# FACTFILE:
# GCSE
# Engineering and Manufacturing
## 3.3.5 Systems in Engineering and Manufacturing – Mechatronics

Rewarding Learning

## Systems in Engineering and Manufacturing – Mechatronics

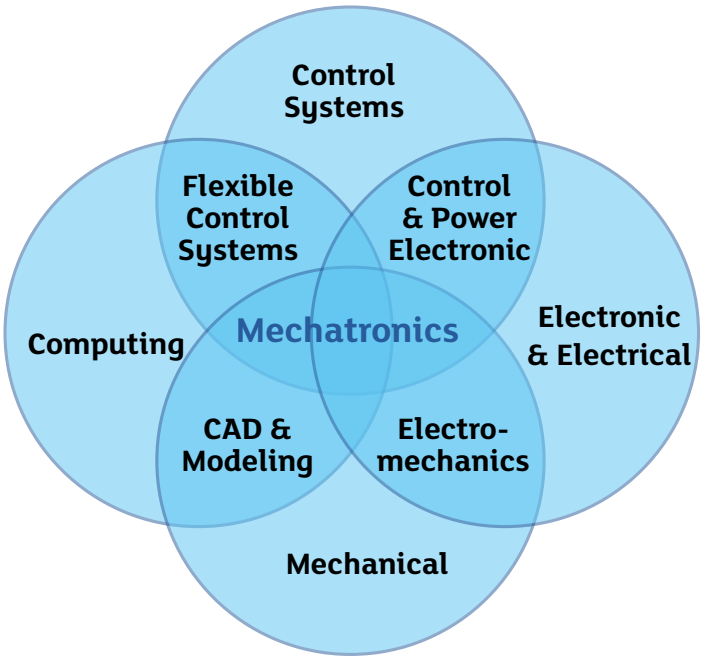
### Learning outcomes

Students should be able to:

- explain the term mechatronics and discuss the use of mechatronics in industry; and
- demonstrate knowledge and understanding of pick and place machines in engineering.

Mechatronics combines mechanical and electrical engineering and computer science in an interdisciplinary area of engineering.

Mechatronics has become an evolutionary and revolutionary design development that demands integration among the various engineering disciplines as well as between the design and manufacturing process. It is primarily driven by the needs of industry and human beings.



The following are examples of mechatronic systems:

**Home appliances**

Many home appliances, e.g. washing machines and heating systems, that are in use today are mechatronic systems. They are manufactured in large numbers and typically require small controllers to be embedded within them.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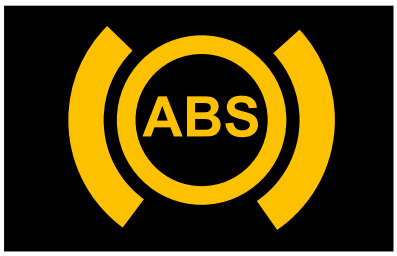
A wash cycle program is a typical example of such control.

**Automotive engineering**

An anti-lock braking system (ABS), on a vehicle uses wheel speed sensors to determine if one or more wheels are trying to lock up during braking. If a wheel tries to lock up, a series of hydraulic valves limit or reduce the braking on that wheel. This prevents skidding and allows you to maintain steering control. This improves braking control and is a vital safety feature of modern vehicles.




**Computer Numerically Control (CNC) production machines**

CNC machines are critical in modern manufacturing systems. They allow the user to produce a product directly from a computer model of the piece. This improves quality, efficiency of production at a reduced cost to the manufacturer.

All the cutting processes that are to be carried out and all the final dimensions are fed into the computer via the program. The computer knows what exactly is to be done and carries out all the cutting processes. CNC machine works like a robot, it has to be fed with instructions which it then follows.

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**Mobile robots and manipulator arms**

Robots are widely used today in all spheres of life and particularly in industrial manufacturing. Robots are generally used for applications that are dull (repetitive and tedious tasks), or inaccessible (difficult locations to get to due to height or space), or dangerous or hazardous environments.



A typical robotic arm is made up of several metal segments, connected by joints. Each joint has an individual stepper motor. The computer controls the robot by rotating the stepper motors connected to each joint. These arms use hydraulics or pneumatics to control the movements.

**Sorting and packaging systems in production lines**

Mechatronic systems are effectively the basis for modern factory automation from food packaging through to selection of online shopping purchases.

**Airplanes**

There are complex examples of mechatronic systems that incorporate hundreds or even thousands of smaller sub-mechatronic systems on today's airline fleets which enable the pilots to safely fly these complex machines.



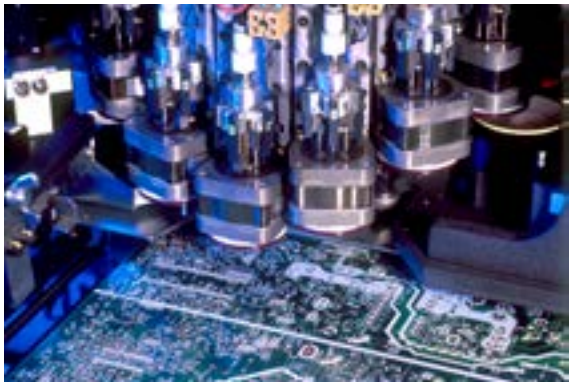
**Lift systems**

Lift systems present good examples of mechatronic systems. They have many sensors to detect the position and speed of the lift, as well as any requests 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 people and goods.

**Pick and place machines in engineering**

Pick and place machines or P and Ps, are robotic machines which are were initially used to place surface-mount devices (SMDs) onto a printed circuit board (PCB). These component placement systems use SMT (surface mount technology), and are used for high speed, high precision placing of a broad range of electronic components onto the PCBs. These in turn are used in computers, consumer electronics as well as industrial, automotive, medical, telecommunications and military equipment. Today this pick and place technology can be found across the whole spectrum of industrial manufacturing.







This technology first appeared back over thirty years ago, and at that time, a SMT assembly line employed two different types of pick and place (P and P) machines. These machines were built around a single turret design. They could place up to 50,000 parts per hour. From the high speed machine, the board transfers to a precision placement machine which uses high resolution verification cameras and fine adjustment systems to place parts more accurately than the high-speed machines. However, many electronic component machine manufacturers abandoned the technique because of the inflexibility of the machines. Around fifteen years ago there was a move to an all-in-one modular, multi-headed, and multi-gantry machines. Some machines were capable of placing the whole spectrum of components at speeds up to 136,000 components an hour.

Pick and place machines are used in many different manufacturing situations. For example, the packaging industry has been revolutionized by the introduction of such technology.

In this industry pick and place machines are a fully automated, high-speed method of packaging wrapped products for shipment. The system uses visual sensors to identify individual items, and a mechanical arm to pick out the item and place it into a box.

Pick and place machines remove the human error from the packaging process and can improve quality control by only selecting properly formed products for packing and ignoring any defective items. The system is highly adaptive, and is capable of picking out items from an irregular flow of product, then properly orientating them so they are packed correctly.

**Key advantages**

High Speed
The system can visually pick out and place specific items from a mix of irregular packages quickly and without error.

Fully Automated
The pick and place machine is fully automated and greatly reduces the manual labour required in a packing operation.

Multi Format
The system can pick out different types of objects and place them into a range of packaging patterns simultaneously.

## Revision Questions

1. Identify and list the control systems that combine to create a mechatronic system.

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2. What is meant by an interdisciplinary approach to manufacturing?

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3. Select a household device that has a control process and outline its operation.

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4. Describe how the use of CNC manufacturing processes would benefit the manufacturer.

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5. Select **one** of the advantages of using pick and place machines in manufacturing and describe the benefits for the manufacturer.

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6. Describe how using a mechatronic approach to manufacture can have an impact on industrial production methods.

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## Additional resources:

- www.engineersgarage.com/articles/mechatronics
- https://www.freestudy.co.uk/mechatronics
- www.innovateus.net/science/what-are-examples-mechatronics-design
- http://www.rethinkrobotics.com
- https://www.robots.com
- https://www.youtube.com/watch?v=BepAMlrJwXI
- https://youtu.be/QmDR29YNKqc
- https://www.youtube.com/watch?v=S8qkaTsr2_o
- http://www.goughengineering.com/en/gough-equipment/automated-packaging-systems/pick-place-machines