Mechatronics: Concept & Components

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ME 475: Mechatronics

Tentative Lecture Schedule

Topic	No. of Lecture
Mechatronics Introduction	1
Electronics Circuits & Components	2
Semiconductor Electronics	2
Digital Electronics	3
System Response	4
Control Systems & Controller Basics	4
Robotics & Machine Vision	3
Sensors	2
Actuators	4
μ-processors, μ-controllers & PLCs	4
Signals, Data acquisition & Communications	3

References

- M.B. Histand & D.G. Alciatore, *Introduction to Mechatronics & Measurement Systems*, McGraw-Hill, Inc.
- S. Centinkunt, *Mechatronics*, J. Wiley & Sons, Inc.
- C.T. Kilian, *Modern Control Technology*, Thomson Delmar Learning.

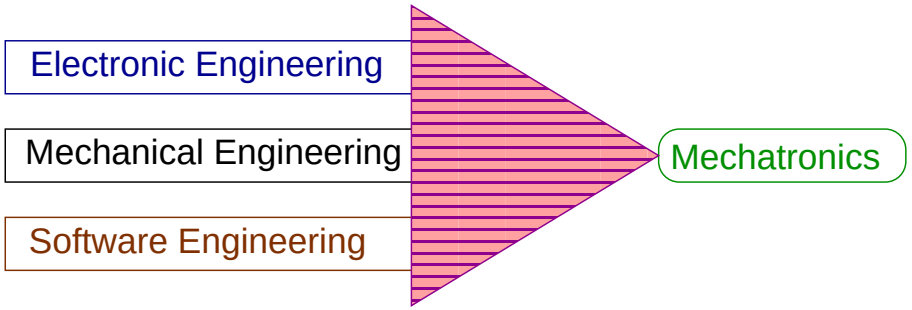
Mechatronics

- The portmanteau **Mechatronics** was first coined by Mr. Tetsuro Mori, a senior engineer of the Japanese company Yaskawa, in 1969.
- Mechatronics is the synergistic combination of precision mechanical engineering, electronic control and systems thinking in the design of products and manufacturing processes [1].
- Mechatronics is a *methodology*[2] used for the optimal design of electromechanical products.

[1] *IEEE/ASME Transactions on Mechatronics*

[2] a methodology is a collection of practises, procedures, and rules used by those who work in a particular branch of knowledge.

Mechatronics Constituents



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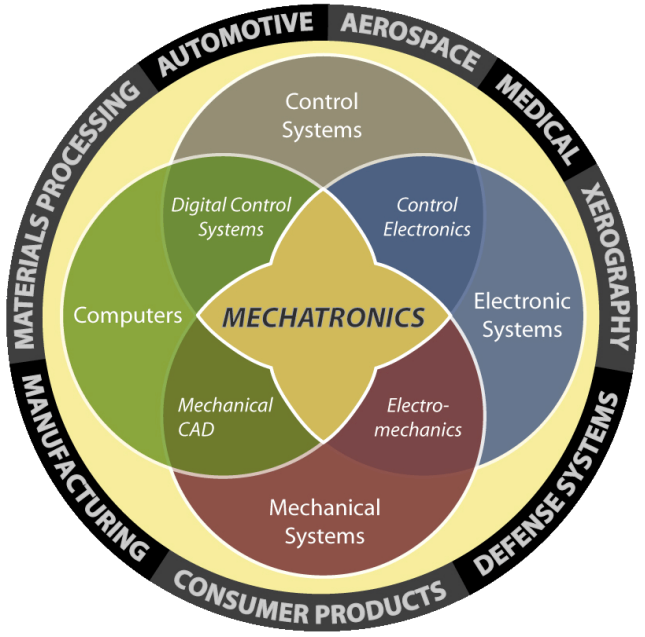

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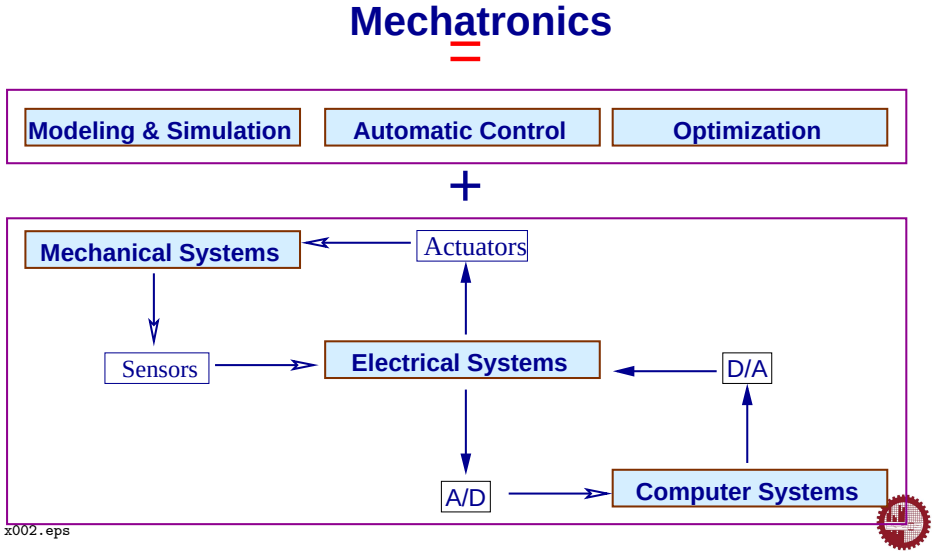
Mechatronics Key Elements



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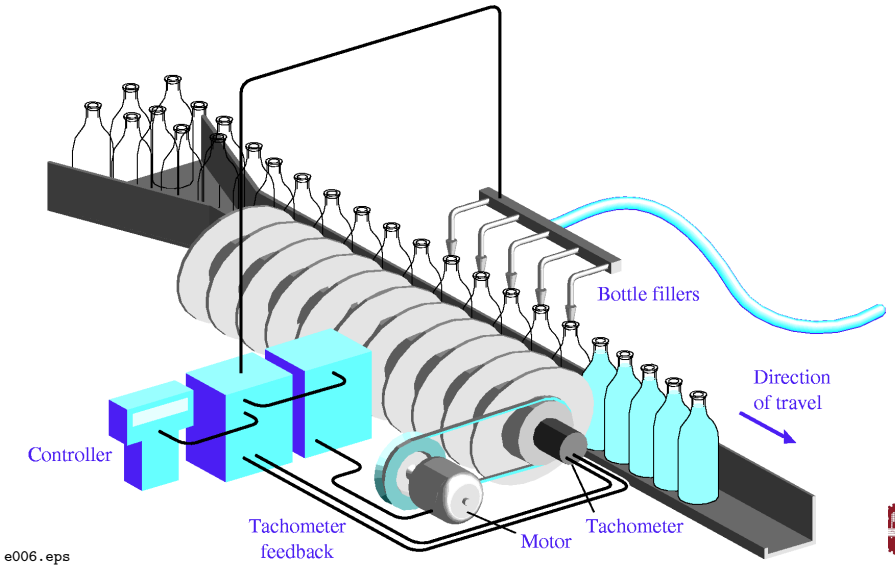
Simulation and Modelling

- **Modelling** is the process of representing the behaviour of a real system by a collection of mathematical equations and logic.
- **Simulation** is the process of solving the model and is performed on computer.
- Simulation process has the three basic steps:
  1. Initialisation
  2. Iteration
  3. Termination.

Industrial Control Application



Optimisation

- In mechatronics, optimisation is primarily used to establish the optimal system configuration. It solves the problem of distributing limiting resources throughout a system such that the pre-specified aspects of its behaviour is satisfied.
- In general, resources are referred to as **design variables**, aspects of system behaviour as **objectives**, and system governing relationships (equations and logic) as **constrains**.
- Example - for a box-shaped luggage to maximise volume:

  Design variables: L (length), W (width), H (height)
  Objective: Maximise V = V(L,W,H)
  Constraints: System relationship V = LHW

Integrated Design Issues in Mechatronics

- Mechatronics approach is intended to cause the developers, from the outset, to consider all elements of the product life-cycle from conception through disposal, including quality, cost, schedule, and user requirements.
- Important life cycle factors are:
  - Delivery - time, cost and medium
  - Reliability - failure rate, materials and tolerances
  - Maintainability - modular design
  - Serviceability - on board diagnostics, prognostics and modular design
  - Upgradability - future compatibility with current design
  - Disposability - recycling and disposal of hazardous material.

Automation in Production Systems

- **Automation** is the technology concerned with the application of mechanical, electronic and computer based systems to operate and control production.
- The **production system** is the collection of people, equipment, an procedures organised to accomplish the manufacturing activities of a company.
- Production system can be divided into two categories:
  - **Facilities:-** factory, equipment and their organisation.
  - **Manufacturing Support Systems:-** procedures to manage production and solve the logistic and technical problems encountered in ordering materials, moving work through the factory, and ensuring the product quality.

Reasons for Automation in Production System

- To increase labour productivity
- To reduce labour cost
- To mitigate the effects of labour shortage
- To reduce or eliminate routine manual or clerical tasks
- To improve worker safety
- To improve product quality
- To reduce manufacturing lead time
- To accomplish processes that cannot be done manually

Manual Labour in Factory Operations & Manufacturing

A number of situations in which manual labour is usually preferred over automation:

- Task is technologically difficult to automate
- Short product life cycle
- Customised product
- To cope with the ups and downs in demand

Even if all the manufacturing systems in the factory are automated, there will still be a need for the following kinds of work to be performed

- Equipment maintenance
- Programming and computer operation
- Engineering project work
- Plant management

USA Strategy for Automation

1. **Understand** the existing process
2. **Simplify** the process
3. **Automate** the process

Where is all these leading to?

- Reduced engineering design cost
- Decrease overall lead time
- Increase productivity of manufacturing operations
- Reduced work in progress.