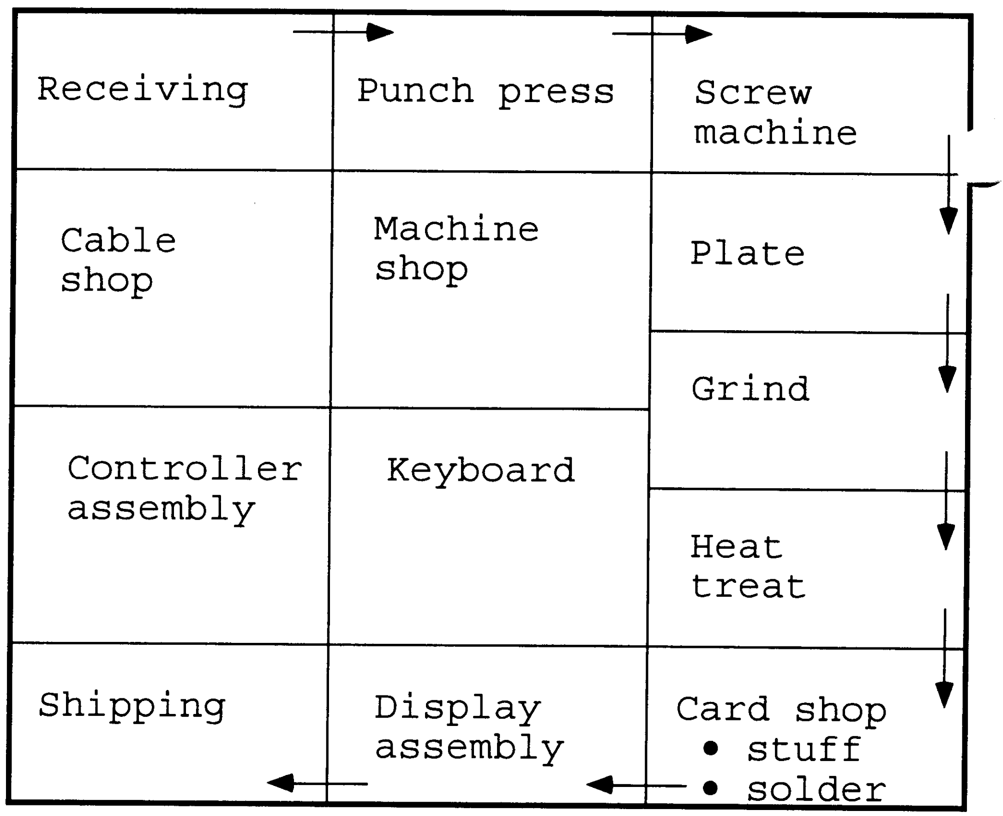
- *Computer-Integrated Manufacturing (CIM):*
  This is the ultimate step toward full factory automation. CIM uses groups of technologies that are integrated plantwide and controlled by an ICBIS.

2.35 a(1). Redesigned plant layout for Tour De Frame: JIT cell



2.35 a(2). Redesigned plant layout for Tour De Frame: functional departments

Problem 2.35
Redesigned Plant Layout for Tour De Frame



b. Actions that Magafilters, Inc. can take to ease the transition to JIT:
   - The first action is team building and employee training. This will require identifying and correcting any problems that arose in the metal stamping department's conversion. Without overcoming the problems in that department, management and workers will continue to be increasingly cautious.
   - The second action is to assure all employees of a top management commitment to employee empowerment through cross training programs, and evaluation and reward systems that will support the JIT process.
   - To help the employees believe that they providing customer satisfaction through high quality production, Megafilters' customers should be included in the JIT planning process. Similarly, suppliers need to be involved as they too are stakeholders in the JIT conversion.
   - Most importantly, there has to be a top management commitment to allowing the employees to redesign the process into a JIT. The employees must feel that it is their system, not some threatening thing mandated by top management. Top management support will be evidenced by providing the time, resources, and rewards for the employees to do this.

c.

> ***Let's Talk***
>
> Some of the material used in part c is from Chapter 3 on electronic data interchange (EDI) systems. Thus, this problem may serve as a good transition vehicle into the next chapter.

Vendor relationships:
Develop an EDI system using a few reliable, certified vendors and long-term supply agreements. Such a JIT relationship will assure quality materials are being received where and when needed to allow JIT production. A number of vendor performance measures are discussed in Chapter 11 on Activity-Based Management (ABM), such as a vendor performance index, acceptance ratios for quality, and on-time delivery measures.

Employee relationships:
This issue was discussed in part b. Employees need to be empowered to control operations. This requires top management commitment to training and reward systems that will motivate the employees to take quality control actions while they are performing their production tasks. Reward systems can be based on evaluations of machine uptime and work force productivity (see Chapter 11 on ABM).

Customer relationships:
An EDI system may be appropriate for Megafilters because it may have only a few customers for its heavy construction oil and air filters. EDI can enhance the long-term relationships with key customers by assuring prompt deliveries and payments. It will also allow Megafilters' customers to feel as if they are part of the team. They are in fact stakeholders. Chapter 11 introduces a number of customer satisfaction measures that can promote this relationship, including on-time delivery, complete order-filling, and snake charts.

2.37 *Under what circumstances is flexibility required?*
- When customers need a variety of products.
- When customers need the product quickly.
- When workers need to fill in for other absent workers.
- When occasional bottlenecks occur.

Is flexibility always desirable?
It is hard to argue that flexibility is not always desirable. The more tasks employees can perform, the greater the response capability of the enterprise. It has been argued, though, that there is a point of diminishing returns to continual training in new skills. It may be more useful if training is restricted to only a few related skills to allow for greater expertise. For example, training in machine repairs and maintenance is a value-added activity, but superficial training in unrelated tasks may not provide the benefits desired.

Can a pay-for-knowledge program backfire?
Yes. Employees may be motivated to sign-up for every type of training program available solely to increase their pay. Some training programs may not relate to skills they need to know, or activities they may ever be involved in. Attendance may become a means to escape their jobs, causing other production flow problems. Simply attending training seminars does not assure that the skills have been properly learned, especially if they are skills not used in the normal activities of those workers. Again, training should be restricted to those skills employees are expected to have for the tasks they are expected to perform. A little knowledge in many unrelated areas may not be as beneficial as expert knowledge in a few areas related to their jobs.

Structuring the reward system:
Rewards should be for ***applied*** training. For example, effective training should be evidenced by increased machine uptime, reduction in WIP buffers or kanban container sizes, reduction in scrap, rework, and spoilage, and increased throughput. It will also be evidenced by suggestions for productivity improvements. An interesting and effective system of rewards is provided by International Game Technologies. IGT pools all the cost savings from suggestions for improvements and jointly rewards all employees throughout the entire company from this pool.

2.38

> ***Let's Talk***
>
> Three topics from Chapter 3 have been incorporated in the answers below: material requirements planning (MRP), manufacturing resource planning (MRP II), and electronic data interchange (EDI). Thus, this is a good problem to use as a bridge into the next chapter. It is also an excellent problem to assign after Chapter 3 as it can be used as a means to integrate much of the materials presented in Part I of the text, and to provide closure to this material.

Productivity (increase by 100 to 200%):
Productivity has two components: effectiveness, which is doing the right thing; and efficiency, which is doing it right the first time.

- *Effectiveness:*
  - The first step involves creating the right products. The total quality management (TQM) technique of design of experiment (DOE) can be employed for product development. The goal is to create problem-free designs that meet customer needs.
  - Sales employees should instigate new product development as they are in close proximity to the customers and are frequently exposed to their desires and needs. A risk-taking environment for free-thinking solutions should also be encouraged.

- *Efficiency:*
  - To improve efficiency, production operations need to be synchronized. This can be accomplished through redesigning the shop floor into a JIT employing cellular manufacturing.
  - Automation through computer-integrated manufacturing (CIM) can reduce lead time and increase product quality.
  - Efficiency can also be increased through installing an MRP or MRP II system (discussed in Chapter 3).
  - A process of total preventive maintenance (TPM) ensures that equipment will function without costly breakdowns.
  - Synchronized operations also need to be supported by a control system, such as a visual factory using andon. The TQM techniques of statistical process control (SPC) and jidoka can be used to monitor the process and stop it when problems arise.
  - Factory workers need to be properly motivated to take control actions while they are making the product. This requires proper training and reward systems. Developing a feeling of team membership can enhance communication and problem solving.
  - Synchronization does not just involve the shop floor, however. It also involves suppliers and customers. An EDI system linking vendors and customers into the production process can significantly increase efficiency.

Quality (reduce defects by 95%):

- The four TQM techniques are important for quality assurance.
  - Design of experiment addresses creating problem-free products.
  - Total preventive maintenance addresses keeping the machinery running at peak effectiveness so that defects are not created by it.
  - Statistical process controls monitor operations. This type of control is preventive. It seeks to catch problems before the process or activity can create defective products.
  - Jidoka is a means to stop production when quality problems arise. The goal is to solve them immediately so that defects are not passed through the remainder of the process.
- To control the quality of materials received from suppliers, vendors should be chosen on quality and timeliness, rather than the lowest price.
- Striving for zero defects must become a primary concern of all workers, not just management. Plantwide rewards for delivering high quality products can promote individual internalization of TQM. These rewards should be based on evaluations of the reduction in scrap, rework, and spoilage.

Product development cycles (shorten 75% to 80%):

- Flexibility is required to respond to changing market demands. A mushroom concept in which preliminary operations are as standardized as possible should be designed.
- Sales personnel should initiate new product development as they are in close proximity to the customers and are frequently exposed to their desires.
- This information should be provided to product designers for DOE-based product development.

Lead time (reduce 90%):

Lead time, or cycle time, is the time it takes to complete a product or service.

- World-class manufacturing is supported by synchronized production utilizing CIM and ICBISs within a JIT philosophy. Production should be driven by a PULL (versus PUSH) system, that, in turn, is driven by customer expectations.
- Success in redesigning the physical plant to synchronize operations can be measured through the LTE ratio and changes in it over time. Ideally the LTE ratio should approach the value of one. Achieving this requires the elimination of nonvalue-added activities, such as: move time, wait time, and final inspection time. MRP II systems can reduce lead time through effective and efficient scheduling and control of the production process.
- Electronic Data Interchange (EDI) with suppliers can greatly facilitate production and result in improved lead times. For this to work, long-term relationships with a few certified suppliers must be established, and based on quality and timeliness rather than raw materials price. Scheduling materials shipments can be facilitated if an MRP system is used.
- EDI can also reduce lead times by processing customer orders in real time. With this input into an MRP II system, more effective and efficient production scheduling should further reduce lead time.

Span of control (increased by a factor of 5 to 10):

- Span of control increases with the reduction in layers of management. For this increased span of control to be successful, employees must be empowered and responsible for solving problems, designing innovations, and performing TPM activities.
- The team approach requires leadership, guidance, and consensus building skills <u>within</u> the workers, rather than authoritative command and control by management.
- Quality improvement techniques and training become key methods of control, replacing the activities performed by middle managers.
- CIM supported through an ICBIS allows collection of data and continual feedforward and feedback of critical control information.
- The visual factory greatly aids both upper management in monitoring this increased span of control, and workers in having the feedforward and feedback information they need to assume these previously middle management coordination functions.

Continuous learning (training increased 200% to 300%):