Option Topic 2: Automated Manufacturing Systems
1. Characteristics of Automated Manufacturing Systems

1.1 – Outline
1.2 - AMS
1.3 – Direct Users
1.4 – Block Diagrams

- Characteristics of Automated Manufacturing System
- Examples of Automated Manufacturing Systems
- Collecting in Automated Manufacturing Systems
- Other Information Processes
- Issues Relating to Automated Manufacturing Systems
• **Automation** refers to the application of automatic control to industrial processes. These tasks were once completed by humans.
• Information Technology is driving innovation and development – as IT has increased so has Automation
• It began in the early 20th century and was made popular by Ford – producing the Model T
• Manufacturing is the process of producing a product that meets a specific need
1.1 - Questions

1. What tasks can Automation complete?
   1. Mass production
   2. Can be precise
      • Eg Painting
      • Fasten
      • Welding

2. What are some benefits of automation? (p195)
   – Cheaper for mass production
   – Precise
   – Repetitive
   – Can work 24/7

3. Name 5 objects in the room which are manufactured and name 1 that is not.
   1. Computer
   2. Chair
   3. Tables
   4. Projector
   5. Screen
1.2 – Automated Manufacturing Systems

- An AMS is an information system involved all areas of production including:
  - Inventory Tracking
  - Record Keeping
  - Production Scheduling
  - Production
1.2 – AMS Tasks

• To function correctly, an AMS must have the ability to perform 3 tasks:

1. Collecting
   • An input device such as a sensor is used.
   • Motion, Light, Temperature, Flow

2. Processing
   • Microprocessors are used to receive data from sensor and changes the information so it can be understood
   • Eg: Analog to digital converter

3. Performing
   • Actuators are used to carry out the work
   • Take a signal from the Controller and create physical motion
   • Accurate positioning is needed at each stage of the assembly line
1. List and explain each of the 4 areas an AMS is used
2. Why is scheduling so important in an AMS?
3. Research and explain the JIT system
1.3 – Direct Users

- Only a few people in an organisation are classed as direct users
  - Operators: Physically operate one or more machine on the assembly line
  - Supervisors: Ensure that production does not fall behind schedule
1.3 – Questions

1. What information is included in an AMS? (p189)
2. Explain the organisation structure of a manufacturing company. Include a basic diagram with at least 6 parts.
### 1.4 – Block Diagrams

A system is a group of elements that work together to achieve a purpose.

A block diagram is a diagram used to represent a system.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="External Input Symbol" /></td>
<td>External Input</td>
</tr>
<tr>
<td><img src="image" alt="System Symbol" /></td>
<td>System</td>
</tr>
<tr>
<td><img src="image" alt="External Output Symbol" /></td>
<td>External Output</td>
</tr>
<tr>
<td><img src="image" alt="External output/input Symbol" /></td>
<td>External output/input (When moving from one place to another)</td>
</tr>
</tbody>
</table>
1.4 – Block Diagrams

- Block diagrams play a key role in refining a system.
- Each part in the process is considered a subsystem, and a block diagram is created.

- Example – Subsystem: Making a Keyboard

![Block Diagram Example]
1. **Review Questions**

1. What is the purpose of a block diagram?
2. Explain 3 tasks performed by automated systems
3. Explain the difference between a sensor and actuator
4. List 3 common actuators
5. What is the role of accounting in manufacturing? What sort of information would the accounting department of a factory need?
6. How is a database used in an automated manufacturing system? Draw a simple data flow diagram to indicate the interaction between the customer and system
2. Examples of Automated Manufacturing Systems

2.1 – Assembly Line
2.2 – Automated Warehouses
2.3 – CAD/CAM
2.4 – Mail Sorting

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2.1 - Assembly Line

- Is a sequence (or line) of operations in which each process contributes to the final product.
- It is a continuous movement of equipment, parts and people.
- Each movement is as short and efficient as possible.
- Each workstation is designed to complete 1 specific task.
- Work is often carried out simultaneously. Eg. The engine and body are made at the same time on different assembly lines.
2.1 - Assembly Line - PLC

- Programmable Logic Controllers (PLC) are the main process control computers.
- They are attached to sensors and actuators and can be programmed to suit the purpose – extending the life of the machine.
2.1 - Assembly Line - PLC

- Are part of an Open Loop system – a system which does not includes sensors
- Are programmed to operate timing and sequence
2.1 – Case Study – Model T Ford

- Watch the video in the link and answer the questions below:
  - [http://www.youtube.com/watch?v=S4KrIMZpwCY](http://www.youtube.com/watch?v=S4KrIMZpwCY)

1. How much faster could Henry Ford build cars?
2. What colour could you order the car in? Why?
3. How are people, and their lives automated?
4. What parts of the assembly line are still manufactured by hand?
5. Create 3 block diagrams for various parts of the construction.
2.2 - Automated Warehouses

- Are storage centres where all the tasks relating to receiving, storing, recording and transferring goods automatically.

- Managers can easily determine
  - Stock level for each part
  - Sales
  - Capital tied up in stock
  - Space requirements
Automated warehouses are only possible through the use of Barcoding

- The barcode of all stock incoming and outgoing is scanned and recorded to a central database or inventory.
- The location of each part in the warehouse is also recorded.
- Machines, such as pallet lifts, forklifts, can be directed by the information given in barcodes.
  - Eg. A forklift may have a barcode scanner and could automatically sort boxes.
2.2 – Questions

1. Outline the benefits of an automated warehouse
2. Explain the role of barcoding in an automated warehouse
3. What role do people play in an automated warehouse? See the following link:

2.3 – CAD – Computer Aided Design

• The use of computers to design and create models of real world objects

• It is used to design everything from tools and machines, to cars, planes and buildings

• It is fast, efficient, cheap and allows for changes to be made quickly.

• Requires high powered computers to produce quality 3D models
2.3 –CAM – Computer Aided Manufacture

• Takes the 3D virtual model from the CAD program and creates a real 3D model.

• Numeric Control (NC) is the programming language used to control the position of the cutting bit.

• Incredibly accurate models produced very quickly.
2.3 – Questions

1. What are the benefits of using a CAD/CAM approach over a traditional method?
2. What are the three main types of NC code?

- Another form of CAM is 3D printing. Open the hyperlink the picture to answer the questions.
1. Give 3 benefits of this method
2. What is needed to create a model?
2.4 – Mail Sorting

- Almost all mail is now sorted automatically, through the use of OCR technology.
- All mail is scanned, and Optical Character Recognition is used to read and interpret the letters.
- Mail is then automatically sorted and forwarded to the correct location.
- The NP-8000 can sort up to 40000 letter per hour.
1. Modern cars have over 5000 individual parts. The Xbox 360 has over 1700 parts. Discuss how automation has impacted on these manufacture of ONE of these devices (3 paragraphs)
2. Exercise 6.2 Q 2, 9, 10, 12.
3. Learning Activities 1, 4
3. Collecting in Automated Manufacturing Systems

3.1 - Sensors
3.2 - Barcode Readers and Inventory Tracking
3.3 - Analog Digital Conversion
3.4 - Damping
3.1 – Sensors

- Are input devices that measure data from the environment.
- They convert one form of energy into another, and are sometimes called transducers.
- It is part of a closed loop system.
3.1 – Sensors – Types and Accuracy

- Sensor types include:
  - Flow
  - Temperature
  - Speed (Tachometer)
  - Pressure

- The quality of sensor is measured by a number of factors such as:
  - Accuracy
  - Resolution
  - Repeatability
  - Range
  - Dynamic Response
3.1 – Questions

- Work in pairs to create a small Website in Publisher which includes all of the sensors and information listed in pages 200-201
3.2 – Barcode Readers and Inventory

- Allows for fast automation of stock tracking and storage
- All numbers are stored in the companies inventory
- The inventory of a supermarket might include details such as: item cost, purchased date, size etc.
- The barcode standard consists of:
  - Country code
  - Product code
  - Digit Checksum – Used for error detection, it is the addition and multiplication of select numbers – see Pg 203.
3.2 – Questions

1. Using the information on pg 202, outline the role of an inventory in a supermarket.
2. What does the barcode reader actually see?
3. What sensor does a barcode reader use?
Most data collected by sensors must be converted to digital for it to work with computers.

ADC (Analog Digital Converter) takes an analog signal and electronically converts it to digital data.

Voltage output is directly related to the analog input. Eg. When the temperature increases, so does the output voltage.
3.3 – Questions

1. Why is it necessary to consider discrete quantities in the Analog-Digital process. (p.204)
3.4 – Damping

- Damping is the decrease in the amplitude of a wave. Eg a shock absorber.
- A shock absorber ensures that your car does not bounce down the road, or let every bump into the car.
- With robotics, it is important that the acceleration of each part is not severe, and occurs quickly.

A shock absorber is a type of damper.
3.4 – Damping – Types of Motion

Under damping:
Change occurs too fast, and the actuator overshoots the required position.

Over damping:
Change does not occur fast enough.

Critical damping:
The required position is achieved quickly with good stability.
3. – Questions

- What type of damping is preferable in a car? Explain
- Exercise 6.3: 1, 2, 8, 9
- Learning Activities: 1, 5 (Use information on pg.204)
4. Other Information Processes

4.1 - Processing
4.2 - Displaying
4.3 - Transmitting and Receiving

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4.1 – Processing – Mass Production

- Mass Production is the term given to the production of goods in large quantities at a small cost. It must have:
  - High volume using specialised equipment
  - Division of labour into small tasks
  - Standardisation of all repetitive tasks and processes
  - Planning of material flow through the process.

- Parts can be produced with low cost and small workforce
- Machines and tools are often inflexible and cannot be used for another purpose. Eg car body moulds.
4.1 – Processing – Mass production

Sheet metal:
Expensive to change tools
### 4.1 – Processing – 3 Types

<table>
<thead>
<tr>
<th>Description</th>
<th>Continuous</th>
<th>Batch</th>
<th>Discrete</th>
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<tr>
<td><strong>Description</strong></td>
<td>Operates 24/7 and never stops.</td>
<td>Set quantities are produced. The machine then moves onto the next task</td>
<td>Several processes carried out at each stage by a team. Highly labour intensive as hand tools are often used</td>
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<tr>
<td><strong>Application</strong></td>
<td>Paper production, Steel rolling, Chemical production, Concrete structures</td>
<td>Plastic and Metal cans</td>
<td>Luxury car manufacture, Satellites, Ships</td>
</tr>
</tbody>
</table>

**Continuous**
- Operates 24/7 and never stops.

**Batch**
- Set quantities are produced. The machine then moves onto the next task

**Discrete**
- Several processes carried out at each stage by a team. Highly labour intensive as hand tools are often used
4.1 – Questions

• Create a block diagram for the entire pen manufacturing process given in the picture link.
• This will require you to have an overall diagram, along with subsystems
4.2 - Displaying

• Actuators are used to “display” a mechanical action
• Common Actuators include:
  – Solenoids
  – Electric Motors
  – Stepping motors
  – Relays
  – Hydraulic Pumps
4.2 – Displaying - Solenoids

- A coil of wire around a magnet.
- When a current passes through the wire, the magnet can move in a set direction, pushing a shaft.
- The more current that passes through, the more movement.
- It can be used in valve openings.
• Direct Current (DC) are widely used in automated manufacture. They can:
  – Run continuously
  – Provide smooth motion
  – Develop a large amount of torque
  – Be highly precise
  – Reliable

4.2 – Displaying – Electric Motors

Electric Motor from the Honda Clarity
4.2 – Displaying – Stepper Motors

- Provide motion is steps
- Very useful for precise distances or angles, eg the PLC could tell the stepper motor to rotate to 130°
- Not powerful, therefore cannot be used in high load applications
4.2 – Displaying – Relays

- A switching device used to control a large electric current.
- It uses a solenoid to control the flow of current to the larger machine.
4.2 – Displaying – Hydraulic Pumps

- Used when great strength is needed (hydraulic fluids are incompressible)
- The fluid powers either the pump or actuator
- Power from the pump is transmitted through the fluid.

![Simple Hydraulic System](image_url)
4.2 – Questions

1. Give 3 applications for a solenoid
2. What are the benefits of a DC motor? Why are they so popular?
3. When is a stepper motor used?
4. What type of actuator would I use for lifting a car?
5. Explain why oil is normally used in a hydraulic system.
4.3 – Transmitting and Receiving

• The transfer of information must be through a signal. Signals are the electrical signals sent from machine to machine.
• Often a signal is corrupted, or include noise (unwanted data). Signal conditioning (filters) modifies the signal, removing unwanted noise
• Shielding a cable reduces noise and electromagnetic interference
4. – Questions

- Exercise 6.5: Q1, 2, 5, 8, 11
- Chapter Review
5. Issues Relating to Automated Manufacturing Systems

5.1 – Nature of Work
5.2 – Semi Automation
5.3 – Human Centred Systems
5.4 – Reliability and Quality
5.5 - Safety
5.1 – Nature of Work

- The introduction of machines has changed the role humans play. Jobs are shifting towards information technology rather than manual labour.
- Retrenched staff are sometimes retrained in machine operation.
- By effectively designing the automation process, repetition can be avoided.
- Employees can have different tasks to avoid boredom and repetition.
5.1 – Questions

1. The introduction of machines has led to unemployment. If you were the manager of a business, what would you do with unemployed staff? Explain

2. Other than redundancies, how has automation affected jobs?

3. Is it always possible to retrain staff? Why
Some tasks are performed by machines, other by humans.
Often humans are best suited to the job. Eg. When a car dashboard is fitted, a human completes the task.
This method is designed to use the skills of humans and machines to best complete the task.
Foxconn is the largest electronics manufacturer in China, making iPods, Xbox 360’s and PS3’s. Over the recent months there has been many suicides from factory workers.

Use the link in the picture to answer the questions:
1. Explain what a normal day is for a Foxconn worker
2. What is the monthly pay?
3. How many people work at the Foxconn factory?
5.2 – Questions

- The food industry uses semi-automation for its quality control. Why?
5.3 – Human Centred Systems

- Machine centred systems are designed to be efficient only for the operation of the machine. These are often hard to use, with complicated controls.

- Human Centred systems are designed for ease of use and allow users to work as efficiently as possible. This requires additional work and study to change from a machine centred system.
5.3 – Questions

- Why are human centred systems so important? What are the benefits?
• Automation allows for fast, efficient and accurate work. However, no machine is perfect all of the time.
• The reliability and quality must be monitored.
• When a machine is properly maintained, it should always produce the expected result.

• List all of the quality issues raising in the film clip.
5.4 – Questions

1. Why are reliability and quality important in an automated manufacturing systems?

2. What dangers are there in producing an unsafe motor vehicle?
5.5 – Safety

• The use of machines has **improved** safety in manufacturing by removing people from dangerous jobs.

• However care must be taken when designing machines and workshops to ensure that people are in a safe working environment. This can include:
  – PPE (glasses, earmuffs, clothing etc.)
  – Safety guards on machines
  – Markings on floor
  – Training
5. – Review Questions

• Give 2 examples of information systems in automation.
• Exercise 6.5: Q4, 9, 10
• Learning Activities: 1, 2
References

- Solenoid:  http://www.fwmurphy.co.uk/images/RP23xx_solenoid_medres.jpg
- PLC diagram:  http://1.bp.blogspot.com/__O36vLCsD3k/R9YHGFDq7tNI/AAAAAAAAACE/zU9uGmekPLM/s400/Clip_10.jpg
- Solidworks lift:  http://www.dasi-solutions.com/newsletterPages/images/fig1_lift1.jpg
- Sheet Metal:  http://www.supplierlist.com/photo_images/98767/SHEET_METAL_STAMPING_DIE_Metal_stamping_dies_Sheet.jpg