IENG/MANE 332 summary of chapters 1, 2, and 3

Reference: PRODUCTION, Planning, Control, and Integration by SIPPER & BULFIN.

Prepared by: Dr. Faramarz Khosravi

Chapter 1: THE PRODUCTION PARADIGM

INTRODUCTION

1 Global production

1.1 Evolution of production systems:

1.1.1 History:

Four major types of production system have evolved historically: ancient, feodal, european, and american.

We can trace the begining of **Ancient systems** to 5000 B.C when sumerian prisets started to records of inventories, loans, and tax transactions. Around 4000 B.C Egyptians were using the basic management concepts of planning, organizing, and control in their large projects such as the pyramids and similar structures. This period of time continued by Hebrews and Chinese for developing basic concepts on production system such as qualification of workers and initial steps over time and motion study.

During the middle ages, the **Feudal system** evolved, in which the emperor, king, or queen had total power over the country. Land and labor were the major production factors of the feodal system.

The **European system** started evolving during the Renaissance. Although we normally think of the renaissance for cultural development, much was happening, particularely in Italy, that would affect industrialization and production systems. Adam Smith publicized the division of labor in his book, *The Wealth of Nations*. Rather than have one person complete a product, he suggested each be responsible for only one part of the completed job.

In the American system, Eli Whitney, inventor of the cotton gin, promoted manufacturing with interchangable parts. Widely credited as the first to use this idea. Whithney used jigs and fixtures to orient and hold the parts, which could be made by less-skilled machinists.

In 1903 Oldsmobile Motors created a stationary assembly line to produce their cars. The Assembly line is the logical outgrowth of specialization of labor and the use of capital to replace labor.

1.1.2 Management theories

Fredrick Taylor is often called the father of scientific management. He felt the solution was not to make them work harder but to manage them better.

As scientific management gained acceptance in the United States, Henry Fayol developed his theories in France. Fayol beleived a firm had six functions: technical (the actual production), commercial (buying and selling), financial (getting and allocating money), security (protection of people and property), accounting (keeping records), and managerial (planning, organizing, command, coordination, and control).

2 Production systems:

Production system is anything that takes inputs and transforms them into outputs with inherent value. A good example of a production system is a firm that manufactures simple pencils. Raw materials such as wood, graphite, and paint are the inputs. The transformation consists of cutting the woods in sheets, sanding it, grooving the wood, adding the lead, joining the sheets, cutting the pencil shape, and finally painting the finished pencil. The pencil is the output.

We structure our discussion of production systems around four different components: production flow, building blocks of the system, technology, and system size.

2.1 The flow process

The backbone of any production system is the manufacturing process, a flow process with two major components. The physical flow of material can be seen, but information flow is intangible and more difficult to follow.

In figure 1-1 we show a generic model of physical flow in production systems. Material flows from the supplier to the poduction system, to become raw material inventory. It then moves to the production floor, where the material conversion process takes place. The material moves through different conversion processes performed at workstations but does not necessarily traverse the same route each time. Material on the production floor is called work-in-process inventory (WIP). From the production floor the material flows to a location where it becomes finished goods inventory. From there it flows to the customer, sometimes through intermediaries such as distribution centers or warehouses.

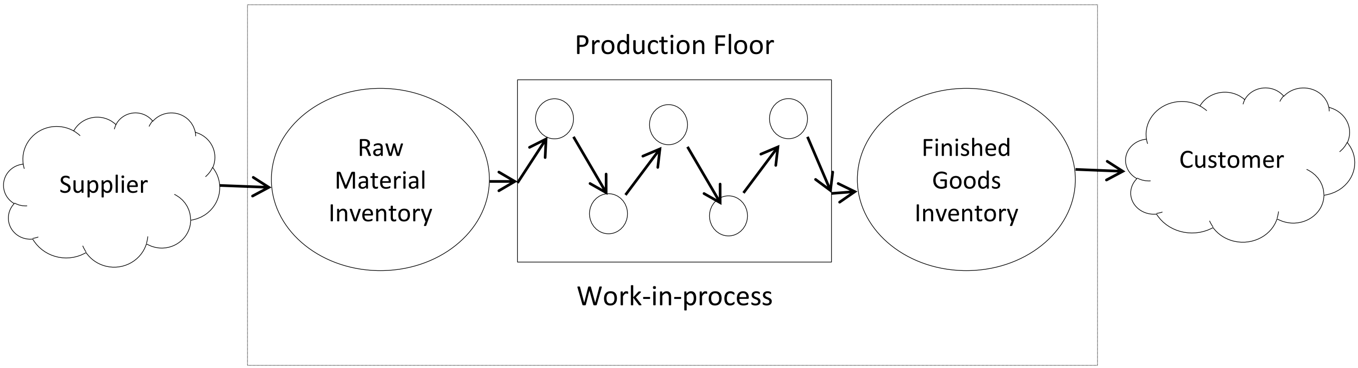


FIGURE 1-1 Generic Physical flow

2.2 Building blocks

The goal of production systems is to manufacture and deliver products. The goal is that the material conversion has to meet, concurrently, the following objectives.

- **Quality**: the product must have superb quality- equal to or better than its competitors.
- **Cost**: the cost of the product must be lower than the competition.
- **Time**: the production must be delivered to the customer on time, every time.

2.2.1 PHYSICAL ARRANGEMENTS:

The material conversion process takes place on the production floor, which is arranged in a certain way to facilitate conversion. Production volume and production variety determine the type of arrangement, or **layout**. To meet these varying needs, two fundamentally different types of physical layout have evolved: the **job shop** and the **flow shop**.

A Job shop produces low-volume highly customized products. Job shops usually have several elements in common. Workers must be skilled enough to make a variety of products.

A flow shop produces a high-volume standardized product. The automobile industry is a good example of a flow shop. An assembly line maintains the material flow, hundreds of thousands of a given model of car may be made, and production may last for a year. Workers use special purpose equipment, need little skill, and are able to do fewer tasks than job shop workers.

Between the extremes of job shops and flow shops is a hybrid of the two, the **batch shop**.

The final physical layouts encountered are the **modern shops**. Modern shops and include three major types: Cellular Manufacturing Systems (CMS), Flexible Manufacturing Systems (FMS), and Computer Integrated Manufacturing (CIM).

2.2.2 ORGANIZATIONAL ARRANGEMENT:

There are three major types of organizational structures: **functional, divisional, and matrix.**

Functional and divisional are classic, though opposite, organizational structures. **Functional structure** is built around **inputs** used to achieve the task of an organization.

Divisional structure is built around the **outputs** generated by the organization. The most common is to structure the organization around its products. However it could be built around projects, services, programs, clients, specific markets, or geographical locations. Today, a divisional structure is called the *strategic business unit* (SBU).

2.3 Technology

2.4 Size of organization

3 PRODUCTION MANAGEMENT TECHNOLOGIES

3.1 Evolution

3.2 Production planning and control

Production planning and control technology combine the physical and information flows to manage the production system. PPC has several distinct elements. In figure 1-8 we super impose these elements on the physical flow of a production system.

We position these elements at different places along the physical flow route and interaction between the elements is not shown. The PPC function integrates material flow using the information system. Integration is achieved through a common data base (Figure 1-2).

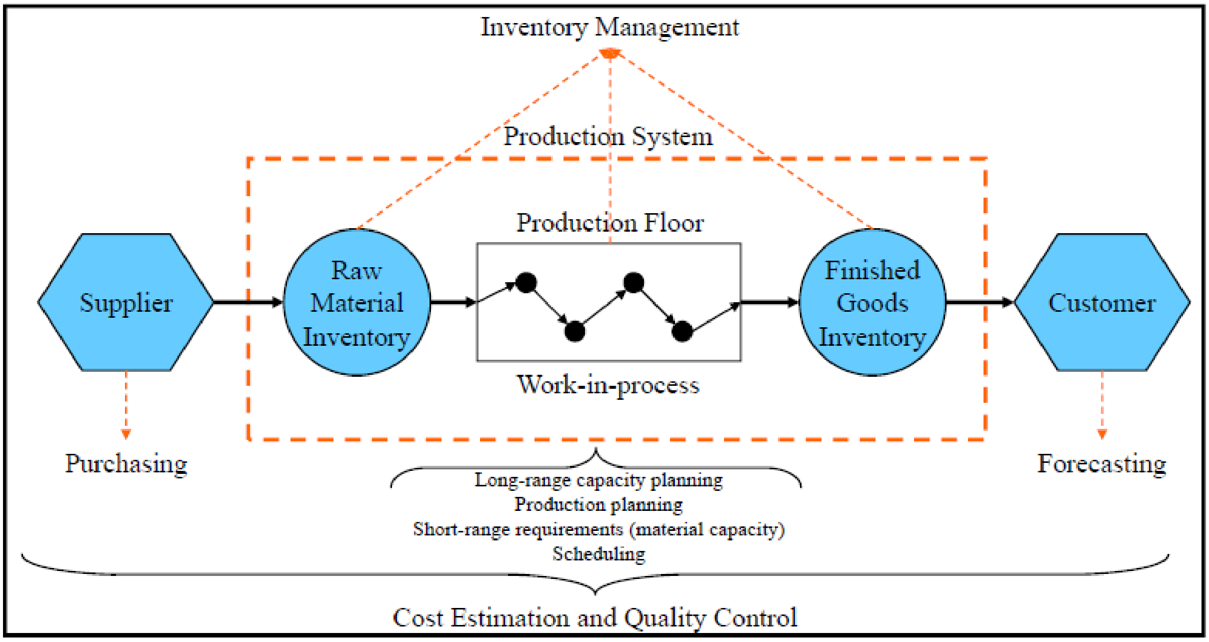


FIGURE 1-8 Elements of production planning and control

Interaction with the external environment is accomplished by forecasting and purchasing. Forecasting customer demand starts the production planning and control activity. Purchasing connects the production system with its inputs provided by the external suppliers. Extending production planning and control to suppliers and customers is known as **supply chain management**.

3.3 Product life cycle

The five stages of a product life cycle are product planning, introduction, growth, maturity, and decline. Figure 1-9 shows sales in each of these stages.

Product planning is the development stage, in which both product design and production process are determined. There are no sales during this stage.

Introduction represents a period of low-volume sales. The product is refined, and marketing efforts are beginning.

The **growth** stage has rapid product growth and a fast increase in sales. This period is difficult for the manufacturing organization, which has to keep up with the increasing sales volume.

At **maturity**, we see a tapering off in the growth rate as the market becomes saturated. Demand is stable and may decline slowly. A wise producer in this stage, must think about designing and planning for the next product.

A drop in product demand is seen in the **decline** phase. The product has been replaced by new products. Sales and profits decrease, and at same point, production is halted.

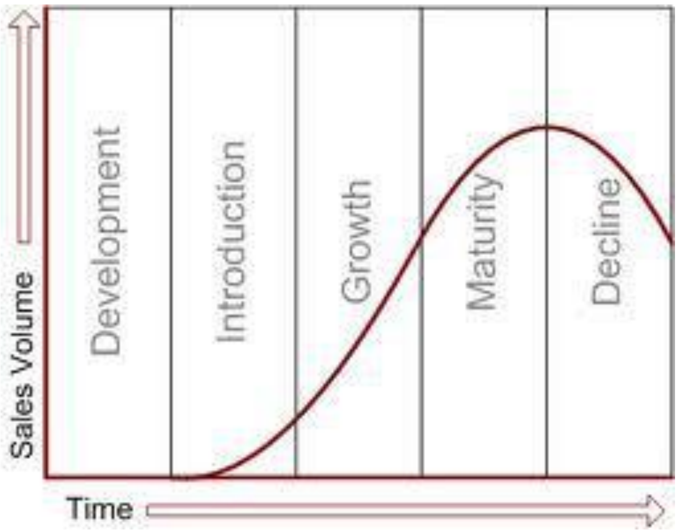


FIGURE 1-9 Product life cycle

4 DECISIONS IN PRODUCTION SYSTEMS

4.1 Planning Horizon:

The types of decision in a production system depend on the planning horizon. For planning purposes, business and industry usually identify three types of planning horizons: long, medium, and short.

A **Long planning horizon,** sometimes called strategic planning, covers a horizon of one to several years into the future. The decisions made for this horizon are called strategic decisions. They have a long-range impact on the direction of production systems and should be consistent with long-term organizational goals.

A **medium planning horizon** covers any period from one month to one year and is called tactical planning. Decisions made for this time frame, known as tactical decisions, are oriented towards achieving the annual goals set for the production system.

A time frame ranging from days (sometimes hours) to weeks or one month is the **short planning horizon**, also known as operational planning. Operational decisions are concerned with meeting the targets of the monthly production plan.

4.2 Types of decisions:

Typically, strategic decisions are made by top management, tactical decisions are made by middle management, and operational decisions are made by operations managers. A strategic decision might involve capacity expansion.

Chapter 2: MARKET-DRIVEN SYSTEMS

1 INTRODUCTION

2 THE WHEEL OF COMPETITIVENESS

The wheel of competitiveness, shown in figure 2-1,illustrates some of those concepts required to role American industry back to its leadership position.

The wheel has four concentric circles; each represents different aspects of the emerging production management theory. We briefly define each circle and then follow with a more detailed discussion. The **Hub** of the wheel is also the hub of all future systems; the **customer.** The **Delivery circle** (Circle 2): shows what the production system should deliver to the customer. The **Support circle** (Circle 3) indicates concepts needed to support what is delivered by the production system. The **Impact circle** (Circle 4) shows the consequence of those concepts on the whole organization

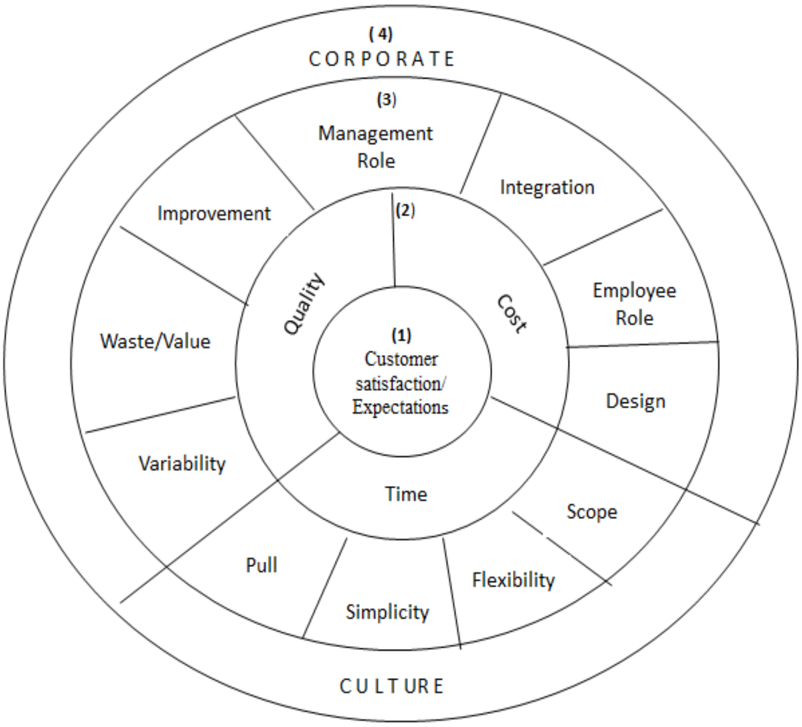


FIGURE 2-1 Wheel of competitiveness

3 THE HUB

It is no coincidence that the customer is the hub of the "new industrial world" concepts. The customer is the engine that drives competitiveness.

Rather than operating to respond to and satisfy customer needs only, organizations must make an effort to achieve **customer satisfaction** as well.

If the customer is the engine driving the organization, expectation is the engine's fuel. Customer satisfaction with acceptable financial returns is the measure of business success.

4 THE DELIVERY CIRCLE

In order to achieve customer satisfaction and meet its expectation, the whole business has to rise to the challenge. Each segment must contribute its share, and the manufacturing system is no difficult. İts role is to deliver a product of superb quality at the required time while keeping the cost as low as possible.

4.1 Quality

Quality is a traditional concept whose scope has expanded and whose importance is enhanced in the modern production system. The common product-related definition of quality is **conformance to specifications**.

4.2 Time

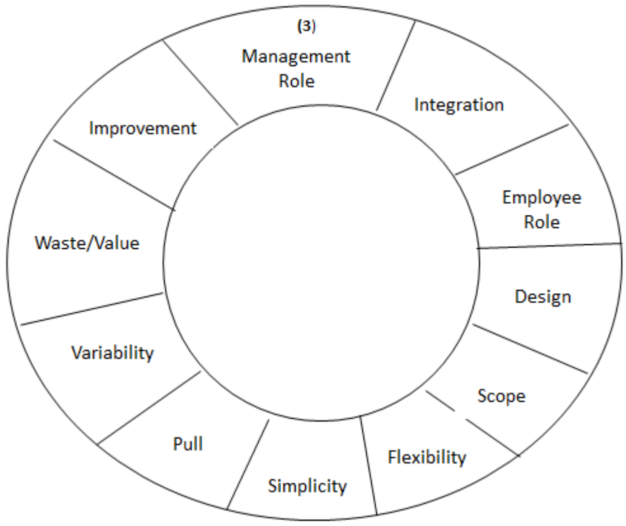
Delivery or lead time is the length of time needed to deliver a product from order until the receipt by the customer. If the customer needs a shorter delivery date, we must find a way to shorten delivery time. It is not enough to shorten delivery time and deliver on time once. We have to be able to do it repeatedly.

4-3 Cost

Cost is a common term, but it has different meanings in different situations. Although the price of a product is a "cost" to the consumer, it is not the sum of the cost of all activities associated with generating the product. The price of the product should reflect profit the company intends to make above cost.

5 THE SUPPORT CIRCLE

We have stated the difficulty of combining the goals of the manufacturing system (quality, time, and cost) into one unified goal. List of the major concepts is shown in the support circle of figure 2-1.



5.1 Scope
The scope of a business has been redefined to include both the customer on one hand and the external supplier on the other hand, which represents a direct contrast to the past, when the customer was " out there" and the supplier was considered more an adversary than a partner.

5.2 Integration
We consider integration as the process of looking at a system rather than a component, or to phrase it differently, the process of seeking global.

5.3 Flexibility
Flexibility requires the production system to be able to rapidly design a new product and introduce it to the market place, cater to changing patterns of product volume required, and cater to greater product mix.

5.4 Design
Design has undergone a major turnaround. We accept the belief that the major portion of product cost and quality are determined in the design phase.

5.5 Simplicity
In the new manufacturing environment we simplify for two important reasons.

- simple things are understood by more people
- simple situations enable us to use simpler solutions, which are less expensive, less time consuming, implemented faster, and have a low risk.

5.6 Variability
Variability, a universal enemy, is traditionally accepted as a fact of life. Now we try to eliminate it completely, reducing the need for a number of tools developed to control it.
By applying one Japanese concept- Poka yoke- we can eliminate variability in our production system.

5.7 Pull
The production process is basically a flow process. First there is physical flow; the raw material, later the semi-finished product, moves from one machine workstation or assembly

station to another. At each station some processing of the raw material is done, and the material moves to the next station in the manufacturing sequence.

The governing law changed to the rule of **pull** or **pull production**. The essence of pull production is to **do things upstream only when requested from down stream**. The terminal point of the downstream is the customer. In a push production system, the physical and information flows are in the same direction. However in the pull system the physical and information flows are in the opposite direction

5.8 Waste/Value

We classify production activities into two major categories: value-adding activities and cost-adding activities. **Value-adding activities** are those that by their nature are supposed to add value. Typically they are conversion activities where raw or purchased material are transformed from their received state into the final product. Here waste would be the use of excess resources. **Cost-adding activities** are those that enable a smoother operation or make life easier in the production system. They support a conversion process, and although they may be important and even necessary, add no value-for example, materials handling. A third type of hybrid activities falls somewhere in between value adding and cost adding-for example quality control.

5.9 Improvement:

5.10 Management Role:

The manager's role is to facilitate change positively in three ways.

- **Commitment**: management must first and foremost show a commitment to the new concepts, which may be a major break from the status quo.
- **Participation**: management should become a part of process and not stay above the process. Changes starts at the top, and management must undergo the elements of the change process throughout the organization.
- **Goals**: management should set extraordinary goals. Only then it is possible to obtain first rate results. İn quality, for example, the goal is perfection, without an "acceptable" level of defects.

5.11 Employee role

6 The impact circle

The concepts described in section 5 have tremendous impact on an industrial organization adopting all or part of them. The bottom line of this impact is represented by a major cultural change in the organization.

The net result of this change is that the organizational culture changes from pursuit of **efficiency** to **effectiveness**, which has a broader scope.

Efficiency: a local measure of performance is defined as the ratio of output to input. The idea is to make things right.

Effectiveness, on the other hand, focuses on requirements of the total system, not subsets of it. The idea is to make the right things. Performance standards on the major parameters of the system are specified, and these become a framework within which efficiency measures still play a role.

7 PRODUCTION SYSTEM OBJECTIVE

8 FROM CONCEPT TO IMPLEMENTATION

8.1 Overview- Integrated Production Systems

8.2 Aspects of integrated Production Systems

8.2.1 Integration niche

8.2.2 INTEGRATION ESSENCE

8.2.3 Integration strategy:

Integration can be examined from two different perspectives: top down or bottom top.
Currently, there are three leading approaches to integrated production systems design-all focused on medium- variety and medium- volume production. They are as follows

- Cellular Manufacturing Systems (CMS)
- Flexible Manufacturing System (FMS)
- Computer Integrated Manufacturing (CIM)

8.4 Integration processes

8.4.1 TEAMWORK. Machines do not run organizations, people do. People are the most important resource of an organization and in the final analysis make the difference. It is no wonder that the human element is the basis of many integration processes.

8.4.2 CONCURRENT ENGINEERING. Concurring engineering is a systematic approach to the integrated, concurrent development of products and their related processes, including manufacture and support. The process of concurrent engineering is implemented by using a team approach; cross functional teams are formed that include representatives of design and manufacturing, marketing, quality, and sometimes finance. Each team is responsible for a product or family of products.

8.4.3 TOTAL QUALITY MANAGEMENT (TQM). TQM is an organization-wide quality focused culture. It is a journey to achieve excellence in all aspects of the organization's activity. It involves all members of the organization at all levels of operation.
Statistical quality control is the use of statistical methods to control quality.

9 WORLD CLASS MANUFACTURING (WCM)

9.1 lean Production

It promotes elimination of inventory and other forms of waste, greater flexibility in production scheduling, shorter lead times, and advanced level of quality in both product and customer service.

9.2 Agile Manufacturing

The major thrust of agile manufacturing is an enterprise view, which, specifically, includes the following:

- Greater product customization –manufacturing to order but at a relatively low unit cost
- Rapid introduction of new or modified products, in some cases through quick formation of a temporary strategic partnership to take advantage of brief windows of opportunity in the marketplace, which is called a virtual enterprise or virtual organization
- Upgrade able products that are designed for disassembly, recyclability, and reconfigurability
- Interactive customer relationship

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CHAPETR 3: PROBLEM SOLVING

1 INTRODUCTION

1.1 Problems

A **problem** exists when what is happening differs from what should happen. What is happening is the current state, and what should happen is the goal state.

1.2 Solutions

Ackoff (1991) discusses four approaches to a problem. The first, **Absolution,** ignores the problem and hopes it gone away, which is seldom a good approach. The second approach is resolution. **Resolution** finds an acceptable solution to the problem using common sense; resolution is usually better than absolution, but the answer may not be a good one. **Solution** is his third approach. It uses quantitative and experimental methods to get the "best" answer under the current conditions. The fourth approach, d**issolution,** redesigns the system to eliminate the cause of the problem.

1.3 Problem solvers

Who is the problem solver? The person who has the problem or someone paid to solve problems could be the **problem solver**.

2 PROBLEM SOLVING APPROACH

We present a six step process, outlined in Figure 3-1. These steps are:

1- Identify the problem
2- Understand the problem
3- Develop a model
4- Solve the model
5- Interpret the solution
6- Implementation

3 PROBLEM IDENTIFICATION

Problem identification converts a "mess" into a simple problem statement. Identification is an important step in problem solving. A problem never recognized will never be solved.
Two sources of problem are need and opportunity. A broken machine is need driven problem but increasing market share is an opportunity.

3.1 Problem mission

The mission is the overall purpose – what we want to accomplish. The mission will later be translated into goals, and the objectives.

3.2 Problem owners

Problem owners are people who must live with the solution.

3.3 Assumptions

When identifying the problem, we seldom know all the facts, so we make assumptions. If you work on well-structured problems, assumptions may be necessary.

3.4 Initial problem statement

Once you identify a problem, write down a "formal" problem statement. Include a one or two sentence description of the mission and a brief description of the current state and the goal state. Do not include restrictions, and do not go into great detail. List all assumptions.

4 UNDERSTAND THE PROBLEM

From the initial problem statement, we refine our understanding of the problem. Because problems do not exist in a vacuum; the problem solver must understand how the problem fits into its environment. We must describe the system within which it occurs.

4.1 The systems perspective

A **system** is a collection of interacting components; its function cannot be done by any single component. Machines are one component of a production system.
Analysis is one way to study a system. The system is taken apart and each component studied separately to see how it works. The knowledge of the components is combined to gain knowledge about the system, which can usually tell us how a system works.
Synthesis is another way to look at a system. Synthesis views the system as a component of a larger system and we try to explain the behavior of the larger system. It tells us how the system operates and tells us why it operates as it does.

4.2 Goals:

The mission is our overall purpose, but the goal should be one or more accomplishments that will lead to fulfilling the mission. If our mission is to have satisfied customers, the goal might be to improve the quality of our product or service.

4.3 Problem characteristics

The time frame in which the problem exists is important. If it is a one-time problem, the solution must be given before the problem disappears or changes. For example, we must determine the best way to lay out a production facility before using it.

4.4 Validate understanding

Our understanding of the problem is an abstraction of the real problem. If we understand the actual problem, our abstraction should capture its important features. We must make an effort to ensure this; i.e. we **validate** our problem understanding…

4.5 Problem statement

We can now write a more precise, detailed problem statement. After further study of the problem, we may have revised the mission or modified assumptions. Document all changes.
As before, involve the problem owners.

5 DEVELOP A MODEL

A **model** is a representation of something.

5.1 Model representations

Iconic Models: are physical representations that usually have different scales that what they represent. For example, CAD systems.
Analog Models: behave the same way the system does but do not look like the system. A flowchart showing the information flow in a production system is an analog model.
Symbolic Models: As the name implies, the system is represented by symbols. This class includes graphical, tabular, and mathematical models.

5.2 Data

Data are often needed to identify and understand a problem. Data are used to validate assumptions, estimate model parameters and validate models and are usually collected at every step of problem-solving process. Availability of data may dictate the type of model used.

5.3 Modeling Concepts

We now discuss some common components of models:

5.3.1 Boundaries: the first step in describing the problem is to determine the important parts of the problem. Important information should be included, and irrelevant details should be left out in order to determine appropriate **boundaries** that contain the problem. For example if

new are considering equipment and layout for a production facility, the boundaries may be the building walls.
5.3.2 Objectives: Once we tentatively set boundaries, we determine the objectives. An objective is a refinement of a goal. It must be measurable. If the goal is to improve the quality of a product, the objective might be to decrease the number of items defective.
5.3.3 Constraints: With unlimited resources, solving most problems is easy, but there are usually limitations or **constraints** on what we can do. These limits may be on people, time, knowledge, data, capacity, technology, money, or other resources. Constraints are inviolate-they must hold.

5.3.4 Relationships: once boundaries, objectives, constraints, and data are defined, we determine the **relationships** between them.

5.4 Assumptions and involvement
Involve the problem owners in modeling to ensure that the model is a reasonable representation of the problem. Depending on the results, we may need to return to a previous step to make revisions.

5.5 Internal validation
Validation ensures that the solution will be relevant to the real problem, and it occurs throughout the problem-solving process. After constructing the model, we check to see if it is doing what we intended, which we call **internal validation**.

6 SOLVE THE MODEL
Starting with the model statement, the problem solver chooses and algorithm. When the model and solution algorithm are satisfactory, we solve the model and get a model solution.
6.1 External Validation:
External validation tests the model solution. It finds inconsistencies in the model not fond during internal validation and validates the solution procedure as well. **Model simplification** and **historical analysis** are two strategies for external validation.

This concept is very close to Deming-circle.
The **Deming Cycle** or PDCA Cycle is a four stage change management model used by companies for continuous improvement and problem solving

The four stages are:

- **Plan:** identify and analyze the problem or opportunity, develop hypotheses about what the issues may be, and decide which one to test.
- **Do:** test the potential solution, ideally on a small scale, and measure the results.
- **Check/Study:** study the result, measure effectiveness, and decide whether the hypothesis is supported or not.
- **Act:** if the solution was successful, implement it.

6.2 Solution strategy
The solution procedure depends on the model, and the model depends on available solution procedures.

Other models can be solved by algorithms that generate alternatives as well as evaluate them. **Optimal**, or exact, algorithm look implicitly at all alternatives and choose the best; a critical path algorithm is an example. Other algorithms, called **heuristic** algorithms, generate alternatives that are not guaranteed to be optimal, but are, hopefully, close to the optimal

7 INTERPRET THE SOLUTION

Model solutions are not necessarily problem solutions. If the model is a good representation for the problem, it may lead to the solution of the problem. Because it is difficult to include all interactions in a model and still solve it, be careful in applying the model solution to the actual problem.

8 IMPLEMENTATION

Once a problem solution is found, implementation begins. All concerned must accept the solution. Necessary resources are committed and appropriate people are trained to carry out the new solution. It is good practice to have parallel operation of the new and old methods.

9 **Software**

Many software packages aid problem solving and some problems cannot be solved without a computer. Spreadsheets (Excel, Lotus) are easy to use and very helpful in problem solving.
There are also a number of software packages tailored especially to Production Planning & Control courses (STORM) and so on.