

Manufacturing and Manufacturing Systems

Manufacturing covers wide areas of inputs, processes and products. It reaches out to the demands in production for thousands of different varieties and types of goods. These demands range from large ships to hand drilling equipment, and from micro circuits to automobiles. The number and complexity of processes involved in the production of these goods varies drastically. The extent of alterations involved in these processes form the very basis for getting a bird's eye view of the manufacturing activity. Some are simple primary product and some are simply transformed products such as basic metallic shapes, paint and utensils. The next are moderately transformed products such as wires, rods, metal pipes and tubes, while others are elaborately transformed products such as prefabricated metal shapes, wire products, glassware and ceramic products. The mechanization and extent to which it is involved in the process of production gives another view of manufacturing. Manufacturing covers a very wide range of situations right from robot controlled highly mechanized lines of production to some simple day to day use equipments with mechanical activities.

Thus, manufacturing industries, today, encompasses a dimension scale of more than fifteen orders of magnitudes. The design and manufacture of huge machinery, ship and spacecrafts on one side while nano and pico technology on the other side of the dimension scale, highlights the challenges ahead for engineers and technologists. With the advancement of technology newer materials, energy sources, manufacturing technology, decision-making and management techniques are being developed. These unfold lot of opportunities for the scientific and academic fraternity. At the same time, newer challenges in the form of environmental and other issues put stringent requirements on the technology. Global competition, the thrust on quality and demand for higher productivity are some of the challenges before the present industrial and manufacturing units. To survive and to succeed further, the competitors have a unique option, which is understanding of the dynamic changes that are taking place in the business environment. In view of the above, a nation should develop and update its infrastructure, such that the new and advanced technology gets into hand in hand, with the ongoing time.

What is manufacturing?

There are many ways and definitions available to explain the concept of manufacturing. Some of these definitions are listed below:

- A. The process of converting raw materials into finished products
- B. Manufacturing is defined in the Macquarie Dictionary as the making of goods or wares by manual labor and / or by the use of machinery, especially on a large scale
- C. Manufacturing is a very broad activity, encompassing many functions – everything from purchasing to quality control of the final product
- D. Chemical or Physical transformation of the materials, substances or components into some new products
- E. Manufacturing is a value addition activity to the raw materials, substances or components
- F. Manufacturing is a process through which products are made through various production activities

G. Manufacturing may be considered as a system, wherein there is an integration of people, equipment, policies and procedures to accomplish the objectives of an organization i.e. production of the required product.

H. Manufacturing is the use of machines, tools and labor to make things for use or sale

I. Manufacturing is an application of different resources such as machinery and people used for converting the materials into finished goods

Manufacturing System

In order to consider manufacturing, as a system; we need to look beyond the conversion of raw materials and processes which lead to finished products. The understanding of the manufacturing system as a whole helps in identifying, which process parameters and functions of the organizations are important; this helps to make decisions about the economical ways of producing the end products. There are several factors which are usually considered in taking a final and relevant decision about the best way of producing the desired end product. A manufacturing system can be considered as a simple input-output system at the first stage.

The input-output system does not provide the sufficient information about all the aspects of manufacturing. Manufacturing involves more than just processing of raw materials. The overall manufacturing system starts from the market or specifically from the customer requirements and ends when the product reaches the hands of customers. The present day trends also look beyond the delivery of the product to the customer i.e. after sale, services offered by the organization. The basic model at Fig. 1.1.2 is further expanded to incorporate most of the functions involved in an organization for the design, planning and manufacturing of a product. The manufacturing system incorporating all the above aspects (holistic approach).

Design: Consumer's Perspective

The product must be designed to meet the requirement of the end-customer. It must be designed 'right' the first time and 'every time' and while designing all aspects of customer expectations must be incorporated into the product.

Manufacturing: Manufacturer's Perspective

The product must be manufactured exactly as designed. The activities involved at this stage include: defect finding, defect prevention, defect analysis, and rectification. The difficulties encountered at the manufacturing stage must be conveyed to the designers for modification in design, if any. The two-way communication between design and manufacturing can help to improve the quality of the product to a great extent, as different issues such as practical difficulties, achievable tolerances and process capabilities will be addressed.

Performance of the manufactured product

The product must function as per the expectations of the end customer. The two way communication between designers and customer is the key to have a high quality product.

Manufacturing Process Selection Criteria

The following points need to be considered before the actual manufacturing of a product. • Material selection including and considering all the environmental and recycling aspects • Selection of processing methods such as metal casting, metal forming, sheet metal working, powder metallurgy, machining, joining, finishing etc. • Shape and appearance of the final product • Dimensional tolerance and surface finish aspects of the final product • Economics of tooling • Design requirements • Functional requirements of the product • Production quantity required • Safety and environmental concerns • Cost Product design is the most important parameter amongst all the parameters of the manufacturing system. As quality is imbibed at each stage in the product, if the product has not been designed right at the first stage, no subsequent operation or steps can bring back the quality into the product. Hence, the material and manufacturing process selection and all associated concerns such as availability, environmental considerations, recycling etc must be taken care of right at the product design and development stage. As far as the manufacturing process is concerned, it must be economical and capable of producing the geometric surfaces and other features which are embodied in the design of the product.

Manufacturing Processes Classification

There are six basic / fundamental classifications of manufacturing processes.

1. Metal casting or Molding: expendable mold and permanent mold
2. Metal Forming and Shearing: rolling, forging, extrusion, drawing, sheet forming, powder metallurgy
3. Material Removal Processes / Machining Processes: turning, boring, drilling, milling, planing, shaping, broaching, grinding, ultrasonic machining, chemical machining, electrical discharge machining (EDM), Abrasive flow machining (AFM), abrasive jet machining (AJM), electrochemical machining, high-energy beam machining, laser beam machining (LBM) etc.
4. Joining: welding, brazing, soldering, diffusion bonding, adhesive bonding, mechanical joining, plasma arc, plasma MIG, projection welding, ultrasonic, electron beam welding, laser welding etc.
5. Finishing (painting, anti-corrosion coatings, etc.)
6. Rapid Manufacturing: stereo-lithography, selective laser sintering, fused deposition modeling, three dimensional printing, laminated object manufacturing, laser engineered net shaping.

Automation

Automation^[1] or **automatic control**, is the use of various **control systems** for operating equipment such as machinery, processes in factories, boilers and heat treating ovens, switching on telephone networks, steering and stabilization of ships, aircraft and other applications and vehicles with minimal or reduced human intervention. Some processes have been completely automated.

The biggest benefit of automation is that it saves labor; however, it is also used to save energy and materials and to improve quality, accuracy and precision.

The term *automation*, inspired by the earlier word *automatic* (coming from *automaton*), was not widely used before 1947, when Ford established an automation department.^[1] It was during this

time that industry was rapidly adopting [feedback controllers](#), which were introduced in the 1930s.^[2]

Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic devices and computers, usually in combination. Complicated systems, such as modern factories, airplanes and ships typically use all these combined techniques.