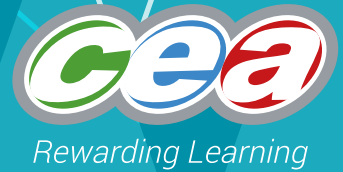


FACTFILE:

GCSE

Engineering and Manufacturing

3.3.6 New and Emerging Technologies



## New and Emerging Technologies

### Learning outcomes

Students should be able to:

- discuss the impact of new and emerging technologies in relation to:
  - the workforce;
  - the efficiency of production methods;
  - the environment;
  - health and safety; and
  - sustainability.

### The workforce

In a recent report from the Government's Department for Business Innovation and Skills, Sir Mark Walport and Sir Richard Laphorne stated that "manufacturing in 2050 will look very different from today, and will be virtually unrecognisable from that of 30 years ago. Successful firms will be capable of rapidly adapting their physical and intellectual infrastructures to exploit changes in technology as manufacturing becomes faster and more responsive to changing global markets and closer to customers".

There has been a seismic shift in the way many of the products we use regularly are being manufactured. Computer controlled manufacturing has revolutionised the way these products are made. Modern factories are now full of robots and manufacturing has become automated. An industrial robot can execute an action very quickly and repeatedly with great precision. These robots can do this 24 hours a day, seven days a week without failures. In some modern factories the only people to be seen are a few engineers who are responsible for keeping the robots and other machinery running smoothly. This is very different to old factories, where everything was done manually by men and women.

The robots used in factories are very expensive and some factories have dozens of robots. This requires a huge financial investment by the manufacturer running into many millions of pounds. Why would a manufacturer spend so much money on these expensive machines?

There are a number of reasons that robots are used:

- robots are extremely accurate compared to humans so product precision and quality is high;
- robots can perform tasks more quickly than humans so more products can be made;
- robots can execute the same precise action repeatedly;
- robots can work continuously, 24/7 without a break; and
- robots can work in hazardous conditions.

With further development and expansion of CAD/CAM and CIM current approaches linked to preparation for full-time jobs will be insufficient. We have already seen the impact of automation on manufacturing jobs and are starting to see its impact spread to managerial and administrative jobs. As computers become more sophisticated, creative, and versatile, more jobs will be affected by technology and more positions made obsolete.

The future workforce will most likely be smaller in number and need to be armed with new skills to enable them to play a full part in future engineering and manufacturing projects. Successful firms will have a wider skills base, with highly qualified leaders and managers whose expertise combines both commercial and technical knowledge, typically in science, technology, engineering and mathematics.

## The efficiency of production methods

One major benefit of CAD/CAM and CIM for the manufacturer has been an increase in production efficiency in that there is:

- an increase in productivity,
  - production line running 24/7.
- a reduction in design costs,
  - CAD packages reduces the number of people in design team.
- reduction in manufacturing time,
- reduction in scrap material,
  - CAD packages can fully utilise raw materials.
- a reduction in the size of the workforce,
  - fewer shop floor workers required, leading to a reduction in total manufacturing costs.

Computer integrated manufacturing allows for all the operations in the production process to be controlled by computers, including the following:

- ordering of the necessary materials needed for the manufacturing process;
- determining the efficient method for manufacturing by calculating the costs and considering the production methods;
- computer aided manufacturing of the products with the help of computer numerical controllers;
- product assembly with the help of robots;
- quality controls at each phase of the development; and
- quality check and automated storage.

The introduction and development of these production methods has led to a greater efficiency in producing finished products in terms of manufacturing time and costs.

## The environment

Technology has improved our lives in many ways. But is it doing the same for the planet? The answer is probably yes and no.

The negatives of our technology filled world are complicated. For example, smart phones and tablets are making information more accessible, people more connected and careers more mobile than ever before. However, more than 250,000 mobile devices are discarded every day worldwide, sometimes just to enable an upgrade to the latest version of the device. Recycling programs exist but as few as 10% of phones are recycled, the rest are sent to waste.

On the positive side there are emerging technologies that have a positive net effect on the earth. Utility companies are experimenting with two-way digital communication technology that makes it possible to monitor consumption more accurately and to automate responsive power delivery, integrating renewable energy onto the grid. On a smaller scale, manufacturers are tapping into this smart grid as they build smarter appliances, being able to programme the more power-intensive functions to avoid peak power hours.

The need for smart technologies is increasing, whether it's the simple innovations such as the smart thermostat that helps people use less energy or the development of electric cars, which are less polluting, simply because the world's population is growing and non-renewable resources we have been dependent upon are limited.

How will we protect our environment in future years? Research and development of the techniques listed below could be vital to this success:

- Coal fired electricity generation becomes increasingly cleaner, with advanced technologies widely deployed as many existing coal power stations reach the end of their lives. Storage of imported natural gas extends available gas reserves, while imports of liquefied natural gas (LNG) grow;
- Increasing amounts of the carbon produced by fossil fuel power stations are securely deposited deep underground using carbon capture and storage (CCS) technologies;
- Renewable energy technologies such as offshore and onshore wind power, wave energy, tidal energy, biomass, combined heat and power (CHP) and solar energy see significantly greater take-up. Heat pumps become increasingly widespread as a means of meeting small-scale energy needs;
- Biofuels, electric vehicles and other emerging low-carbon technologies change the face of transport. Hydrogen starts to have an impact as an energy carrier, in the transport, domestic and other sectors.

## Health and safety

In industrial manufacturing the health and safety of the workforce has become a key issue over the past number of decades. The introduction of new manufacturing technologies has led to a reduction of risk to the manufacturing workers.

### Smart robots and autonomous machines

Smart robots are independent, self-correcting machines which are increasingly user-friendly and integrated with the human worker. These autonomous systems are used to:

- automate some part of a human task;
- transport items from one area to another;
- automate warehouse retrieval and storage;
- lift heavy items from place to place;
- assemble parts together to create things;
- join parts together using glue, or by welding; and
- work in hazardous conditions.

Some of these operations could pose serious risks to operators. In utilising autonomous machines to carry out these tasks the risk to the human operator is removed.

### Smart sensors

Smart sensors is a key technology. Sensor technologies provide information about a physical environment, in response to certain stimuli. Two major types of sensors are being deployed by manufacturers:

- actuated sensor; and
- non-actuated.

An actuated sensor is a device that converts an electrical signal to a physical output.

Non-actuated sensors including temperature sensors, vibration sensors, and soil moisture sensors, send information about the environment to a processing engine that can convert the physical parameter to an electrical output. This information is processed and can manage a working environment to ensure it is a safe environment for the operator.

## Sustainability

The Brundtland Report in 1987, defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Developments in engineering and manufacturing have a duty to adhere to this desire for sustainability which presents a number of challenges in a world with a growing demand for new products.

New challenges need new technologies to tackle them. There are promising technology trends that can help to deliver sustainable growth in the decades ahead as global population and material demands on the environment continue to grow rapidly. These are some of the technologies considered to have made breakthroughs and are close to large-scale deployment.

- **3-D printing and remote manufacturing**  
Three-dimensional printing allows the creation of solid structures from a digital computer file, which could revolutionise the economics of manufacturing if objects can be printed remotely. The process involves layers of material being deposited on top of each other in to create free-standing structures made from plastics, metal alloys or other materials.
- **Remote sensing**  
The increasingly widespread use of sensors that allow responses to external stimuli will continue to change the way we respond to the environment, particularly in the area of health. Examples include sensors that continually monitor bodily function, such as heart rate, blood oxygen and blood sugar levels, and if necessary, trigger a medical response such as insulin provision. Other examples include vehicle-to-vehicle sensing for improved safety on the road.
- **Fourth-generation reactors and nuclear-waste recycling**  
Current nuclear power reactors use only 1% of the potential energy available in uranium, leaving the rest radioactively contaminated as nuclear “waste”. While the technical challenge of geological disposal is manageable, the political challenge of nuclear waste seriously limits the appeal of this zero-carbon and highly scalable energy technology. Fourth generation technologies, including liquid metal-cooled fast reactors, are now being deployed in several countries.
- **Energy-efficient water purification**  
Water scarcity is a worsening ecological problem in many parts of the world. Where freshwater systems are over used or exhausted, desalination from the sea offers near-unlimited water but a considerable use of energy. Emerging technologies offer the potential for significantly higher energy efficiency in the purification of wastewater, potentially reducing energy consumption by 50% or more.
- **OnLine Electric Vehicles (OLEV)**  
Wireless technology can now deliver electric power to moving vehicles. In next generation electric cars, pick-up coil sets under the vehicle floor receive power remotely via an electromagnetic field broadcast from cables installed under the road. Online electric vehicles are currently undergoing road tests in Seoul, South Korea.

## Revision Questions

1. Give **three** reasons why an industrial robot is more productive than a human operator.

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2. Select **one** benefit of an industrial robot and describe how it improves the manufacturing process.

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3. What impact has the introduction of industrial robots had on the workforce?

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4. List **three** benefits of CAD/CAM in the production process.

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5. How have modern manufacturing processes benefitted the environment?

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6. How has the use of smart robots made the manufacturing environment safer?

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7. What is meant by 3-D printing?

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### Additional resources

<https://www.brookings.edu/wp-content/uploads/2016/06/robotwork>

<https://www.gov.uk/government/publications/future-of-manufacturing/future-of-manufacturing-a-new-era-of-opportunity-and-challenge-for-the-uk-summary-report>

<http://www.igcseict.info/theory>

<http://www.rethinkrobotics.com>

<https://www.robots.com>

<http://www.livescience.com/11334-top-10-emerging-environmental-technologies.html>

<http://www.hse.gov.uk/eet/assets/pdf/new-energy-economy>

<https://www.weforum.org/agenda/2013/02/top-10-emerging-technologies-for-2013/>

