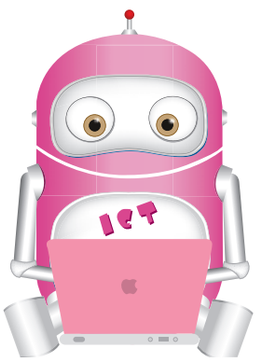
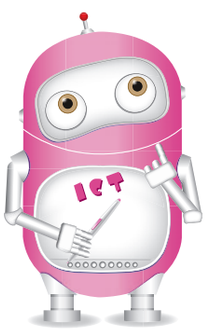
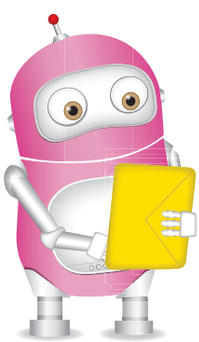






Module 5
Control for a Purpose

Learning Objectives

	Student is able to:	Pass/ Merit
1	Design a control system	P
2	Build a sequence of events to activate multiple devices concurrently	P
3	Correct and improve procedures	M
4	Evaluate the system, identifying limitations	M

5.1 Control devices

Learning Objective: Introduction

Control devices

- Examples of control devices:
  - fire alarm
  - traffic light
  - greenhouse
  - car-park barriers
  - burglar alarm
  - fridge-cooling system.
- Name 2 more common control systems or control devices:

  _____

  _____

Inputs and outputs

- Each control device is set to receive inputs directly or through sensors.
- The device will then process according to the inputs and the conditions set.
- The reaction is then reflected in the outputs.
- Examples of inputs: microphones, switches, sensors that detect changes, TV aerials, sound detectors and light detectors.
- Examples of processors: amplifiers, decision-making circuits, counters, timers.
- Examples of outputs: light bulbs, LEDs, loudspeakers, motors.

Identifying the devices

- Identify the input, processor and output devices of each system below (the first one is given as an example):
  - Fire alarm
    - Input: heat sensor
    - Processor: decision-making circuit
    - Output: sound (loudspeaker)
  - Traffic light
    - Input:
    - Processor:
    - Output:
  - Greenhouse
    - Input:
    - Processor:
    - Output:
  - Car-park barriers
    - Input:
    - Processor:
    - Output:
  - Burglar alarm
    - Input:
    - Processor:
    - Output:
  - Fridge-cooling system
    - Input:
    - Processor:
    - Output:
- Fill in the two control-device or control-system examples that you gave above:
  - _____
    - Input:
    - Processor:
    - Output:
  - _____
    - Input:
    - Processor:
    - Output:

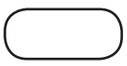
5.2 Flowcharts

Learning Objective: Introduction

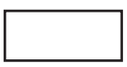
What are flowcharts?

- A process or work procedure can be illustrated by using flowcharts or graphical representations.
- Each step in a process is represented by a symbolic shape.
- The flow of the process is indicated by arrows connecting the symbols.
- Flowcharts are useful for displaying how a process functions or could ideally function.
- Flowcharts can help you see whether the steps of a process are logical.
- They can be used to uncover problems or miscommunications and to develop a common base of knowledge about a process.
- Flow-charting a process helps to avoid redundancies, delays, dead ends and indirect paths that would otherwise remain unnoticed or ignored.

Basic symbols


Oval

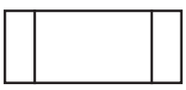
- An oval indicates both the starting point and the ending point of the process.


Box

- A box represents an individual step or activity in the process.

Flow line

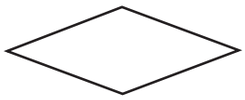
- This indicates the direction flow of the process.


Box

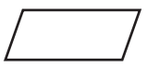
- A box with 2 side margins represents a subroutine.


Circle

- A circle indicates that a particular step is connected within the page. A numerical value placed in the circle indicates the sequence continuation.

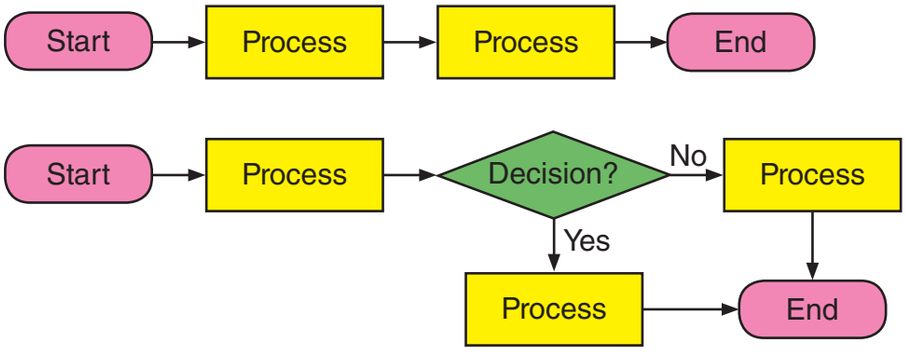

Diamond

- A diamond shows a decision point, such as yes/no or go/no-go. Each path emerging from the diamond must be labelled with one of the possible answers.


Rhombus

- A rhombus shows input or output devices.

Examples of flowcharts



5.3 Creating a working module

Learning Objective: 1

Design

- Design is the first of the 5 criteria for success in creating working module:
  - design
  - create
  - test
  - change
  - evaluate.
- Identify the function of the system, the inputs and the outputs.
- Collect evidence at each stage.
- Well-planned modules make it easier to test, change and evaluate the system.

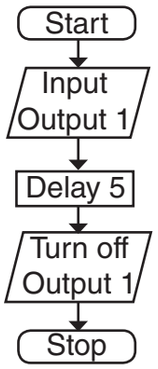
Zebra-crossing system

- Basically the system works as below:
  - The system turns on the light for the pedestrian to cross.
  - The light stays on for a few seconds.
  - The system turns off the light.
- The following shows the planning for creating the system.

Description of the event in ordinary words	Control words	Flowchart symbol
Begin the system.	Start	Start
Turn on the light.	Turn on Output 1	Input Output
Let the light stay on for 5 seconds.	Delay 5	Process
Turn off the light.	Turn off Output 1	Input Output
Stop the system.	Stop	Stop

Flowchart

- Draw the flowchart.
- The flowchart shown is only an example.
- Test the flowchart with appropriate simulation software such as Flowol or Learn & Go.
- You can draw the flowchart easily using the features and functions that come with these types of software.
- Software with special mimics makes the simulation more interesting.
- Save your work as zebra1.

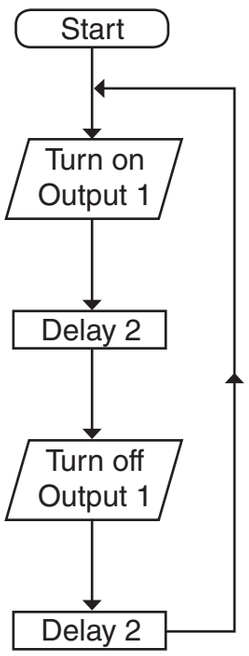


5.4 Looping

Learning Objective: 1

Looping and blinking

- The previous system stops until it is activated again.
- We can make the system blink by adding another delay and repeating the process.
- After the system is switched on, it will immediately trigger the light.
- The first delay will determine the duration for the light to stay on.
- The light is then turned off.
- The next delay will then determine the duration for the light to stay off.
- The loop – the line that leads the way back to the starting point – will repeat the whole system from the beginning.
- Make changes to your first flowchart.
- Test the new system again.
- Save your work as zebra2.



The lighthouse

- The blinking effect can be applied to a lighthouse.
- Simultaneously, the lighthouse can also give a second output: the buzzer.

Description of the event in ordinary words	Control words	Flowchart symbol
Begin the system.	Start	Start
Turn on the light and the buzzer.	Turn on output 1 and Output 2	Input Output
Let the light and buzzer stay on for 5 seconds.	Delay 5	Process
Turn off the light and the buzzer.	Turn off Output 1 and Output 2	Input Output
Let the light stay on for 5 seconds.	Delay 5	Process
Repeat the system.	Loop	(Lead the arrow back to the first Input/ Output box)

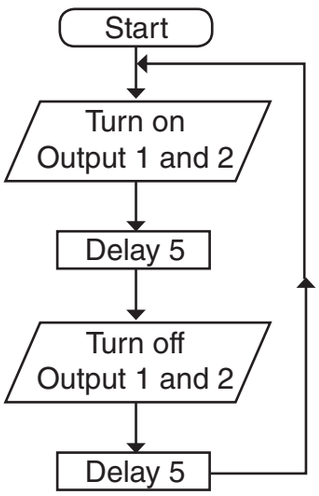
5.5 Input switch

Learning Objective: 1

Multiple inputs and outputs

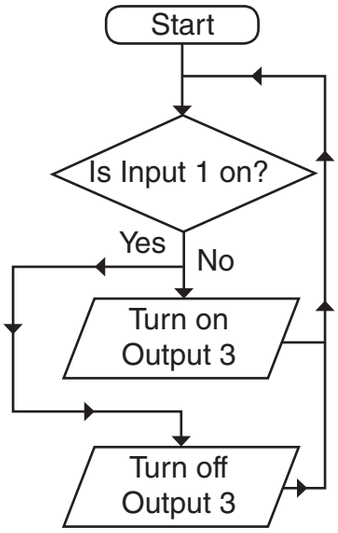
- Construct the flowchart.
- Some simulation software allows more than 2 inputs or outputs to be listed in the same symbol. (Check the manual for your software.)
- The inputs or outputs will be executed at the same time.
- Test your system.
- Save your work as lighthouse1.

Lighthouse



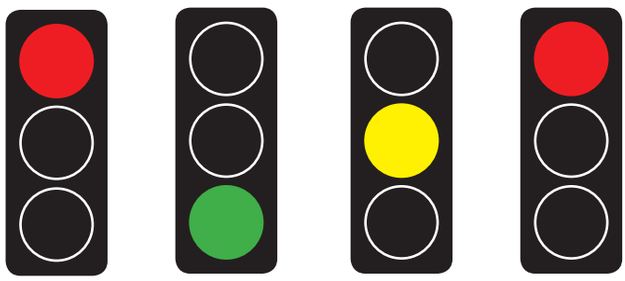
Input and decision

- The brightness (sun/moon) can be used as an input for deciding whether the internal light of the lighthouse needs to be switched on or not.
- If it is bright (sun), the decision will lead to switching the output (internal light) off.
- If it is dim (moon), the decision will lead to switching the output (internal light) on.
- Test your system.
- Save your work as lighthouse2.



Traffic lights

- At the start, the red light is switched on and stays on for 5 seconds.
- The green light is then switched on at the same time as the red light is switched off. The light stays on for another 5 seconds.
- The green light is then switched off while the yellow light is switched on simultaneously.
- The yellow light is allowed to stay on for 3 seconds before it is switched off while the red light is switched on. The process is then repeated.
- Based on the description above, construct the flowchart based on the contents of the table on the next page.



Red = STOP	Green = GO	Yellow = READY TO STOP	Red = STOP
Output 1	Output 2	Output 3	Output 1

5.6 Double sets of traffic lights

Learning Objective: 2

Traffic lights

- Make a flowchart of the system indicated by the table.

Description of the event in ordinary words	Control words	Flowchart symbol
Begin the system.	Start	Start
Turn on the red light.	Turn on output 1	Input Output
Let the red light stay on for 5 seconds.	Delay 5	Process
Turn off the red light and turn on the green light.	Turn off Output 1 and turn on Output 2	Input Output
Let the light stay on for 5 seconds.	Delay 5	Process
Turn off the green light and turn on the yellow light.	Turn off Output 2 and turn on Output 3	Input Output
Let the light stay on for 3 seconds.	Delay 3	Process
Repeat the system.	Loop	(Lead the arrow back to the first Input/ Output box)

Flowchart

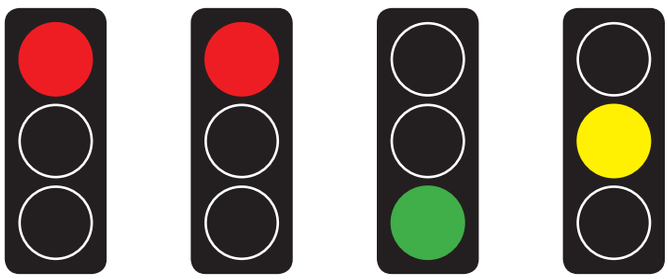
- Use the simulation software to draw your flowchart.
- Print the flowchart and glue it in the space on the right.
- Test the system with your software, observe the limitations and compare it with a real-life situation. (Note: the suggested system may be different from the system in your country. You are free to make the necessary changes.)
- Save your work as traffic1.

Glue your printed flowchart here!

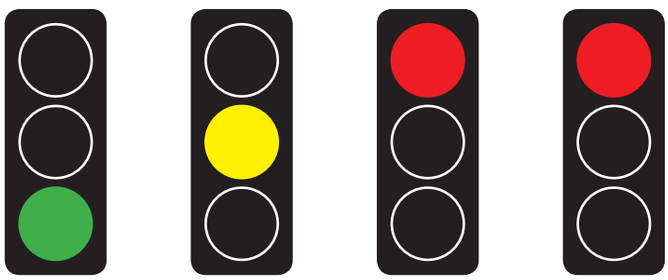
Traffic lights at crossroads

- Two different sets of traffic lights are needed at the crossroads junction.
- The two sets of traffic lights must work with reference to each other.

Output	Description	Function
Output 1	Red 1	Stop
Output 2	Green 1	Go
Output 3	Yellow 1	Wait
Output 4	Red 2	Stop
Output 5	Green 2	Go
Output 6	Yellow 2	Wait



Set A



Set B

Flowchart

- Complete the following table for creating the flowchart of a set of traffic lights.

Description of the event in ordinary words	Control words	Flowchart symbol
Begin the system.	Start	Start
Turn on the red light of set A. Turn on the green light of set B.	Turn on Output 1 and Output 5	Input Output
Let the red light stay on for 5 seconds.	Delay 5	Process
Turn off the green light and turn on the yellow light of set B. The red light of set A should stay on.		Input Output
Let the light stay on for 3 seconds.		Process
Turn off the yellow light and turn _____ _____ _____ light of set _____. Turn on the _____ light of set A.		Input Output
Let the light stay on for 5 seconds.		Process
Turn off the _____ light and turn on the _____ light of set _____. The red light of set _____ should stay on.		Input Output

Flowchart (continued)

- Continue to complete the following table for creating the flowchart of a set of traffic lights.

Description of the event in ordinary words	Control words	Flowchart symbol
Let the light stay on for 3 seconds.	Delay 3	
Turn off yellow light and turn _____ _____ _____ light of set _____. Turn on the _____ light of set B.	Turn off Output 3. Turn on Output 1 and Output 6.	
Repeat the system.	Loop	

- Save your work as traffic2.
- Test your system with simulation software.

Evaluation

- Compare the system with a real-life system and discuss what possible changes you should make to improve the system.

  (Hints: 1. Compare the time delay of the system with the real-life system. Is the time delay long enough in terms of safety?
  2. In the system, the light turns green immediately after the red light is turned off. Is this safe? If not, what can be done about it?
  3. What limitations are there in this system? What will happen if there is a power failure?
  4. What will happen if one or more of the bulbs burn out?)

  .....

  .....

  .....

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  .....

- Save your flowchart as traffic3.
- Re-set your flowchart using the software and make further changes needed.

5.7 Using subroutines

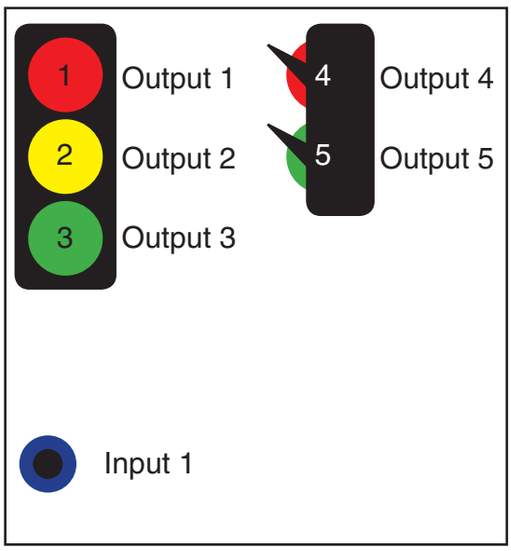
Learning Objective: 2

Pedestrian crossing

- The pedestrian-crossing system will be activated when it receives input from the pedestrian who wishes to cross the road.
- Here is a list of the input and outputs that are used:

Input	Description
Input 1	Signal from pedestrian

Output	Description
Output 1	Red light – stops vehicles
Output 2	Yellow light – warns vehicles to get ready to stop
Output 3	Green light – safe for vehicles to continue
Output 4	Red light – stops pedestrian from crossing
Output 5	Green light – pedestrian safe to cross



Subroutines

- The system may need a long flowchart.
- You can always break down the flowchart into subroutines.
- You can then command them from a main routine.
- Some software may need to create the subroutine first.
- A subroutine starts with Sub. You can then give it a name.
- Use the table below to plan for a subroutine to stop the vehicle.
- Name the subroutine Sub 1(stop).

Description of the event in ordinary words	Control words	Flowchart symbol
Begin the subroutine.	Sub	Sub 1(stop)
Switch off the green light 3 and switch on the warning yellow light 2 for vehicles.	Turn off Output 3. Turn on Output 2.	Input Output
Allow the light to stay on for 2 seconds.	Delay 2	Process
Switch off the yellow light 2 and the red stop light 4; switch on the green light 5 (for the pedestrian crossing) and the red light 1 (to stop the vehicles).	Turn off Outputs 2 and 4. Turn on Outputs 5 and 1.	Input Output
Allow the lights to stay on for 8 seconds.	Delay 8	Process
Switch off the green light 5 and the red light 1.	Turn off Outputs 5 and 1.	Input Output
Stop the subroutine.	Stop	Stop