# 6

# POSITIONING THE OPERATIONS SYSTEM

## INTRODUCTION

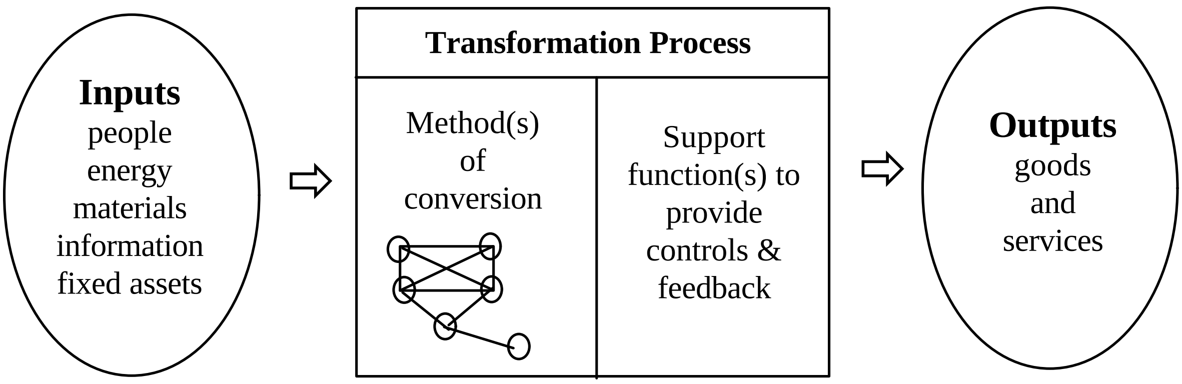
The choice of operations system is influenced by the balance of the competitive factors of emphasis on quality, volume of output, flexibility, cost, and delivery reliability to its customers.

The operations task concerns managing the transformation process which takes input and converts it into output, together with the various supporting functions associated with completing this basic task. The transformation process and methods of conversion to produce goods or provide service will actually be an interrelated set of processes feeding into one another as part of the total task. The level of complexity within operations depends on factors such as:

- The size of the organization
- Complexity of the products/services involved
- Mark or buy decision

**Exhibit 6-1** shows the basic transformation process for all the diverse range of goods and service activities.

**Exhibit 6-1: The Operations Function**




One key perspectives on the operations function is recognizing that it is not a technical or engineering-related function, but a business-related function within any business. The inherent characteristics of a business's markets are directly opposite to the inherent characteristics of its operations function. While the former are inherently dynamic, the latter are inherently fixed.

If the positioning of the system is wrong, the operations strategy will be ineffective. One of the most common mistakes in positioning strategy is to attempt the production of products with fundamentally different market requirements within the same basic operations system. The result is that the match between market requirements and the operations system is out of sync for some of the products. As a result, costs may be out of line, quality may not receive the necessary emphasis, or delivery times may not meet requirements. Another common mistake is the failure to recognize the dynamics of the process life cycle, which necessitates the basic redesign of the production system as the product goes through its life cycle.

## The Product Life Cycle

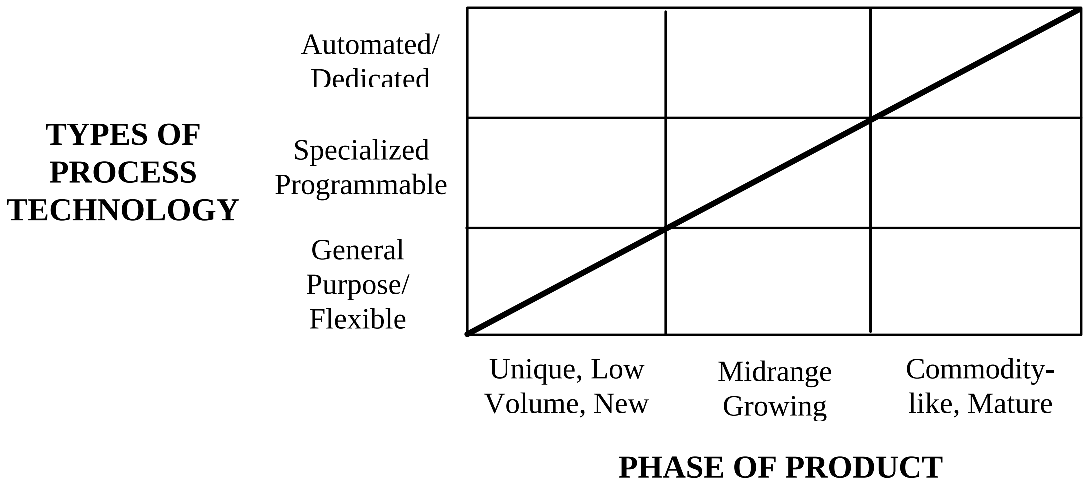
The *product life cycle* theory is particularly important in marketing strategies and product strategies.

If we traced the development of an available product in high volume and highly standardized form from its introduction, we would find that it had gone through phases: introduction at low-volume and custom design, sales growth during which variety becomes more limited; maturity during which variety is even more limited and products become standardized; and decline as substitutes become available that are superior in terms of function, quality, cost or availability. Hayes and Wheelwright (1979) formalized the concept of the product / process life-cycle matrix as shown in **Exhibit 6-2**.

As the product develops through its life cycle, the production system goes through a life cycle of its own to position the system to match the market situation.

During the introductory stage, the firm defines a production and marketing formula and positions the new product by trial and error. Innovation puts the design and development department in the front line, and the product is mainly characterized by its design and performance. The production system is process-focused to order, i.e., a job-shop system; which provides flexibility to product variety, and high-quality production.

**Exhibit 6-2: The Product/Process Life-Cycle Matrix**




A quality plan (well-defined verification, validation, and certification procedures at the various phases of development) can help to minimize modifications at a later stage. It requires considerable flexibility to adjust final quality characteristics to the fluctuating demands of the markets. The quality-innovation strategy must be adopted. During the development stage, the firm establishes its new product by developing the necessary production capacity to gain a solid market share. To increase volumes while maintaining conformity to specifications, the firm must invest massively in industrial engineering, learning and training.

The quality-enhancement strategy should be adopted. It requires building a capable quality system, capable processes, and capable human resources; all deployed to maintain the promised and perceived satisfaction even in the face of a rapid volume build up.

The development stage is likely to be as follows. First, process-focused system that produces batches to order; then, a process-focused system that produces larger batches to stock; and finally a product-focused system that utilizes time-sharing of facilities on a cycling basis to stock. Cycling of a product-focused to-stock system makes possible better facility utilization while retaining a degree of flexibility to produce a variety of types and sizes in a product line. It is common to use combinations of process-and product-focused systems to obtain good facility utilization.

During the maturity stage, the product becomes standardized and market share is consolidated. Differentiation is based on cost reduction and improvement. The demand on the production systems to produce highly standardized products results in continuous use. The production system will be more product-focused.

Quality must be maintained in performance, attractiveness, reliability, service and assistance; cost reduction will follow suit. A certain degree of flexibility must be given for some product customization to maintain competitiveness.

The product life cycle and its position of production system are summarized in **Exhibit 6-3**.

Looking at the international phases of product life cycles over a period of time, developed countries such as the US, UK and Japan may have more of a comparative advantage for product innovation than less developed countries. However, less developed countries such as China, Hong Kong, Taiwan, Korea or Singapore may have a comparative advantage in producing standardized products due to low-cost endowments. The process-focused system is a necessary strategy for most developed countries, while the product-focused system may suit most less developed countries. Japan more successfully shifted from a product-focused system to a process-focused system than most of its counterparts. Therefore, the quality and productivity of Japanese firms make them more competitive than most US and European firms.

**Exhibit 6-3: The Stages of Product and Production System Development**

| **Customization** | | **Standardization** |
|---|---|---|
| Design and development phase | | Production solid phase |
| **Introductory Stage** | **Development Stage** | **Maturity Stage** |
| Control of innovation process<br>◆ Positioning<br>◆ Development cycle<br>◆ Number of modifications<br>◆ Performances<br>◆ Reliability<br>◆ Design flexibility | Control of mass production<br>◆ Process capability and control of variation<br>◆ Conformity<br>◆ Volume and delivery reliability<br>◆ Volume flexibility | Control of efficiency and improvement<br>◆ Service improvements<br>◆ Cost reduction<br>◆ Productivity and quality improvement<br>◆ Flexibility of mix |
| **Strategy of Innovation** | **Strategy of Mass Production** | **Strategy of Product Differentiation** |
| Process-focused system | | Product-focused system |
| Made-to-order | | Made-to-stock |
| Low-volume | | High-volume |
| High-price | | Low-price |

## Factory Focus

Another concept useful to the creation of operations strategies is 'Factory Focus', popularized by Wickham Skinner (1974).

The operations systems of the firm are determined by the product complexity and the operating complexity. An operation with a small number of process technologies is called **'Process Focused'**. An operation manufacturing similar products, possibly using several different process technologies, is called '**Product Focused'**.

The *Process Focused systems* produce custom products designed to the specifications and needs of the customer, usually of a low-volume nature. The manufacturing strategy focuses on uniqueness, quality and flexibility to change the production process in accordance with customer requirements. Cost or price is a lesser consideration.

At the other extreme are highly standardized products, which are usually of high volume to meet the market demand. Availability and price are important elements of this competitive strategy. This system is *Product Focused.*

Between the extremes are mixed strategies that are sensitive to variety, flexibility, and reliability of supply. In these situations, quality is an important but not overwhelming criterion. Some of the products are available in fairly low-volume, but some are available in high-volume, such as automobiles. The great majority of products available today are in this middle category.

The different manufacturing strategies can be illustrated by a product / process matrix, as shown in **Exhibit 6-4**.

**Exhibit 6-4: The Types of Factory Focus**

| PRODUCT COMPLEXITY | Simple | Complex |
|---|---|---|
| Many | PROCESS FOCUSED<br>Specialized technology-based, needs centralized planning | ALL-PURPOSE<br>Lacks mission, complex, difficult to manage |
| Few | PRODUCT/ PROCESS FOCUSED<br>Unique mission, specialized area, responsive, needs centralized planning | PRODUCT FOCUSED<br>Responsive, suitable for decentralized planning |

OPERATING COMPLEXITY

1. ***High-volume, single-product (product focused)***

   When competition is largely based on price and delivery reliability, product quality and differentiation will be in a lower priority. The manufacturing strategy is dedicated to producing a single high-volume product.

   The operations system for highly standardized products is concerned with dependability of supply and low-cost. The process-focus is low because processes are adapted completely to the product, and are physically arranged in the sequence required. Products of this type are usually available from inventory.

2. ***High-volume, multiple-product (all-purpose)***

   The high-volume, multiple-product situation is likely to employ a mixed manufacturing strategy that combines the process-focused and product-focused systems.

In production, parts fabrication is often organized on a batch-intermittent basis with final assembly organized on a line or continuous basis. Because the output volume of parts fabrication may be substantial but not large enough to justify continuous use of facilities, parts are produced in economical batches. The nature of assembly makes possible continuous lines dedicated to certain products.

When competition is based on quality and product differentiation, some production processes are adjusted to obtain a certain degree of flexibility. Although standardized, there are a great many production options to choose from.

**3. *Low-volume, multiple-products (process focused)***

The low-volume, multiple-product situation usually involves a process-focused system. Products, however, are produced in batches thereby achieving certain economies of scale compared with the 'job-shop' system designed to deal with custom products.

In this situation, quality and flexibility are the critical success factors. Managers need to take into account the distinctive competencies that their particular organization has developed, to help achieve the coordination between functional departments. Cost and quality responsibility is also at a high level.

**4. *Low-volume, customized-product (product/process focused)***

A production system for low-volume customized products must be flexible. Production processes must change in accordance with changing customer preferences.

The equipment and personnel must be capable of meeting individual component specifications and assembling the components in the special configurations of the custom product.

Because attention is on individual jobs, process-focused systems for custom products are usually called 'job shops'. Physical facilities are organized around the nature of processes and personnel are specialized into generic process types.

## The Reality of Process Choice

Companies invest in processes to meet the needs of their products or services. The first step in process selection is to assess the volumes involved and the process choices available. The relationships between the volumes and their process choices are illustrated as follows:

| Process Choice | Product Structure | Example |
|---|---|---|
| 1. Project | Large-scale / Complex | Civil Engineering |
| 2. Jobbing, Unit or One-off | One-off / Small-order or Low Volume / High Variety | Purpose-built Equipment |
| 3. Batch | Medium Volume / Medium Variety | Engineering and Molding |
| 4. Line | High Volume / Low Variety | Motor Vehicles |
| 5. Continuous Processing | High Volume / Standard | Petro-chemicals |

**Project**: It is concerned with the provision of a unique product or service which requires large-scale input to be coordinated to meet the customer's requirements, whilst minimizing costs throughout the process.

**Jobbing**: A jobbing process is chosen to meet the one-off or small order requirements of customers. It requires the supplier to interpret the design and specification of the task, in cooperation with a small group of skilled people.

**Batch**: The essential characteristic of batch is that each order is processed by setting up the first step of the process to complete the first stage of the task, then the next step of the process is set up and the second stage of the task is completed, and so on.

**Line**: Products or services are processed with each product/service passing through the same sequence of operations. A process is dedicated to the needs of a single or small range of products/services and the process does not have to be stopped and reset.

**Continuous Processing**: One or several basic materials are processed through successive stages and refined into one or more products. The materials are transferred automatically from one part of the process to the next with the labor tasks being predominantly concerned with system monitoring.

The characteristics of each process and its strategic implication are shown on **Exhibit 6-5**.

*TYPICALLY, FIRMS WILL HAVE A MIX OF TWO OR MORE OF THESE PROCESSES IN ORDER TO MEET THE VARYING NEEDS OF THE PRODUCTS/SERVICES THEY PROVIDE AND SELL*

For example, companies prefer not to use the project process if it can be avoided due to the ineffectiveness which comes from having to set up and then dismantle facilities at the start and end of a job. Hence, in the field of construction, more and more subassemblies, sections of buildings or large

**Exhibit 6-5: The Characteristics of each process**

| | Project | Jobbing | Batch | Line | Continuous Processing |
|---|---|---|---|---|---|
| Order winner | High quality | High quality | High quality | Competitive cost | Low cost |
| Variety | High flexibility | Some flexibility | Some flexibility | Low flexibility | Standard-ized |
| Implication | High cost | High cost | Medium cost | Some automation | Automated |
| Machinery | General purpose | General purpose | General purpose | Specific purpose | Specific purpose |
| Product position | Make-to-order | Assemble-to-order | Assemble-to-order | Make-to-stock | Make-to-stock |
| Product type | Special | Special | In-between | In-between | Standard |
| Product range | Wide | Wide | In-between | Narrow | Narrow |
| Rate of new product introductions | High | High | Medium | Low | Low |
| Level of product change required | High | High | Medium | Low | Low |
| Customer order size | Small | Small | Medium | Large | Large |

parts and structures are made elsewhere (and using processes other than project), and then transported to the site where they will be installed or form part of a large permanent structure. Likewise, for continuous processing to be a feasible choice, the product would have to be such as to be transported easily, such as through tubes or pipes. Petrochemicals and some food products are good examples.

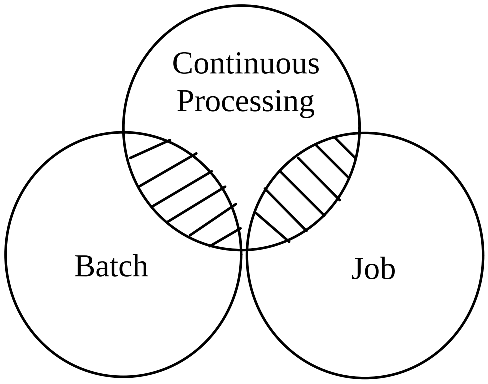
In reality, a company will first decide on the process using the volume dimension, but then needs to recognize that its choice will result in the provision of different sets of trade-offs. These trade-offs present ways for a company to assess which process decisions best fit its current and future markets. In order to minimize the total investment to be committed to the support of a product or service, companies tend to invest in only one project. Therefore, the choice and the mix of trade-offs embodied in the process should be assessed according to:

- The estimated volume of current and future needs
- The product life cycle

For simplicity, we would like to illustrate the mix of choices (hybrid processes) by three kinds of processes: project, job and continuous processing. **Exhibit 6-6** shows the three basis types of operation. The two overlapping zones are the mix of two processes.

The overlap zone on the left includes the hybrid processes of the large project that is ordered in multiple units. An example would be an order for 25 nuclear submarines by the Navy. The overlap zone on the right might include a large quantity job order. For example, a welding business that receives an order to perform 500 identical welds, a job with some characteristics of continuous processing

**Exhibit 6-6: The Hybrid Processes**




In the job and batch operations, managing job and service orders requires extensive scheduling, work center loading, expediting, dispatching, reporting, and control. If we were to add more orders, these would be competition for machines, leading to queries of work-in-progress, and hence to delays. This would lead to a high waste of transport and to long lead times. Such one-way product flows have not been used in job and batch manufacture. Here, product variety leads firms to use general-purpose equipment to allow flexibility in process routing. Processes are divided up into specialist areas, with specialized foremen and maintenance tradesmen allocated accordingly. There is plenty of work and machines around, so operators can be kept busy.

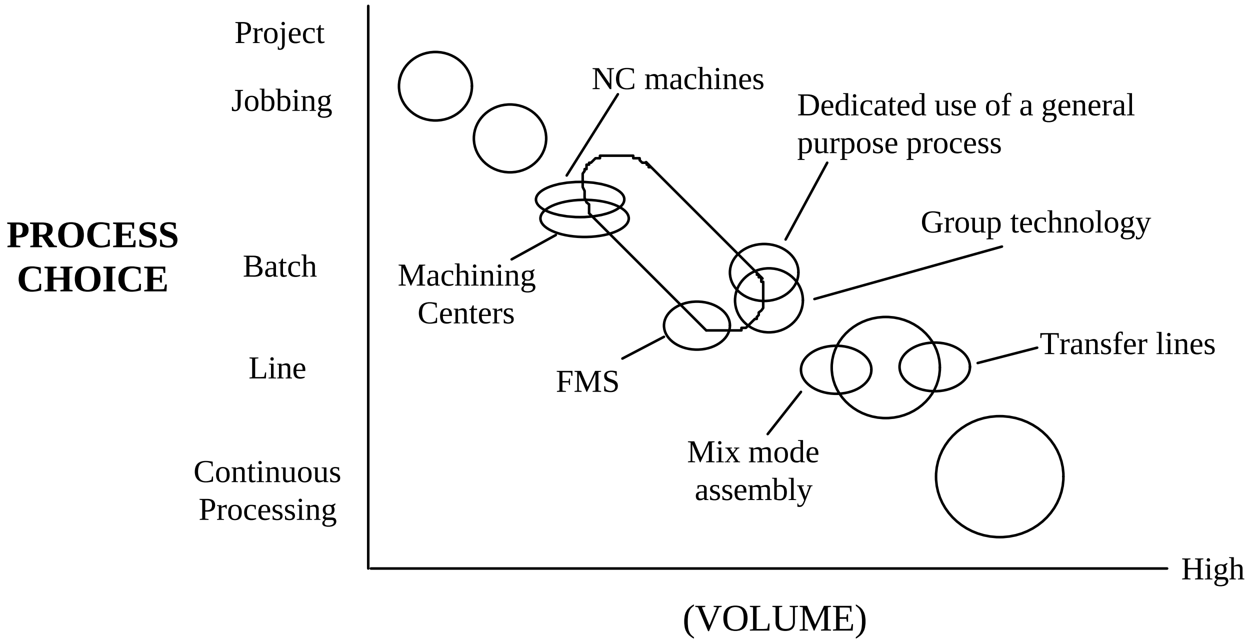
## Hybrid Processes

As mentioned earlier, many companies have used a mix of two of the five classic processes, which are regarded as Hybrid Processes. Although each hybrid format will be different, they can be classified into two major groups:

1. Batch-related Hybrids
2. Line-related Hybrids

**Exhibit 6-7** shows the two major hybrids and their related process technology.

**Exhibit 6-7: The positions of some hybrid processes in relation to the five classic choices of process**




### 1. *Batch-related Hybrids*

- Numerical control Machines (NC Machines)
- Machining Centers
- Flexible Manufacturing Systems (FMS)
- Group Technology (GT)
- Linked Batch
- Dedicated Use of General Purpose Equipment

### 2. *Line-related Hybrids*

- Mix Mode Assembly Lines
- Transfer Lines

## NC MACHINES

*Numerical Control* (NC) machines include a broad range of programmable machine tools. This class of machines can be programmed with a set of instructions that serve as an autopilot, guiding the performance of desired machining operations. If a new job is run, simple changes are made to an existing program. An NC machine is a development of a batch process and one which is low-volume in nature.

## MACHINING CENTERS

*Machining centers* combine NC operations previously provided by different machines into one arrangement. A given piece of work is predetermined to maximize the operations. Thus, a machining center completes many operations in sequence and without removing items from the process. This reflects aspects of line processing within what is still a batch process.

## FLEXIBLE MANUFACTURING SYSTEMS

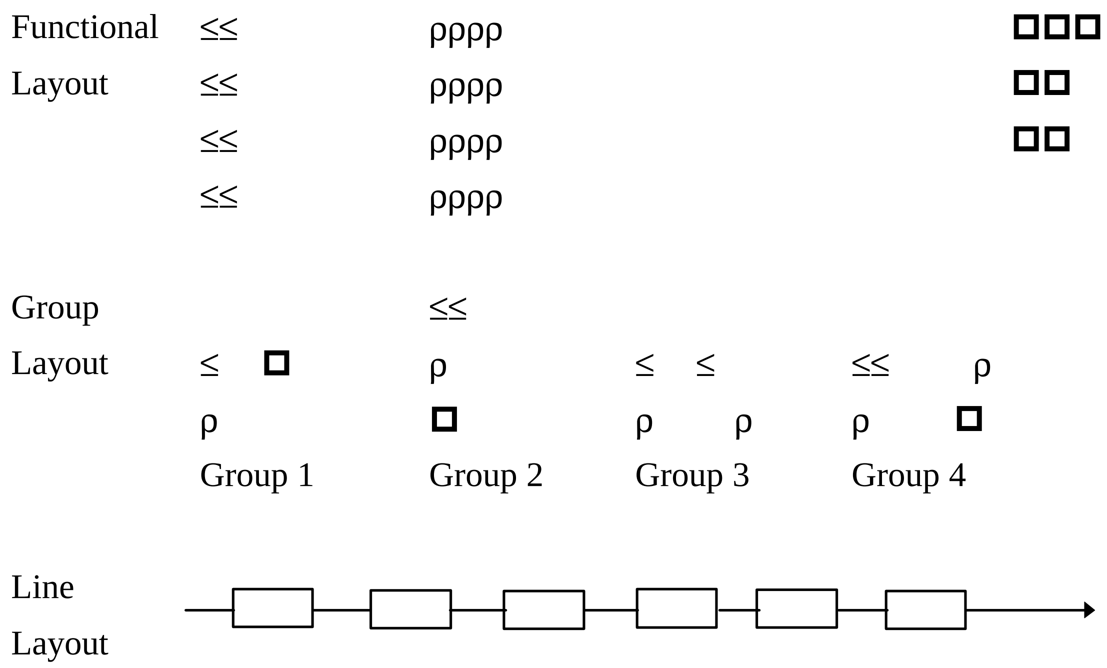
Whereas a machining center is best suited to low volume, a *flexible manufacturing system* (FMS) is appropriate for mid-volume requirements. FMS is a combination of standard and special NC machines, automated materials handling and computer control in the form of direct numerical control (DNC) or the purpose of extending the benefits of NC to mid-volume manufacturing situations.

## GROUP TECHNOLOGY

*Group technology* gains from batch processes some of the advantages inherent in high-volume line situations. This approach is to group together families of like products in terms of the processes required together, and to separate out those processes which do not fit due to factors such as the level of investment involved and health considerations (such as noise or process waste/fumes).

**Exhibit 6-8** shows the group layout, its relationship to functional (batch) and line (product) layouts to illustrate the transition from the former to the latter.

**Exhibit 6-8: The Group technology**




The key advantages of group technology include reduced lead times and lower work-in-progress inventory, and there are also the advantages associated with any form of small-scale manufacturing unit.

## LINKED BATCH

*Linked batch* is a hybrid of batch and line processes, which may link up two or three sequential processes. In some (for example, food packing), the whole of the process may be linked. The sequential processes, though physically laid out in line (one operation following another), are run as a batch process. When product change is required, all the linked operations have to be stopped and reset to accommodate this change, irrespective of the length of the setup time.

## DEDICATED USE OF GENERAL PURPOSE EQUIPMENT

The *dedication* is not the equipment itself, but in the use of a general-purpose process. Where the volume of a specific part is such that it can justify the allocation of a process to its sole use, then operations does so. The process is still batch, but general-purpose in nature. What becomes dedicated is the use of the process, which reflects the volume requirements for the product in question.

## MIX MODE ASSEMBLY LINES

In general, the product range for all line processes is determined at the time of the process investment. However, the term '*mix mode*' has been used to reflect processes where systematic and purposeful investment has been made to increase the product range accommodated by the process, while typically programming the line to make small quantities of different products in a predetermined sequence.

## TRANSFER LINES

*Transfer lines* are a hybrid between line and continuous processing. The process is numerically controlled in part or in full, which provides the systems control afforded, at least in part, by the operator of the process. For example, the operator can check quantitatively the quality as an in-built part of the process, and any deviations from specified tolerances will cause the system to stop without major cost being involved.

## JIT AND CHOICE OF PROCESS

*Just-in-time* (JIT) is a strategy which absorbs all aspects of operations management. Many people have the misconception that JIT is only limited to the flowline/large batch environments of operations systems. However, JIT provides a holistic approach to the improvement process. Some of the principles of JIT can be applied in part to the jobshop / project process. Selected techniques of JIT can also be applied to continuous processing.

Individual projects like the introduction of MRPII (Manufacturing Resource Planning), or a major investment in a new plant, may be at best only partial solutions, and at worst an irrelevant waste of time and money, unless they are part of the overall JIT improvement process.

In the jobshop process, techniques of JIT for eliminating waste can be applied to good effect outside manufacturing as well, such as in sales and distribution. Kao corporation, the largest domestic manufacturer of soaps, hair care and cosmetic products in Japan, use the JIT techniques in the sales and distribution. Kao short-cut Japan's multi-stage wholesaling system by appointing a network of wholesalers who distribute Kao's products exclusively. Daily orders and deliveries operate between retailers and the distribution centers. It is claimed that a customer can get any product within 12 hours. Daily orders for replenishment and non-stock items received at the distribution center are picked by highly automated methods, and loaded in delivery sequence.

The sales and production planning process is coordinated by KAO'S integrated market intelligence system, which tracks sales by product, region, and market segment. Planned and actual sales are monitored daily, and production / distribution plans revised if differences above a given percentage arise. With the implementation of JIT system in sale and distribution, Kao benefited from minimizing finished goods stocks at both manufacturing and retail, reducing retail stock replenishment times, and improved customer service. **Exhibit 6.9** shows the integrated manufacturing and delivery system at KAO.

In continuous processing industries, such as food processing, many JIT techniques are already in place. Supplier relationship development, total quality improvement, total preventive maintenance, workforce flexibility and greater responsiveness to customer's requirements are techniques which can be applied to continuous processing industries.

**Exhibit 6-10** shows the suitability of JIT for a range of process choice environments. Those at the center of the diagram are prime candidates for JIT manufacturing. Those at the top left or bottom right will be suitable for selected applications.

**Exhibit 6-9: The Kao's Jit Delivery System**

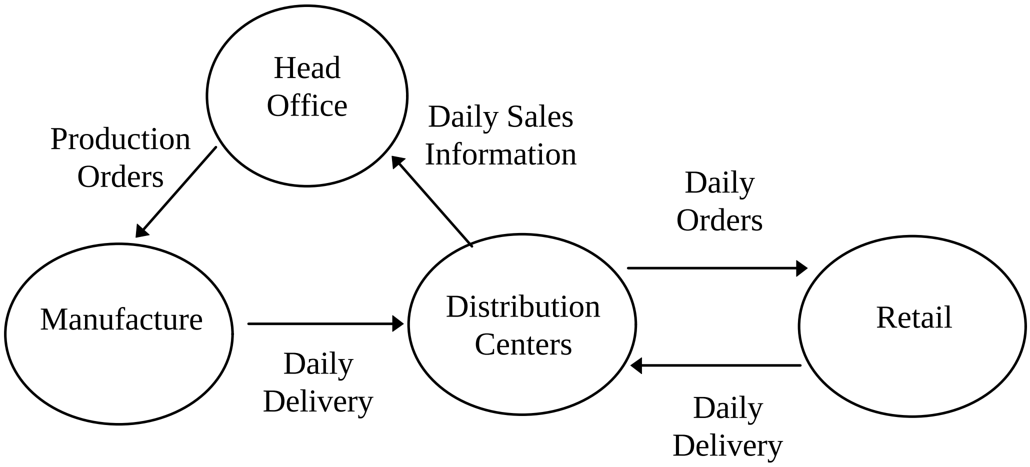


**Exhibit 6-10: JIT and Choice of Process**