MECHATRONICS

Chapter-1

Definition

Mechatronics is a multidisciplinary branch of engineering that focuses on the engineering of both electrical and mechanical systems and also includes a combination of robotics, electronics, computer, telecommunications systems and product engineering.

Originally, the field of mechatronics was intended to be nothing more than a combination of mechanics and electronics, hence the name being a portmanteau of **mecha**nics and elec**tronics**; however, as the complexity of technical systems continued to evolve, the definition had been broadened to include more technical areas.

Advantages of Mechatronics

- It is cost effective and it can produce high quality products.
- It serves effectively for high dimensional accuracy requirements.
- It provides high degree of flexibility to modify or redesign the systems.
- It provides excellent performance characteristics.
- It Results in automation in production, assembly and quality control.
- Mechatronic systems provide the increased productivity in manufacturing organization.
- It has greater extend of machine utilization.
- Higher life is expected by proper maintenance and timely diagnosis of the fault.

Disadvantages of Mechatronics

- The initial cost is high.
- Maintenance and repair may workout costly.
- Multi-disciplinary engineering background is required to design and implementation.
- It needs highly trained workers to operate.
- Techno-economic estimation has to be done carefully in the selection of mechatronic system.
- It has complexity in identification and correction of problems in the systems.

Mechatronics Applications

1. Home appliances (e.g. washing machines): Many of the home appliances that are in use today are Mechatronics systems. They are manufactured in large numbers and typically require small controllers to be "embedded" within them.

2. Anti lock Braking System (ABS), Engine control unit in Automotives

3. Elevators, Escalators -They have many sensors to detect the position and speed of the elevator car, as well as any calls registered by the passengers. It has many actuators, the most important of which is the main hoist motor. Safety is also paramount in these systems as they carry human beings.

4. Mobile robots and manipulator arms

5. Sorting and packaging systems in production lines

6. Computer Numerically Control (CNC) production machines

7. Aero planes and helicopters: These are complex examples of Mechatronics systems

8. Tank fluid level and temperature control systems

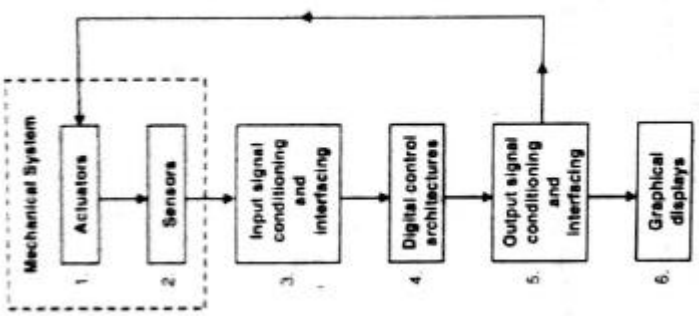
9. Temperature control system in an industrial oven

10. Heat-seeking missiles

11. Using robots for painting windows and doors

Components of Mechatronics System

The term mechatronics system (sometimes referred to as smart device) encompasses a myriad of devices and systems. Increasingly, microcontrollers are embedded in the elctro-mechanical devices, creating much more flexibility and control possibilities in system design.



- **Actuators:** produce motion or cause some action. Solenoids, voice calls, DCmotors, Stepper motor, servomotor, hydraulic, pneumatic.
- **Sensors:** detect the state of the system parameters, inputs and outputs. Switches, potentiometer, photoelctrics, digital encoder, strain gauge, thermocouple, accelerometer etc.
- **Input/output Signal conditioning and interfacing**: provide connection between the control system circuits and the input/output devices. Discrete circuits,amplifiers, filters, A/D, D/A, power transistor etc.

- **Digital devices**: controls the system. Logic circuits, micro controller, SBC, PLC etc

- **Graphic Display**: provide visual feed back to users. LEDs, Digital Displays, LCD,CRT

Importance of Mechatronics in automation

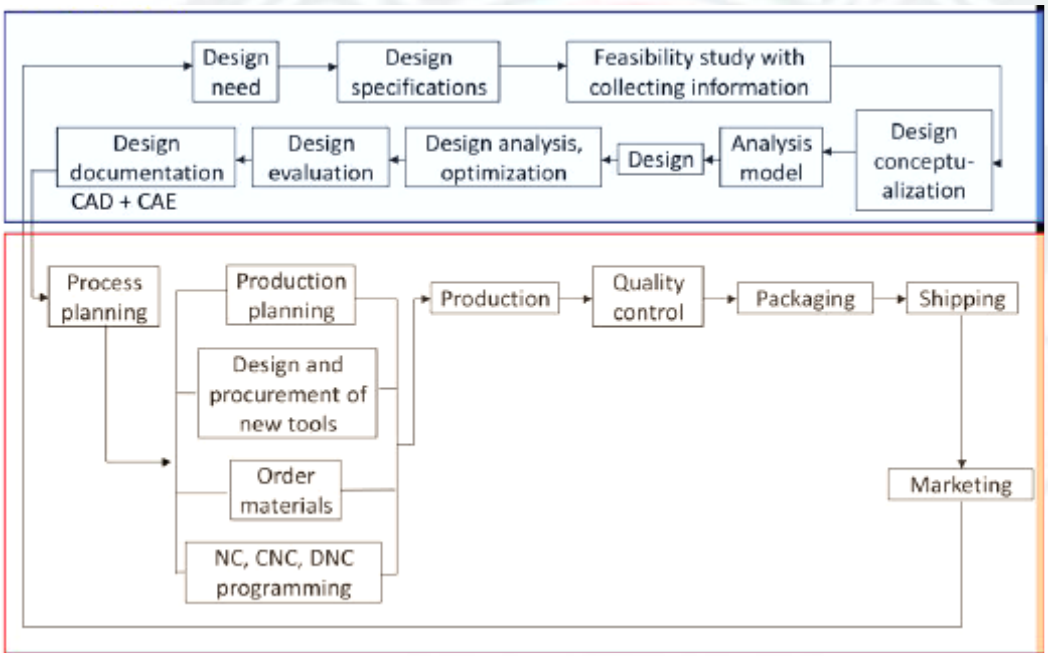


Fig.1-Operations involved in design and manufacturing of a product

Today's customers are demanding more variety and higher levels of flexibility in the products. Due to these demands and competition in the market, manufacturers are thriving to launch new/modified products to survive. It is reducing the product life as well as lead-time to manufacture a product. It is therefore essential to automate the manufacturing and assembly operations of a product. There are various activities involved in the product manufacturing process. These are shown in figure 1. These activities can be classified into two groups viz. design and manufacturing activities. Mechatronics concurrently employs the disciplines of mechanical, electrical,control and computer engineering at the stage of design itself. Mechanical discipline is employed in terms of various machines and mechanisms, where as electrical engineering as various electric prime movers viz. AC/DC, servo motors and other systems is used. Control engineering helps in the development of various electronics-based

control systems to enhance or replace the mechanics of the mechanical systems. Computers are widely used to write various softwares to control the control systems; product design and development activities; materials and manufacturing resource planning, record keeping, market survey, and other sales related activities. Using computer aided design (CAD) / computer aided analysis (CAE) tools, three-dimensional models of products can easily be developed. These models can then be analyzed and can be simulated to study their performances using numerical tools. These numerical tools are being continuously updated or enriched with the real-life performances of the similar kind of products.

These exercises provide an approximate idea about performance of the product/system to the design team at the early stage of the product development. Based on the simulation studies, the designs can be modified to achieve better performances. During the conventional design manufacturing process, the design assessment is generally carried out after the production of first lot of the products. This consumes a lot of time, which leads to longer (in months/years) product development lead-time.

Use of CAD–CAE tools saves significant time in comparison with that required in the conventional sequential design process. CAD-CAE generated final designs are then sent to the production and process planning section. Mechatronics based systems such as computer aided manufacturing (CAM): automatic process planning, automatic part programming, manufacturing resource planning, etc. uses the design data provided by the design team. Based these inputs, various activities will then be planned to achieve the manufacturing targets in terms of quality and quantity with in a stipulated time frame.

Mechatronics based automated systems such as automatic inspection and quality assurance, automatic packaging, record making, and automatic dispatch help to expedite the entire manufacturing operation. These systems certainly ensure a supply better quality, well packed and reliable products in the market.

Automation in the machine tools has reduced the human intervention in the machining operation and improved the process efficiency and product quality. Therefore, it is important to study the principles of Mechatronics and to learn how to apply them in the automation of a manufacturing system.