Production and Operations Management - POM

- POM should teach to understand manufacturing technology and its role in developing business strategy.
- When managers do not understand technology, they tend not to invest in emerging technologies. Would you bet a billion dollars on something you don’t understand?

Functions or departments in business

- Three primary functions:
  - Production: without production, no products or services could be produced.
  - Marketing: without marketing, no products or services could be sold.
  - Finance: without finance, financial failure would surely result.

Production managers

- A production system takes inputs – raw material, personnel, machines, buildings, technology, cash, and other resources – and converts them into outputs – products and services.
- This conversion process is the heart of what is called production and is the predominant activity of a production system.
- Operations managers manage the production system; their primary concern is with the activities of the conversion process or production.

Marketing managers

- Managers in the marketing function are responsible for creating a demand for an organization’s products and services.
- This responsibility entails activities such as identifying prospective customers, advertising and promoting products and services, storing, displaying and demonstrating products and services, supervising salespersons, setting sales prices, receiving revenues, and providing an interface with customer.

Managers in the finance

- Managers in the finance responsible for achieving the financial objectives of the firm.
- This responsibility entails activities such as providing liquidity, providing financial-performance information to other managers, preparing financial information for stockholders, establishing lines of credit, etc.

Operations, marketing, and financial managers have much in common

- They develop plans for the future, they design organization structured, and they manage employees.
- In managing employees, they hire, train, supervise, measure, motivate, and lead employees; they build teams and set goals.
- Business cannot succeed without production, marketing, or finance. Whereas production, marketing, and finance act independently to achieve their individual function goals, they act together to achieve the organization’s goals.
- Although, managers in production, marketing, and finance have much in common, the decision that they make can be distinctly different.
The Evolution of POM

1. **The Industrial Revolution** - In England in the 1700s, this advancement involved two principal elements: the widespread substitution of machine power for human power and the establishment of the factory system.

2. **Post-Civil War Period** - the beginning of modern forms of capital through the establishment of joint stock companies. This development led to the eventual separation of the capitalist from the employer, with managers becoming salaried employees of the financiers who owned the capital.

3. **Scientific Management** - contributions: time study, methods analysis, motion study, human factor in work, Gantt charts - getting the desired result with the least waste of time, effort, or materials.

<table>
<thead>
<tr>
<th>Contributor</th>
<th>Life Span</th>
<th>Contributions</th>
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<tbody>
<tr>
<td>1. Frederick Winslow Taylor</td>
<td>1856-1915</td>
<td>Scientific management principles, exception principle, time study, methods analysis, standards, planning, control</td>
</tr>
<tr>
<td>2. Frank B. Gilbreth</td>
<td>1888-1924</td>
<td>Motion study, methods, theories, construction contracting, consulting</td>
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<tr>
<td>3. Lilian M. Gilbreth</td>
<td>1878-1973</td>
<td>Fatigue studies, human factor in work, employee motivation and control</td>
</tr>
<tr>
<td>4. Henry L. Gantt</td>
<td>1861-1919</td>
<td>Gantt charts, incentive pay systems, humanistic approach to labor, training</td>
</tr>
<tr>
<td>5. Carl G. Barth</td>
<td>1860-1939</td>
<td>Mathematical analysis, slide rules, feeds and speeds studies, consulting to automotive industry</td>
</tr>
<tr>
<td>6. Harrington Emerson</td>
<td>1885-1931</td>
<td>Principles of efficiency, millions-dollars-a-day savings in railroads, methods of control</td>
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4. **Human Relations and Behaviorism** - The human relations movement studies were initially begun by industrial engineers and were aimed at determining the optimal level of lighting to get the most production from work. When these studies produced confusing results about the relationship between physical environment and worker efficiency, the researchers realized that human factors must have been affecting production. This is the first time that psychological and sociological factors affected not only human motivation and attitude but production as well was recognized.

5. **Operations Research** - In World War II enormous quantities of manpower, supplier, planes, ships, materials, and other resources had to be deployed in an extremely hectic environment. The concepts of a total systems approach and of interdisciplinary teams and the utilization of complex mathematical techniques had been used in solving the industrial complex problems. Operations research, seeks to replace intuitive decision making for large complex problems with an approach that identifies the optimal, or best, alternative through analysis.
6. The Service Revolution – The creation of service organizations accelerated sharply after World War II and is still expanding today. More than two-thirds of the U.S. workforce is employed in services, roughly two-thirds of the gross national product (GNP) is produced by services, and investment per office worker now exceeds the investment per factory worker.

7. Today’s Developments

Factors Affecting POM Today

1. Global competition - the rapid expansion of worldwide communication and transportation systems, the conversion of Eastern European countries to free-market economies, the EC Market and free trade.
2. Productivity, Cost, and Quality Challenges - these are so fundamental in global competition that basic changes may need to be made in manufacturing and service operations.
3. Computers and High-Tech Production Technology
   Evolving Uses of Computers in POM
   - 1950s Clerical duties - Payrolls, billings, inventory transactions, cost reports.
   - 1960s Analysis of operations - Linear programming, scheduling, planning and control.
   - 1970s Mfg planning and control systems - Information systems for Mfg that integrate forecasting, inventory planning, MRP, scheduling, and shop floor control.
   - 1980s CIM - Robots, engineering design terminals, FMS, AS/RS, CAD/CAM.
   - 1990s Decision support systems (DSS), expert systems, and AI - these systems may provide computational support or imitate decision makers' through processes.
   - 2000s Internet communication, B2B, financial business. What else?
4. Issues of Social Responsibility
Three ways of studying POM

1. Production as a System

Concept:
- Production system: A system whose function is to convert a set of inputs into a set of desired outputs.
- Conversion subsystem: A subsystem of the larger production system in which inputs are converted into outputs.
- Control subsystem: A portion of the outputs is monitored for feedback signals to provide corrective action if required.
2. Production as an Organization Function

- The process of conversion is at the heart of production and operations management and is present in some form in all organizations. Where this conversion process is carried out and what we call the department or function where it is located vary greatly among organizations.

<table>
<thead>
<tr>
<th>Type of Firm</th>
<th>Some Line Jobs</th>
<th>Some Staff Jobs</th>
<th>Name of Production Function Department</th>
<th>Some Production System Activities in Other Departments (Jobs—Department)</th>
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<tbody>
<tr>
<td>Manufacturing</td>
<td>V.P. manufacturing, Plant manager, Production manager, Superintendent, Foreman, Team leader, Crew chief</td>
<td>Manufacturing engineer, Industrial engineer, Quality control manager, Quality control engineer, Materials manager, Inventory analyst, Production scheduler</td>
<td>Manufacturing</td>
<td>Purchasing agent, Buyer—purchasing, Personnel specialist, Personnel, Product designer, Marketing or engineering, Budget analyst, Accounting, Shipping specialist, Shipping,</td>
</tr>
<tr>
<td>Retailing</td>
<td>V.P. operations, Store manager, Operations manager, Departmental supervisor, Sales clerk, Stocking clerk</td>
<td>Customer service manager, Security manager, Maintenance manager, Supplies specialist, Warehouse manager</td>
<td>Operations</td>
<td>Purchasing agent, Buyer—merchandising, Merchandise control analyst, Merchandising, Budget analyst, Accounting, Inexpensive, Handling,</td>
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<tr>
<td>Trucking</td>
<td>Owner, V.P. operations, Branch manager, Dock supervisor, Truck operations manager, Driver, Dock worker</td>
<td>Rates specialist, Maintenance director, Truck scheduler, Repair mechanic, Dispatcher</td>
<td>Operations</td>
<td>Personnel manager, Personnel, Store manager, Administrative services, Budget analyst, Accounting, Systems analyst, Accounting, Purchasing manager, Administrative services</td>
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3. Decision Making in POM

- The best way to understand how operations managers manage the examination of the decisions in POM, these include:

**Strategic decisions:** Decisions about products, processes, and facilities. (long-term) (launch a new-product development, design for a production process, allocate scarce raw materials, utilities, production capacity, new factories need)

**Operating decisions:** Decisions about planning production to meet demand. (how much finished-goods inventory to carry, what products and how much of next period, whether to increase by overtime or subcontract to suppliers)

**Control decisions:** Decisions about planning and controlling operations. (short term)
Design and Development

1. The search for something new:

**Solo search**: more frequently, ideas are sought for relatively minor modifications and improvements: a way to make an operation safer or a change in data flow that saves time.

**Group ideation**: verbalization is formalized by techniques as brainstorming and synergism: The sum of the ideas from a group of people operating together should exceed the total number of ideas that the same people could generate operating individually.

2. Cause-And-Effect (C&E) Analysis

- The value of visual aids in understanding a problem is tremendous. Diagrams charts, and other graphical representations contribute to better communication by organizing data and focusing attention on specific issues.

- Construction: a C&E diagram is to develop a pithy statement of the problem or objective. First step in the construction of a C&E diagram. Spinal shafts represent composite cause-and-effect factors that pertain to the problem stated in the middle. The date establishes the time frame of action.

With the problem stated, the key factors are identified. The location of the viewpoint, the cost and design, are the dominant causes of the main effects, which are appeal and safety. These five factors are the primary arrows as shown in following.

The diagram is “develop viewpoint” with a desired completion date of July, 4, 1988

- Details are usually developed by concentrating first on the cause side of the diagram. Each of the main causes are questioned as to what components, actions, categories, or factors are involved.
C&E diagram of the factors to be considered in the development of a highway viewpoint. The factors are positioned according to the areas of primary influence.

Example: Christmas tree farming

3. Researches and Development
- A few discoveries were made by individuals, most of the advances were originated by teams of scientists and engineers devoted to seeking new knowledge. This effort is broadly classified as research and development (R&D).
- The National Science Foundation defines the following three divisions of R&D:
  **Basic research**: represent original investigation for the advancement of scientific knowledge and that do not have specific commercial objectives, although they may be in the field of the reporting company’s present or potential interest.
  **Applied research**: represent investigation directed to the discovery of new scientific knowledge and that have specific commercial objectives with respect to either products or processes.
  **Development**: technical activities concerned with nonroutine problems that are encountered in translating research findings or other general scientific knowledge into products or processes.

4. Product Life Cycle
5. Production Functions

- Production organizations are designed to generate an output. Several sequential or concurrent operations are usually involved in converting inputs to outputs.

- Functions of an industrial enterprise (policy and administrative functions of a large organization): the core area of the diagram represents the organization’s policymaking group.

- Functions of a production process: Another way to group functions is according to their relative positions in a production process. The functions displayed in the production cycle are fairly self-descriptive.

6. Technological impacts on manufacturing functions

<table>
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<tr>
<th>Manufacturing Function</th>
<th>Selected Technological Developments</th>
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<tbody>
<tr>
<td>Product Design</td>
<td>Computer-aided Design and Designing for Manufacturability.</td>
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<tr>
<td>Industrial Engineering/Material Requirements Planning</td>
<td>Applications of Computers to Capacity Planning, Labor Planning, Inventory Control, Scheduling, and Shop-floor Control.</td>
</tr>
<tr>
<td>Fabrication</td>
<td>Computer Control of Machine Tools and Multifunction Machine Centers.</td>
</tr>
<tr>
<td>Sales/Distribution</td>
<td>Application of Computers to Logistics Planning, Order Entry, and Delivery Date Forecasts.</td>
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Case: The role of Production Control

In one month, Jack Kelly, senior staff I.E. at McCully Manufacturing, will have to report on a pilot effort to implement a computer-integrated shop floor management system. Jack and Lana Field, a systems analyst, have been developing this system for the Heat Treat Department for about a year. If the pilot study can be shown to work, a major investment will be plant-wide computer-integrated manufacturing (CIM).

Last year, the company grossed about $50 million with its line of commercial and home-use power tools. Their major products are saws, drills, sanders, routers, shapers, and other wood-working tools. The President, Mr. Pearson, believes the next growth step for McCully will be to capture large contracts from nationwide retailers to supply tools under the customer’s brand name. Marketing has acquired several commitments to order but at a lower price than is presently possible.

Thus, to capture this new business, the cost of manufacturing will have to be cut in half. Estimating future volume at $125 million, Pearson has ordered new manufacturing technologies to yield half the needed cost reduction and a better production control to yield the other half. Jack Kelly convinced the president that better production control could come only with computer-integrated shop floor control. As a result, a lot is riding on the pilot study report that Kelly will soon present.

The manufacturing Organization

The manufacturing operation reports to Ray Connoly as shown in following Figure. In addition to Kelly’s group of three staff people, the director of manufacturing, Bill Rourk, and the director of manufacturing support, Jim Vernon reports to Mr. Connoly. The president’s growth plans should not affect the manufacturing support organization but will result in a split of assembly into three departments and the split of small parts machining into departments.

History of Past Experiences

The organization structure presented a few problems for Jack and his new computer system. The two participating departments, production control and Casting/Heat Treat, report to different people with separate views of what should be done. Although Ray Connoly was enthusiastic about CIM, Jim Vernon seemed neutral, and Bill Rourk was playing wait and see. Neither was sure that so much dependence on the computer was needed to meet the cost-reduction goal. Although production and inventory control had long used the computer to generate schedules, work travelers, and inventory reports, these systems were not relied on heavily. In fact, Mr. Rourk often related war stories of the problems they had when the MRP system was first
Material requirements planning (MRP) did not result in the savings that had been hoped for. Inventory levels averaged about 0.4 times annual sales before MRP and dropped very little after MRP. In fact, the President cited this fact when he assigned the computer-integrated shop floor project to Jack Kelly. "I want inventory turns to increase from three a year to ten. If the Japanese can do it, so can we," he ordered. "With these bigger contracts, we'll be able to forecast demand much better and that will make the MRP system more valid. Then manufacturing can hold closer to the schedule and we can get closer to just-in-time inventory. The key is better planning and better control."

Mr. Rourk was not as optimistic about the ability to hold closer to the plan. He was concerned about the small lot sizes that just-in-time manufacturing required. That meant more setup time, and if anything went wrong, a whole order could be delayed for lack of one part. Especially, if McCully bought more automated machine tools, Mr. Rourk felt that "longer runs and more inventory were needed for smooth operations."

Mr. Vernon, on the other hand, felt that the real problem with the existing MRP system was the poor shop floor data collection procedure. At present, a traveler was attached to each batch of parts. A copy of the traveler shown in following, indicates each operation the part needs.

Typically, a part has 10 to 15 operations. The traveler is produced by the MRP system and also is the feedback link to that system. As the parts are processed, each operator notes how many were run, when they were run, and how many were scrapped. After final inspection, the traveler is returned to production control and keyed into the computer. Every night the MRP database is updated to reflect completed travelers from that day. Vernon noted that operators frequently entered the wrong data on the traveler or forgot to enter anything at all. By the time the data entry clerk keyed in the data, it was often too late to rectify problems caused by scrap or late completions. He recalls a batch of gears that was lost 6 or 8 months ago and the MRP system did not indicate a problem for almost 6 weeks. By then several hundred high-priced drill presses were late for delivery.

"This can't happen once we have the big-volume customers. Unless you can solve the shop floor data collection problem, you can't cut inventories to a third their present levels," Vernon said.

Jack agreed with both Rourk and Vernon. To be successful, the new system would have to reduce the cost of setup and guarantee accurate real-time data from the shop floor. His own analysis of the failure of MRP was as follows:

1. The implementation was too much, too fast. The entire system was implemented at once, placing the whole organization in chaos. People were no longer receiving the reports they knew how to use, and the MRP reports did not suit their established mode of operation.

2. The data collection system on the shop floor took too long. The operators perceived no benefit from the effort needed to get accurate data. During shift changes one operator started a job that was finished by another, and the traveler offered no way to split the batch reporting. Because the shop was on a piece rate pay system, there was a tendency to avoid reporting scrap unless absolutely necessary. Thus, the data collection
system was incompatible with the interests of the shop floor people on which it relied.

3. Because the MRP system was acquired from a software house, the contract called for user training by the vendor. This proved inadequate because the trainers did not understand McCully and were prepared only to explain what the reports contained. They could only wave their hands at the input data accuracy problem.

4. The shop floor supervisors felt no ownership of the MRP system. Its success meant nothing to them. The general attitude was that the system did not reflect their day-to-day problems. Although the computer often produced unrealistic schedules, it was they who were blamed if the schedules were not met. As a result, the foreman almost encouraged the inaccurate data input so as to discredit the system and its difficult production schedules.

Plans for the New System

As a result of these problems, the development of the new shop floor information system was to be accomplished differently. For one thing, Jack Kelly had formed several design teams including representatives from the production control and manufacturing departments. For example, a team consisting of people from Methods and Work measurements and from Small Parts Machining was established to find ways to reduce setup times. With the aid of a consultant, this team recommended two new numerical controlled machine tools, one additional machine setup man, and a new philosophy toward designing jigs and fixtures for quick changeover. They estimated the average time to change a machine over could thereby be cut from its present 1.5 hours to 15 minutes. The key to the reduction was for the shop foreman to actively schedule changeovers and prepare to make them as fast as possible. A piece rates incentive for the setup men were established based on changeover standards that would have to be determined later.

Another team with members representing data processing, production control, shop supervision, and labor was working on data collection. Jack Kelly acted as chairman of this team. Together they worked out a bar code-based system in which each batch of parts, each machine, and each operator had a plastic card with needed data imprinted using bar codes. The operator merely inserted the three cards into three slots on a reader and keyed in the quantity of good parts produced. The system responded by displaying how much incentive pay the operator had earned. Scrapped parts were accounted for separately by an inspector, and the operator was also paid for these. If a discrepancy occurred in data entry, the operator was required to reconcile the error on his own time, with a clerk in production control, and his pay for that part was not released until the discrepancy was resolved. Finally, a standard time for data entry was established, and the operator was paid for this activity. This system was being tested in the Heat Treat pilot study, and after two months, first input accuracy had risen to 95 percent.

Finally, a team headed by Lana Field with members from the Production Control and Heat Treat departments was working on the outputs from the new system. The team determined that the supervisors needed more than a daily listing of work orders and a set of job travelers to do their jobs. They needed to be able to use the computer interactively to help them schedule their departments and to be able to communicate problems back to the computer. A simple scheduling support system was devised to help the foreman assign jobs to machines and keep track of the work loads on each machine. In addition, a simple task sequencing routine was developed to help the foreman and setup men know which jobs to run next, so that they could list and prioritize the setup tasks. The Heat Treat foreman was sent to a one-week school to become familiar with using computer terminals, and he spent several hours, with a simple simulation of his shop, learning how to use the scheduling support system. During the development of the new system, Jack Kelly suggested that the President, Mr. Pearson, visit the Heat Treat foreman once or twice to ask how the project was going and to see how it worked. This proved to be a real incentive, and the foreman became a strong advocate of the new approach.

Summary

Jack felt the results from the pilot project were very positive. It was estimated that setup times could be cut drastically by scheduling them and using new fixture designs to make them easier. The accuracy of data
collection was greatly improved by making it easier and connecting it directly to the incentive pay system. Finally, with proper training the shop foremen could be made advocates and users of the computer rather than detractors. It was easy to argue that the new system would work.

The real question still remained---Would all this allow for a very deep cut in the required levels of in-process inventory? To make this transition, Jack would have to argue that the new system would decrease idle machine time. Jack knew that better information would produce more confidence and that production control people would cut raw materials inventories as they became more confident. He also knew that smaller lot sizes would allow production to follow purchase orders more closely, which would reduce finished goods inventory. The manager of production control agreed that this would result in a 20 percent reduction in total inventory.

To reduce inventories to the targeted level, Jack knew that in-process inventories would have to be cut by 50 percent. He recalled from his scheduling class that under steady-state conditions, average in-process inventory levels were inversely proportional to average use of the machine tools. Thus, the new system would have to double machine utilization. A meeting with the manufacturing engineers resulted in an estimate that new equipment would more than double production rates at key bottleneck operations. A quick study of the operations that immediately preceded or followed these bottlenecks indicated that use of existing equipment could be greatly increased but not doubled. Reduced setup times would help. Smaller lot sizes would allow for more, but smaller batches at each machine, which should also reduce the probability of a machine being idle while parts were piling up elsewhere. Finally, improved materials handling to get work to the next machine tool should increase utilization.

Jack felt confident that Mr. Pearson's goal of cutting inventory levels by 70 percent was very realistic. He knew he could identify all the ways machine use could be increased to meet the president's goal. The key to the process, in Jack's mind, was how adequately the shop floor people accepted the need to pay more attention to using the computer when planning their activities. With reference to the Heat Treat pilot study, Jack decided that he would tell Mr. Pearson that close attention to the human factor would make the computer-integrated shop floor management system a great success.