RESEARCHERID
THOMSON REUTERS

[Khushbu, 6(6): June 2019] ISSN 2348 – 8034
IDSTM-2019 Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

MECHATRONICS IN TODAY'S ENGINEERING WORLD RESEARCH ARTICLE

Khushbu[1] & Mehul Pruthi[2]

[1]M.Tech Student, ME Dept., SET, GTC, Solda , Bahadurgarh, Haryana, India
[2]M.Tech Student, ME Dept., SET, GTC, Solda, Bahadurgarh, Haryana, India

ABSTRACT

Mechatronics systems have been one of the most advanced subjects in mechanical engineering and design in recent years, and finding various applications in a wide range of today's modern time. This article presents the brief overview and basics of the mechatronics system. Also, focuses on the most recent development in the mechatronics system that has been made in last few years. The architecture and key elements of the mechatronics system along with basic principal elements and applications have been discussed and presented. This article also presents the overall existing and present scenario of the mechatronics system in design to its present applications.

Keywords*: Mechatronics, Elements, Machines, Engineering, Production.*

I. INTRODUCTION

The Yasakawa Electric Company in Japan coined the word "mechatronics" in 1969. In the 1970s and 1980s, research and development activities made way for the growth and evolution of mechatronics ("Introduction to Mechatronics", n.d.). Yasakawa can be defined the application of electronics and computer technology to control the motions of mechanical systems. It is a multidisciplinary approach to product and manufacturing system design. It involves application of electrical, mechanical, control and computer engineering to develop products, processes and systems with greater flexibility, ease in redesign and ability of reprogramming as shown in figure 1. It concurrently includes all these disciplines (Joshi, n.d.). In other word, mechatronics is the branch of engineering which deals with the integration of the mechanical engineering, electronics engineering and control engineering. We found mechatronics everywhere around us, from medical instruments, robots, washing machines ("Introduction to Mechatronics", n.d.).

ISSN 2348 – 8034
Impact Factor- 5.070

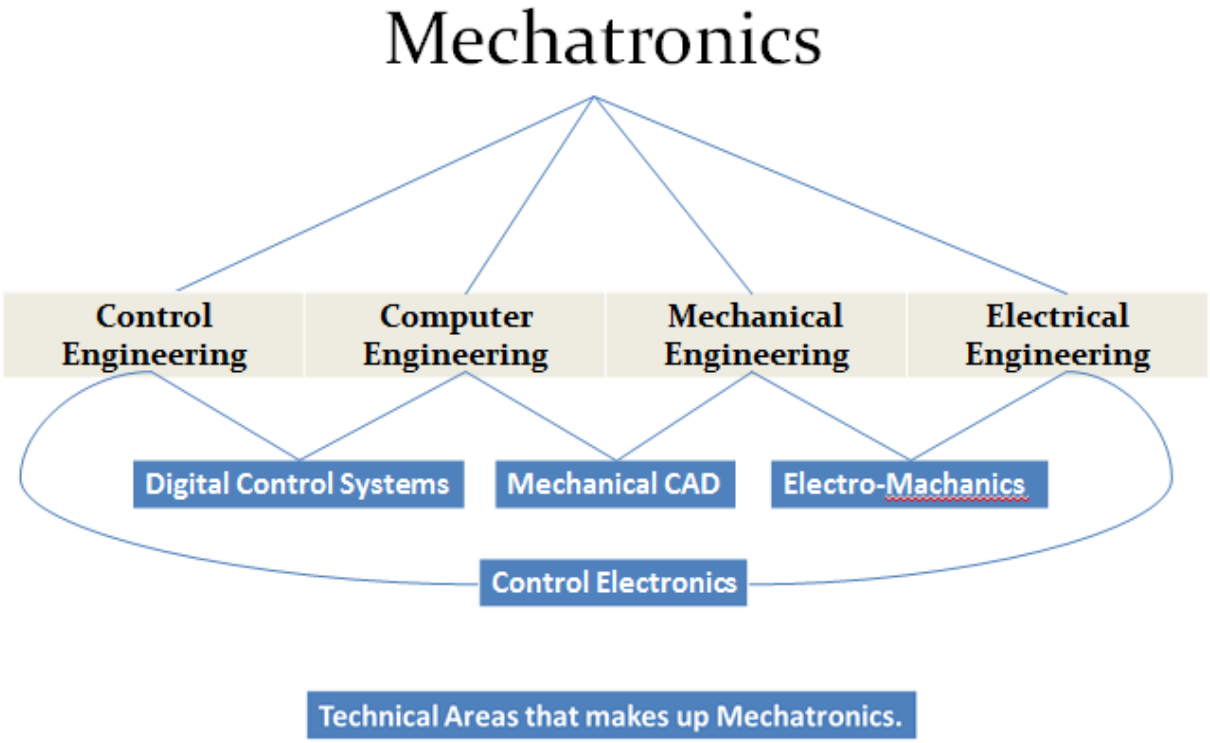

Figure-1: Technical areas that makes up mechatronics

II. PRINCIPAL ELEMENTS OF MECHATRONIC SYSTEMS

Mechanical: Mechanical elements refer to mechanical structure, mechanism, thermo-fluid, and hydraulic aspects of a mechatronics system. The mechanical element may include static/dynamic characteristics and it interacts with its environment purposefully. The mechanical elements of mechatronics systems require physical power to produce motion, force, heat, etc as shown in figure 2.1.

Figure-2.1: Mechanical elements

Electro-Mechanical: Figure 2.2 shows Electromechanical elements refer to sensors and actuators. A variety of physical variables can be measured using sensors, e.g., light using photo-resistor, level and displacement using potentiometer, direction/tilt using magnetic sensor, sound using microphone, stress and pressure using strain gauge;

touch using micro-switch; temperature using thermistor and humidity using conductivity sensor. Actuators such as light emitting diode (LED), DC servomotor, stepper motor, relay, solenoid, speaker, shape memory alloy, electromagnet, and pump apply commanded action on the physical process. In recent years, IC-based sensing and actuation solutions have also become ubiquitous (e.g., digital-compass, -potentiometer, etc.).

Figure-2.2: Electro-Mechanical elements

Electrical/Electronic: Electrical elements refer to electrical components (e.g., resistor (R), capacitor (C), inductor (L), transformer, etc.), circuits, and analog signals as shown in figure 2.3. Electronic elements refer to analog/digital electronics, transistors, thyristors, opto-isolators, operational amplifiers, power electronics, and signal conditioning. The electrical/electronic elements are used to interface electro-mechanical sensors and actuators to the control interface hardware elements.

Figure-2.3: Electrical/Electronic elements

Control Interface/Computing Hardware: Control interface/computing hardware elements refer to analog-to-digital (A2D) converter, digital-to-analog (D2A) converter, digital input/output (I/O), counters, timers, microprocessor, microcontroller, data acquisition and control (DAC) board, and digital signal processing (DSP) board. The control interface hardware allows analog/digital interfacing, i.e., communication of sensor signal to the control computer and communication of control signal from the control computer to the actuator. From figure 2.4 the control computing hardware implements a control algorithm, which uses sensor measurements, to compute control actions to be applied by the actuator.

Figure-2.4: Control interface/Computing hardware

Computer: From figure 2.5 Computer elements refer to hardware/software utilized to perform computer-aided dynamic system analysis, optimization, design, and simulation; virtual instrumentation; rapid control prototyping; hardware-in-the-loop simulation; and PC-based data acquisition and control ("Element of Mechatronics", n.d.)

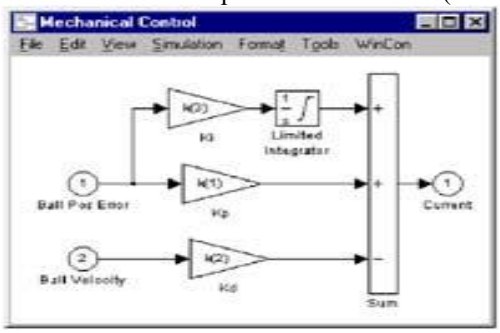

Figure-2.5: COMPUTER

III. KEY ELEMENTS OF MECHATRONICS

A. The need
B. Analysis of problem
C. Preparation of Specification
D. Generation of possible solutions
E. Selection of a suitable solution F. Production of a detailed design
G. Production of working drawings

The system architecture synthesis, system integration, optimization, selection of hardware and software of mechatronic systems design is one of the challenging problems. The design of mechatronic systems is a process that starts from the specification of requirements and progressively proceeds to perform a functional design and optimization that is gradually refined through a sequence of steps. Specification includes the performance requirements developed from systems functionality, operating envelope, affordability and other requirement (Bishop, 2013).

IV. IMPORTANCE OF MECHATRONICS IN AUTOMATION

Design Process

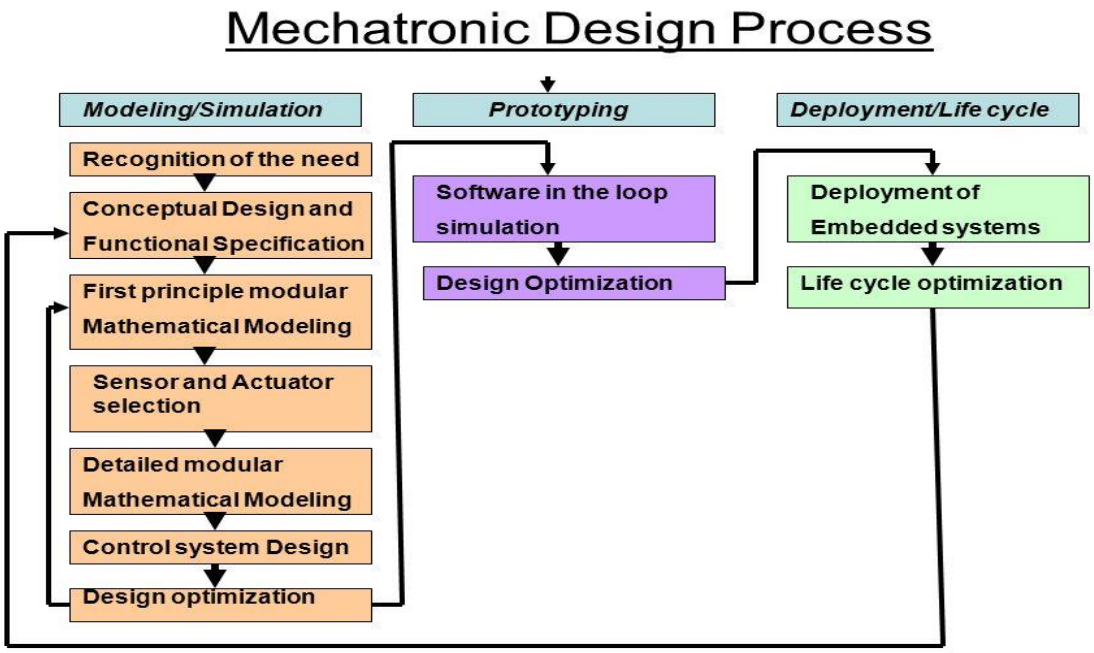

Figure-4: Mechatronic design process

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 4 .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 software 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.

V. THE ROLE OF MECHATRONICS IN ADVANCED MANUFACTURING

Below are some of its most notable uses and benefits:

- Saving time: An integrated production line is much faster in operation as compared to a system with different engineering concepts detached from each other. It saves a lot of time when products are imaged, sorted, measured, and recorded as they move in a belt as opposed to doing it in different stages and locations.
- Increase in output: A fast system means a good uptick in the production capacity. Mechatronics has made it easy to manufacture mass amounts of products.
- It's more cost-effective: When you have an automated production line at work, it means that you have used less manpower. That translates into savings in terms of labor costs. Besides that, an automated system is more efficient in operation, with less technical and input errors ("Application of Mechatronics in Advanced Manufacturing", n.d.).

VI. APPLICATIONS OF MECHATRONICS

Mechatronics has a variety of applications as products and systems in the area of 'manufacturing automation'. Some of these applications are as follows:

1. Computer numerical control (CNC) machines
2. Tool monitoring systems
3. Advanced manufacturing systems
   a.Flexible manufacturing system (FMS)
   b. Computer integrated manufacturing (CIM)
4. Industrial robots
5. Automatic inspection systems: machine vision systems
6. Automatic packaging systems ("MODULE 1: INTRODUCTION", 2013)

VII. CONCLUSION

The mechatronics system plays an outstanding role in the several fields of mechanical engineering. The conventional mechanical systems are not efficient to provide the precise solution. The mechatronics includes the synergistic combination of mechanical engineering, electronics, control systems, and computers and improves the performance of the mechanical design. In this article overview and basic characteristics of mechatronic systems has been presented with use in several areas that has been made in last several years. Also, the key elements of a mechatronic system along with principal elements and with several applications in modern time.

VIII. FUTURE SCOPE

- Design and develop high tech systems and products that entail mechanization and eminence and performance.
- Designing, assembling, testing, and evaluating components and products so that the working becomes more efficient.

REFERENCES

1. *Introduction to Mechatronics. Retrieved February 3, 2019, from https://pdfs.semanticscholar.org/5ff5/cf5a34139391530977de4b915cf85c58433b.pdf.*
2. *Joshi, S.N. Module 1 Introduction. Retrieved February 1, 2019, from https://nptel.ac.in/courses/112103174/pdf/mod1.pdf.*
3. *Introduction to Mechatronics. Retrieved February 2, 2019, from https://pdfs.semanticscholar.org/5ff5/cf5a34139391530977de4b915cf85c58433b.pdf.*
4. *Element of Mechatronics. Retrieved February 1, 2019, from http://engineering.nyu.edu/mechatronics/Description/elements.htm.*
5. *Bishop, R.H. (2013, February 9). The Mechatronics Handbook. Retrieved 2 February, 2019, from https://www.twirpx.com/file/1054593/.*
6. *Application of Mechatronics in Advanced Manufacturing. Retrieved February 2, 2019, from https://www.ecpi.edu/blog/application-of-mechatronics-in-advanced-manufacturing.*
7. *(2013, September 26). MODULE 1: INTRODUCTION. Retrieved 3 February, 2019, from https://nptel.ac.in/courses/112103174/2.*