

Measuring Things

How Can Computers Measure Things?

A [sensor](#), such as a temperature sensor, can be connected to a computer. The computer can then **monitor** the signal from the sensor, reacting to **changes**, or it can **record the data** from the sensor at predefined **time intervals**.

Note: If the sensor is an analogue one then an [analogue-to-digital convertor](#) (ADC) will be required.

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Where is Computer Measurement Used?

Anywhere that data needs to be gathered **regularly**, a computerised **data-logging** system can be used. Some examples are shown below...

Scientific experiments

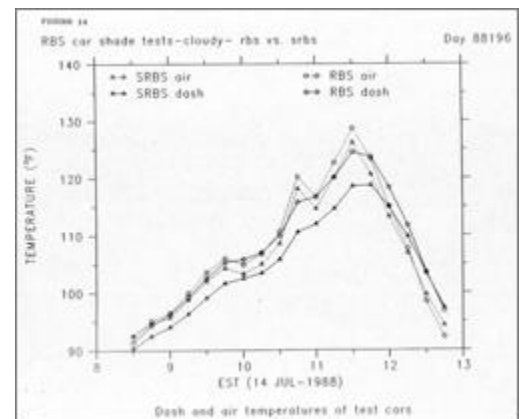
Many experiments can be set-up and left to run with a data-logging system measuring things like the **temperature** of a liquid, etc.

Weather stations

Often these are placed in very **remote** areas to collect data about **rainfall, temperature, wind-speed, wind-direction**, etc. Data needs to be gathered all day, every day. This data can then be used by weather forecasters to help predict the weather over the coming days.

Environmental monitoring

Scientists are very concerned about the effect that humans are having on the environment. Computer-based data-logging is often used to help gather evidence of these effects: the **level of water** in a dam, the **speed of water** flowing down a river, the **amount of pollution** in the air, etc.



Why Use Computers to Measure Things?

The main reasons that you would want to use a computer-based data-logging system, instead of a person taking measurements are...

- Computers **do not need to take breaks** - they can log data all day, every day, without stopping
- Computers take much **more accurate** readings than humans can
- Computers can take data readings **more frequently** (1000s of times a second if necessary)



- Since the logged data is already in a computer, the **data can be analysed more quickly and easily** (graphs drawn instantly, etc.)
- Data logging systems can operate in **difficult environments** (e.g. in the Arctic, or on top of a mountain)
- People are **free to do other more useful tasks** (rather than watching a thermometer)

Controlling Things On the Screen

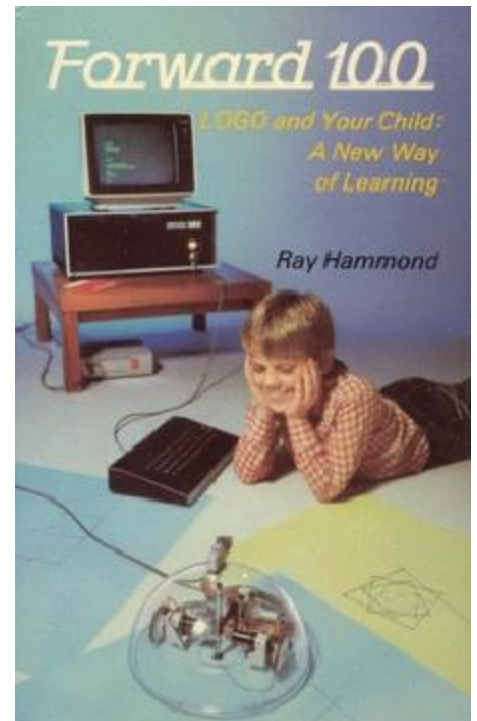
Turtle Graphics

One system designed to teach students the basics of computer programming and control, is called 'Turtle' Graphics.

A 'turtle' is an on-screen object that follows command given to it by the user. As the turtle moves around the screen it drags a 'pen' that leaves a trail behind it.

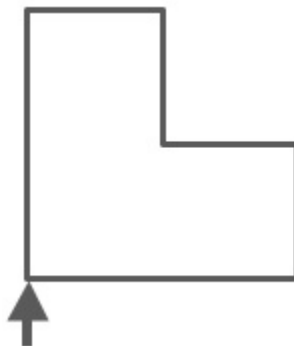
The command language is called 'LOGO'. LOGO has many commands, but the ones most commonly used are:

FORWARD n	Move forwards n steps
BACKWARD n	Move backwards n steps
LEFT n	Turn left n degrees
RIGHT n	Turn right n degrees
PENUP	Lift the 'pen' up from the 'paper'
PENDOWN	Drop the 'pen' down onto the 'paper'
REPEAT n ... END REPEAT	Repeat the commands between these two commands n times



Using these commands, any number of shapes and patterns can be drawn. Here are some simple examples...

```
FORWARD 20
FORWARD 10
FORWARD 10
FORWARD 10
FORWARD 10
FORWARD 20
```



```
RIGHT 90
RIGHT 90
LEFT 90
RIGHT 90
RIGHT 90
```

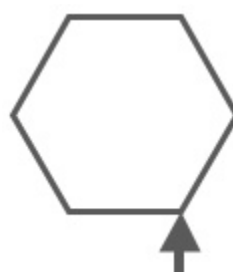


```
REPEAT 6
```

```
LEFT 90
FORWARD 10
```

```
RIGHT 60
END REPEAT
```

```
FORWARD 20
RIGHT 90
10
FORWARD 5
FORWARD 10
FORWARD 5
FORWARD 10
```



```
FORWARD
RIGHT 90
PENUP
PENDOWN
RIGHT 90
```



This is the story about how the on-screen cursor came to be called a 'turtle'...

When the LOGO language was first developed, home computers did not have graphical displays – all they could show on the screen was text.

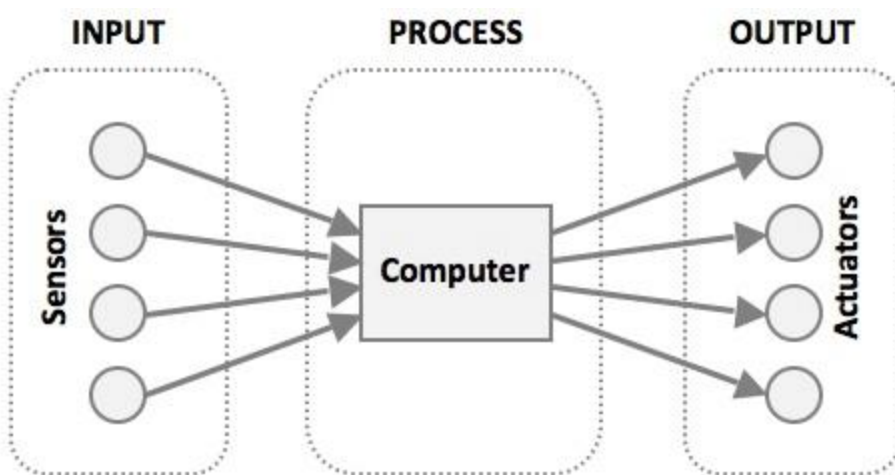
So, instead of an on-screen cursor that moved, the computer was connected to a small buggy which had motors and a pen inside. The computer could turn the motors on or off and so make the buggy move.

The buggy had a plastic dome on top that made it look a bit like a tortoise (or, as Americans would call it, a 'turtle')

Controlling Real-World Things

How Can Computers Control Things?

A computer control system, like any [system](#), is made up of three parts...



called [actuators](#).

1. **Input** devices called [sensors](#) feed **data into** the computer
2. The computer then **processes** the input data (by following a set of **instructions**)
3. As a result of the processing, the computer can **turn on or off output** devices

The best way to understand how a computer can control things is to think about how a **person** controls something...

For example, how does a human control a **car** when he/she is driving?

The person **looks** ahead at the road to see what is approaching, **thinks** about what he/she has seen, then **acts** upon it (turns the steering wheel and/or presses the pedals).

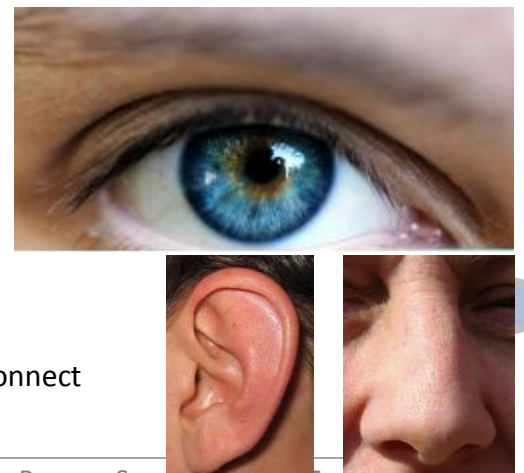
In other words the person **reacts** to what is happening in the world around them.

Computer-controlled systems work in a similar way – the system **detects** what is happening in the world around it, **processes** this information, and then **acts** upon what it has detected.

Sensors

A normal PC has no way of knowing what is happening in the real world around it. It doesn't know if it is light or dark, hot or cold, quiet or noisy. How do we know what is happening around us? We use our eyes, our ears, our mouth, our nose and our skin - our **senses**.

A normal PC has no senses, but we can give it some: We can connect **sensors** to it...





*Note: some of these devices require an **analogue** signal to operate them. This means that they need to be connected to the computer using a [digital-to-analogue convertor](#).*



Making Decisions (The Process)

The steps followed by the computer in a control system are just about the **same for all systems...**

1. **Check** the data from the **sensors**
2. If necessary, **turn on/off** one or more of the **actuators**
3. Go **back to step 1**

That's it! Of course the details vary, but that is basically how things work.



Where is Computer Control Used?

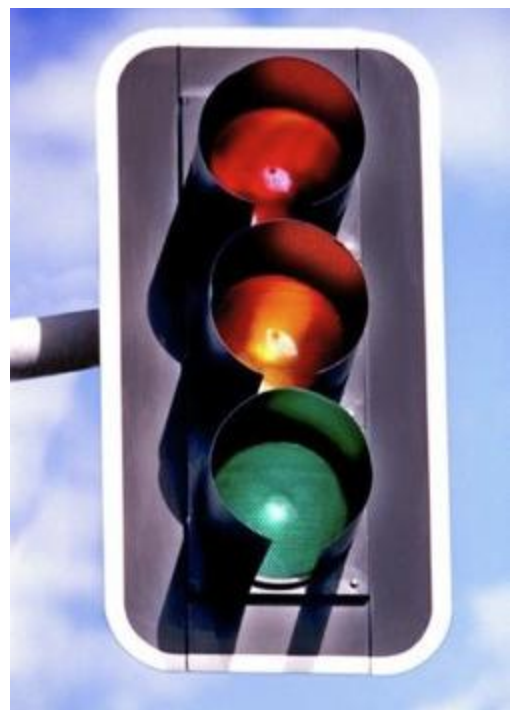
Many of the devices that we use in our everyday lives are controlled by small computers...

- **Washing machines**
- **Air-conditioning** systems
- Programmable **microwave ovens**

If we look beyond our homes, we come across even more systems that operate automatically under the control of a computer...

- Modern **cars** have engines, brakes, etc. that are managed and controlled by a computer
- Most **factory production lines** are computer-controlled, manufacturing products with little or no human input
- **Traffic lights** are switched on and off according to programs running on computers which manage traffic flow through cities

Of course, car engines, factories and traffic lights were not always computer-controlled. Before microprocessors even existed, car engines ran, factories produced goods and traffic lights changed.



However using computers to manage these systems has brought many benefits...



Why Use Computers to Control Things?

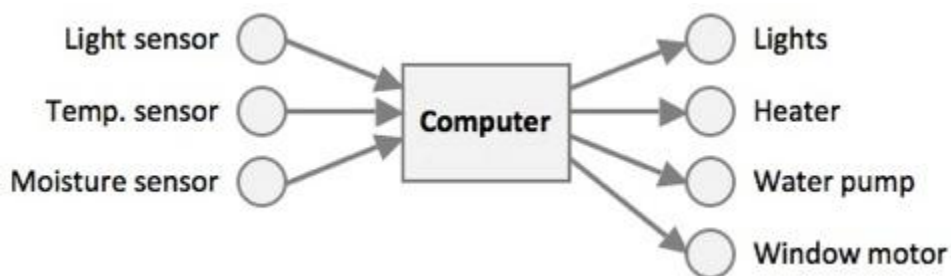
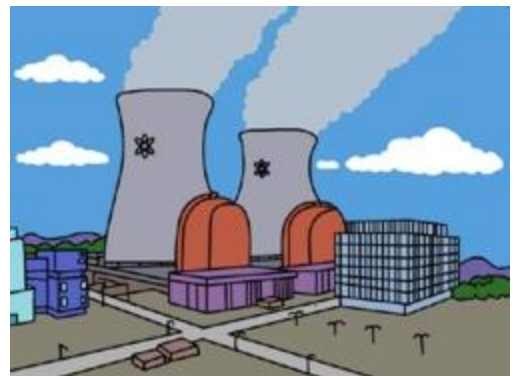
It is often far better to have a system that is managed and controlled by a computer rather than a human because...

- Computers **never need breaks** - they can control a system without stopping, all day, every day
- Computers **don't need to be paid**. To buy and install a computerised control system can be very expensive, but, in the long-term, money is saved by not having to employ staff to do the work
- Computers can operate in conditions that would be very **hazardous to human health**, e.g. nuclear power stations, chemical factories, paint-spraying areas
- Computers can control systems far more **accurately**, and respond to changes far more **quickly** than a human could

An Example Control System - An Automated Greenhouse

A computer-controlled greenhouse might have a number of sensors and actuators:

- A **light sensor** to detect how much light the plants are getting
- A **temperature sensor** to see how cold/hot the greenhouse is
- A **moisture sensor** to see how wet/dry the soil is
- **Lights** to illuminate the plants if it gets too dark
- A **heater** to warm up the greenhouse if it gets too cold
- A **water pump** for the watering system
- A **motor** to open the window if it gets too warm inside



The process for this system would be...

1. Check **light sensor**
 - If it is dark, **turn on the lights**
 - If it is not dark, **turn off the lights**
2. Check **temperature sensor**
 - If it is too cold, **turn on heater** and use motor to **close window**
 - If it is too warm, **turn off heater** and use motor to **open window**
3. Check the **moisture sensor**
 - If soil is too dry, **turn on the water pump**
 - If soil is too wet, **turn off the water pump**
4. Go back to step 1 and **repeat**



Note that if you have to describe a control process, never say that anything like:

“the temperature sensor switches on the heater”

This is totally wrong!

Sensors cannot control anything - all they can do is pass **data** to the **computer**.

The **computer** takes the **actions** and turns on/off the **actuators**.



Modelling Things

What is a Computer Model?

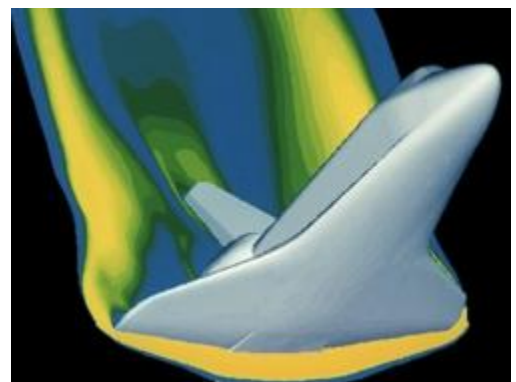
A computer model is a computer program that attempts to **simulate** a **real-life system**. In other words, it is a **‘virtual’** version of something in the **real-world**.

The computer model is designed to **behave just like the real-life system**. The more accurate the model, the closer it matches real-life.

Why Are Computer Models Used?

There are several reasons that computer models are used...

- To **test** a system without having to create the system for real (Building real-life systems can be expensive, and take a long time)
- To **predict** what might happen to a system in the future (An accurate model allows us to go forward in virtual time to see what the system will be doing in the future)
- To **train** people to use a system without putting them at risk (Learning to fly an airplane is very difficult and mistake will be made. In a real plane mistakes could be fatal!)
- To **investigate** a system in great detail (A model of a system can be zoomed in/out or rotated. Time can be stopped, rewind, etc.)



Examples of Computer Modelling

Designing Safer Cars

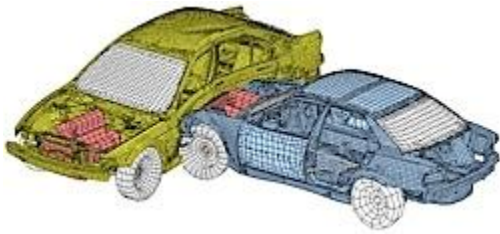
A computer model of a **car** can be used to test **how safe** the **design** of the car is in a **crash**.

The virtual car can be crashed **over and over again**, the effects investigated and the **design easily changed** until it is



as safe as possible.

This is much **quicker** and **cheaper** than building and crashing real cars!



Weather Forecasting

A computer model of a **weather** system can be used to **predict** storms.

The wind patterns, temperatures, etc. for the whole planet are **simulated** using very powerful computers. If the computer model is **accurate** (it is **very difficult** to make an accurate model since our planet is rather big) then weather forecasters can use it to '**fast-forward**' into the **future** to see a **prediction** of what the weather will be tomorrow, next week, next month.

(Since weather is so **complex**, and the models are **not (yet) accurate** enough, often the weather forecast is wrong!)



Building Better Bridges

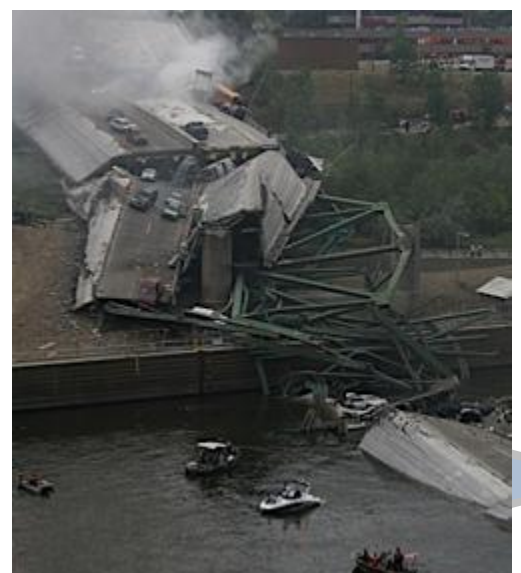
A computer model of a bridge can be used to **test the design**.

Bridges have to be able to survive **extreme weather** conditions. It is obvious **not practical to build a real bridge** and then wait to see if it falls down in a storm. Instead, a computer model of the bridge is created and tested in **virtual storms**.

If the model **breaks**, it can be **quickly and cheaply re-designed** and **re-tested**. If it doesn't break, the real bridge can be built, confident that it will survive real storms.

Bridges can also be tested to see if they can cope with **heavy traffic**. The virtual bridge can be loaded with a traffic jam of **virtual trucks** to check that it won't collapse.

A similar system is used by building designers, especially for very large or tall buildings, such as skyscrapers.



Running a Business

A computer model of a business can be used to help **predict future profits**.

If the workings of a business can be modelled accurately, in particular the financial systems, then these models can be used to make **predictions**. The models are used to help answer ‘**what if ...?**’ type questions, e.g. “What if we decrease the workforce by 15%? Will our profits increase or decrease?”

Based on the answers that the model gives, the **managers** of the business can **make decisions**.



Spreadsheets are often used to model the financial systems of a business.

Training Pilots to Fly an Airplane

Trainee pilots have many hours of lessons in **flight simulators** before being allowed to fly a real airplane.



Flight simulators behave almost exactly like real airplanes since they are controlled by a computer with a **very accurate and realistic model** of the airplane. The main difference is that the simulator **can't actually crash!**

Pilots can **make mistakes** without putting anyone's **life at risk**.

Flight simulators can provide a pilot with any number of highly realistic flying situations: **storms, engine failures, low cloud** hiding the runway, etc.

The **experience** that pilots gain whilst using the simulator means that when they eventually start flying real airplanes, they already have many of the **required skills**.

*There are also **car simulators** that are used to help train learner drivers, and also **ship simulators** to help ship captains learn how to navigate and manoeuvre large ships such as oil tankers.*



Communication Systems

communication was via telephone, fax, telex (a way of sending text messages that printed out on a printer), or by using mail - the old-fashioned paper version!

E-Mail

E-mail is a system that allows **messages** to be **sent** and **received** by **computers**. E-mail is the **most common** form of electronic communication.

E-mail messages are **text-based**, but **other types of file** can also be sent as '**attachments**'.

E-mails that are received wait in a user's **inbox** until the user is ready to read them. (Unlike a telephone call, the user is free to ignore e-mails until they have time to deal with them.)

An e-mail message usually has the following parts:

To send and receive e-mail, you need to have an e-mail address.

*An address is made up of two parts: a **username** and an **e-mail provider**, with an '@' symbol in the middle:*

username@provider

To	The address(es) of the person who the message is for
Subject	A short sentence describing what the message is about
Message	The text of the message. This can be as long as you like

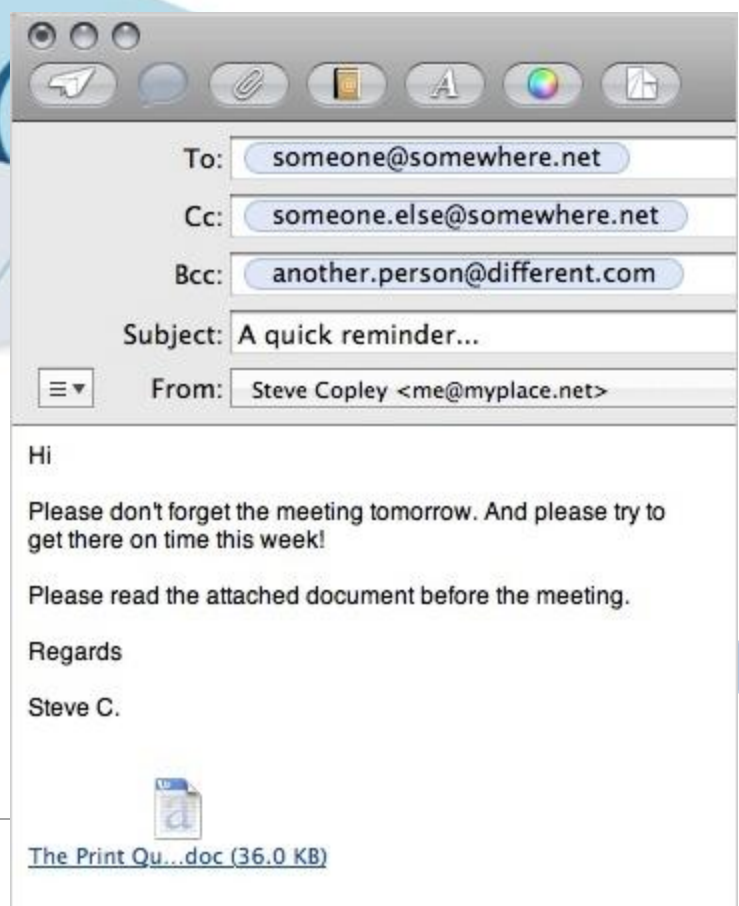
An e-mail may also include the following parts:

CC	The address(es) of people to copy the e-mail to (Carbon Copy)
BCC	The address(es) of people to copy the e-mail to without anyone else knowing (Blind Carbon Copy)
Attachments	Files linked to the message (images, documents, etc.)

Video Conferencing

Video-conferencing is a system that allows people to have **conversations** and **meetings** with other people in **different locations**, but **without leaving their office**.

A video-conference involves people sitting in front of a **camera** and a **microphone**, whilst watching other people of a **screen** and listening to them through **loudspeakers**.



Note: The camera is usually TV quality - much better than a standard webcam.

The system uses the following hardware:

- **Video camera**
- **Monitor**
- **Microphone**
- **Loudspeakers**
- High-speed network / Internet connection

Video conferencing is very popular with businesses as it means:

- **No travel costs**
- **No time wasted** travelling to other cities / countries
- Can organise meetings at **short notice**



However there are some problems with video conferencing:

- **Less personal** than face-to-face meetings
- Documents (e.g. contracts) cannot be **signed**

Mobile Telephones

Mobile telephones allow people to be away from their workplace, yet still be **contactable**. This means that people can still work, even when out of the office.

Modern smart-phones can perform a wide variety of tasks:

- Make and receive **telephone calls** just about anywhere
- Send and receive **SMS** (short message service) messages
- Send and receive **e-mail**
- Send and receive **files** such as images, text documents, etc.
- **Edit** documents
- Most people would be lost without their mobile phone!

However there are some downsides to the use of mobiles:

- Workers never get a chance to 'switch off' since they can always be contacted - can be **stressful**
- Mobiles are easy to **lose**, and often contain a lot of personal and/or business information. A lost mobile could be embarrassing / damaging if the wrong people got hold of it



Internet Telephony / Voice Over IP (VOIP)

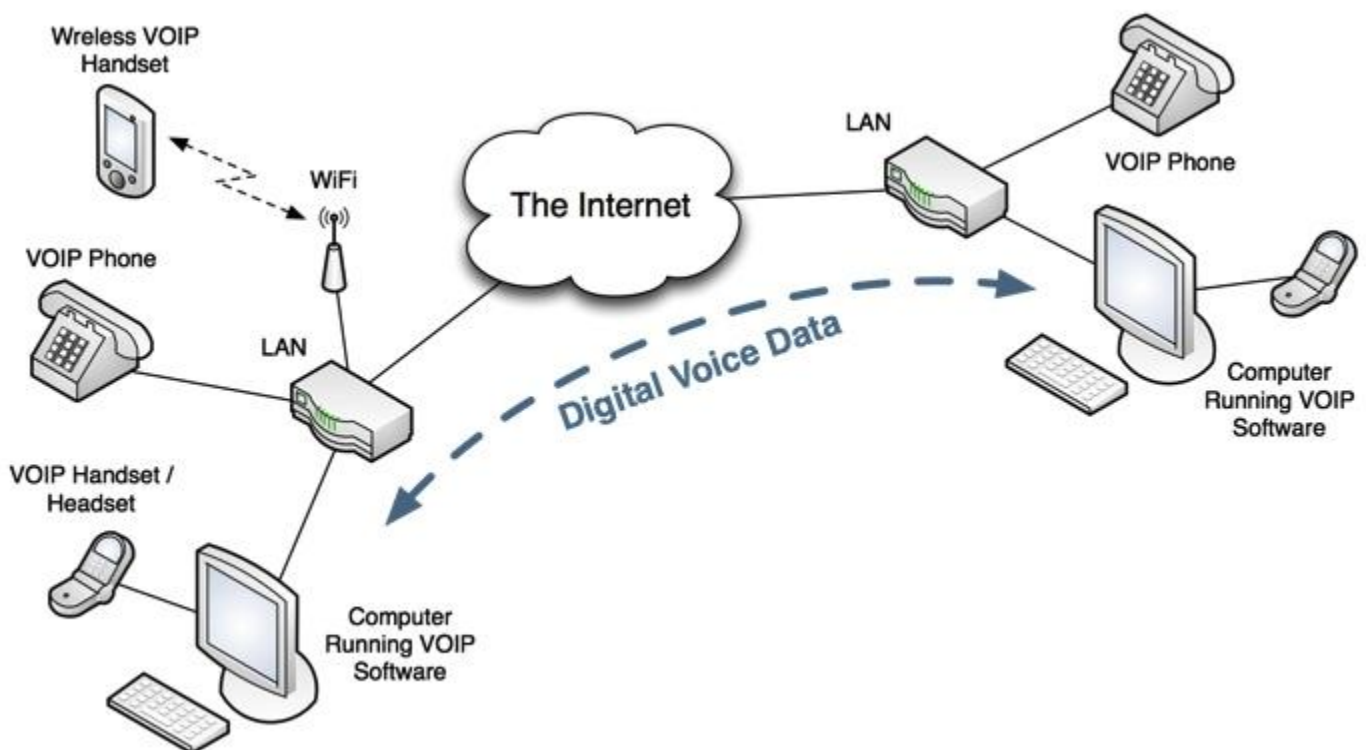
Internet telephony, or 'VOIP', is becoming very popular both for personal use, and within the workplace.

Instead of using the normal telephone network (designed to carry voices using analogue signals), VOIP systems send voices through the Internet as **digital data**, just like any other Internet data (e.g. e-mails, files, webpages, etc.)

In other words, VOIP systems use your **Internet connection** to send and receive **phone calls**.

*'Internet Telephony' means a telephone system that uses the **Internet***

*'VOIP' means **Voice Over IP**, where IP means **Internet Protocol** - the system that the Internet uses to transfer all data*



VOIP systems can work in several ways:

- **VOIP software** can be installed on a computer. Calls are then made using a **headset** (headphones / microphone) or by using a special USB **handset** (looks just like a normal phone)
- Special **VOIP telephones** can be plugged directly into the network (or can connect wirelessly using WiFi)

VOIP systems have a number of **advantages** over a normal telephone system:



- **No telephone line** is required
- Call **costs are very low**, especially for long-distance calls
- Can include **video**

They also have some **disadvantages**:

- Require **special hardware** and an **Internet connection**
- **Not as reliable** as normal phones, so cannot be relied upon for **emergency** calls (911, or 999)

- **Call quality** depends on the speed of the Internet connection

The most well-known public VOIP service is [Skype](#), but there are others such as [Google Talk](#), [Vbuzzer](#), [Fring](#), [ooVoo](#), and [SightSpeed](#).

(Needless to say, the traditional phone companies don't like VOIP as it takes away their business!)



Fax

Fax is short for 'facsimile' which means 'copy'.

A fax machine is a device that can send a **copy of a paper document** over the **telephone network**.

- The sending fax **converts** the **light/dark areas** of the printed document into **noises**.
- These noises travel through the **phone system** and are received by another fax machine.
- The receiving fax machine **converts** the **noises** into **printed marks** on a piece of paper - making a copy of the original document.



Faxes are:

- **Low quality** - images are especially poor
- **Slow** to send (compared to e-mail)

Faxes have been used for many years as a quick way of sharing documents. However, now most people have access to a computer, e-mail attachments are more commonly used.

One reason that faxes are still used is that most businesses would accept a document such as a **contract** that had been **signed**, and sent by **fax**. (Electronically signing e-mail attachments is not yet widespread.)



ICT Use in the Workplace

The syllabus says that you should be able to:

understand the differences between **batch processing**, **on-line processing** and **real-time processing**.

You should have an understanding of a wider range of work-related IT applications and their effects, including:

a. communication applications

- the Internet
- electronic mail
- fax
- electronic conferencing
- mobile telephones
- Internet telephony (VOIP) services

b. publicity and corporate image publications

- business cards
- letterheads
- flyers
- brochures

c. applications in manufacturing industries

- robotics in manufacture
- production line control

d. applications for finance departments

- billing systems
- stock control
- payroll

e. school management systems

- registration
- records
- reports

f. booking systems

- travel industry
- theatre
- cinemas

g. applications in banking

- Electronic Funds Transfer (EFT)
- ATMs for cash withdrawals and bill paying
- credit/debit cards
- cheque clearing
- phone banking
- Internet banking

h. applications in medicine

- doctors' information systems
- hospital and pharmacy records
- patient monitoring
- expert systems for diagnosis

i. applications in libraries

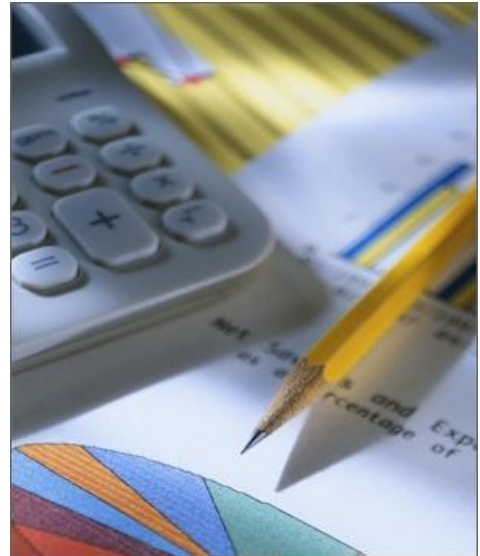
- records of books and borrowers
- issue of books

j. the use of expert systems

- mineral prospecting
- car engine fault diagnosis
- medical diagnosis
- chess games

k. applications in the retail industry

- stock control
- POS
- EFTPOS
- internet shopping
- automatic re-ordering



Medical & Hospital Systems

Computer systems are used in several quite different ways within doctor's surgeries and hospitals...

Monitoring of Patients

When a patient is in hospital, they often require close monitoring. It is not possible for a doctor or nurse to monitor patients continuously, 24 hours a day, so computerised monitors are used instead.



Sensors are attached to the patient. Sensors are used to monitor:



- **Pulse rate** (heart beats per minute)
- **Temperature**
- **Breathing rate** (breathes per minute)
- **Blood oxygen levels**
- **Blood pressure**

The sensors feed information back to a computer which **processes** the data:

- Data is checked for any **problems** (e.g. pulse rate too low/high)
- Data is **logged** so that it can be checked later



Several **outputs** from the computer system let hospital staff the patient's condition:

- A large **display / monitor** shows graphs of pulse, breathing, etc.
 - A loud **buzzer / alarm** can be sounded if there is a problem to attract the attention of a nurse/doctor
 - A small **printer** can produce a hard-copy of the data



The data from several patients can be fed back to a central nursing station so that the nursing staff can see exactly what is happening in the ward.



Diagnosis of Illness

Body Scanners

CT scanners and **MRI scanners** allow doctors to investigate what is happening inside a patient's body without intrusive surgery.



doctor, giving views of the patient's body.

The complex signals that come back from these huge machines are picked up by **sensors** and fed into a computer. The computer **processes** the data, then outputs **full-colour images**, sometimes in **3D**, for the



Expert Systems

Expert systems allow medical staff with limited medical knowledge (e.g. nurses) to get advice from a computer 'expert'

Expert systems are described [here](#). But they essentially work by:

1. Medical staff **inputs** patient's **symptoms** (or answers questions about them)
2. The expert system's search engine **searches** the **knowledge base** (a collection of medical knowledge) to find possible diagnoses
3. The system **outputs** a list of **possible diagnoses**, and treatments



Managing Patient Records

Doctors and hospitals have to deal with thousands of patients every week. It is essential that the **medical details** of every patient is recorded **accurately** so that the correct diagnosis can be made, and the correct treatment can be given.

For this reason, hospitals make use of **computerised databases** to store patient records. Computerised databases mean that:

- Patient data can be easily **shared** between **doctors, pharmacies** and other **hospitals**
- It is easy to **search** for and retrieve patient records
- Doctors can instruct a **pharmacy** to issue **medication** for a patient (no paper note needs to be written)

Databases are described fully [here](#). In the case of hospitals, the patient data that would be typically stored would be:

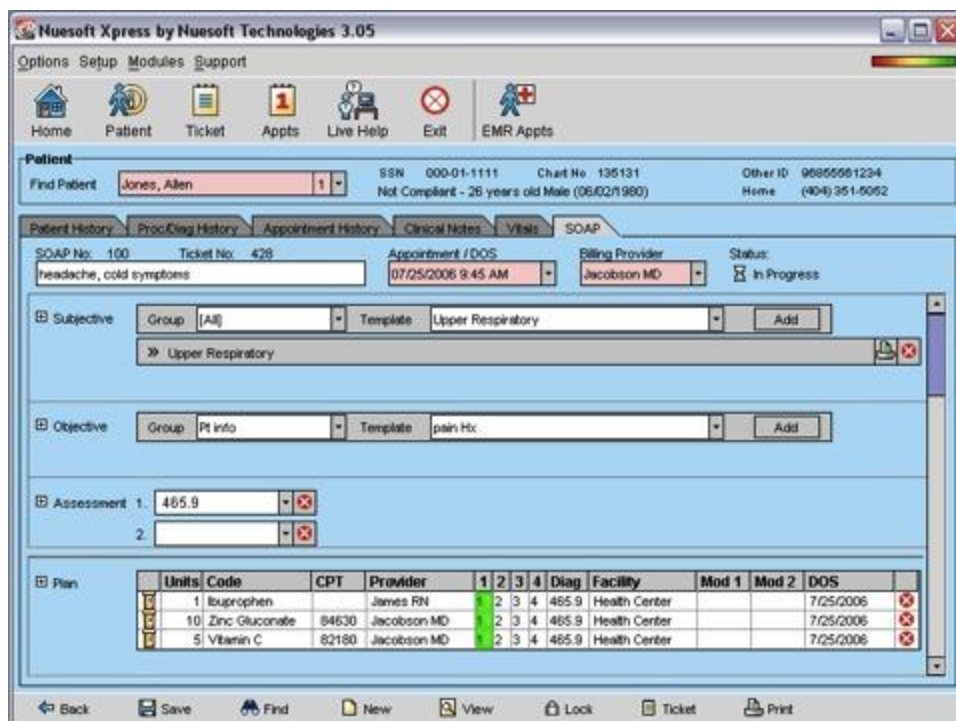
- Patient **ID** (number or text) - this would be the key field
- **Name** (text)
- **Date-of-birth** (date)
- **Gender** (boolean)
- **Blood group** (text)
- **Allergies** (text)
- **Medical history** (text)
- **Doctor** currently treating (text)
- Current **symptoms** (text)
- Current **diagnosis** (text)
- Current **treatment** (text)
- Current **medication** (text)
- **X-rays** or body **scans** (links to image/video files)

It used to be the case that patient records were all written on paper, and stored in huge, manual databases.

This made accessing the records slow. Sometimes records could get lost, and there was no easy way to make a back-up copy.

*Doctors can access a patients record whilst they are visiting patients, by using a computer connected **wirelessly** to the hospital network.*

*Doctors often use **tablet computers** (which are portable like laptops, but have a **touch screen**, and no keyboard) as they can be held in one hand, and operated with the other.*



Notes can be written on the screen using a stylus, and **handwriting-recognition** software converts it into computer text data.

School Management Systems

Schools have to manage many different sets of data:

- **Pupil information** (name, contact details, etc.)
- **Staff information** (name, bank details for pay, etc.)
- **Timetable** (rooms, times, subject, staff, classes, etc.)
- **Pupil attainment** (marks, grades, comments, etc.)
- **Pupil behaviour** (dates, incidents, notes, etc.)
- **Administration** data (letters, forms, etc.)
- **Financial** records (wages, fees, etc.)
- **Exam** entries (times, dates, pupils, results, etc.)



Rather than use lots of different systems to manage this information, many schools use a **School Management System** (sometimes called a **School Information System**, or SIS). This is a system that manages all of a school's data in a single, integrated application.



Having all of the information in a single system allows schools to more easily **connect** data together.

For example, when viewing a pupil's record, the user could follow a link to the pupil's class, and from there a link to the pupil's teacher, and from there a link to the teacher's other classes, and so on.

These connections between sets of data allow complex tasks to easily be performed such as:

- Sending letters to all parents of pupils who scored below 50% in their last English test
- Printing personalised timetables for IGCSE pupils (even though they have all chosen different options)
- Monitoring the progress of pupils in multiple subjects, over a number of years

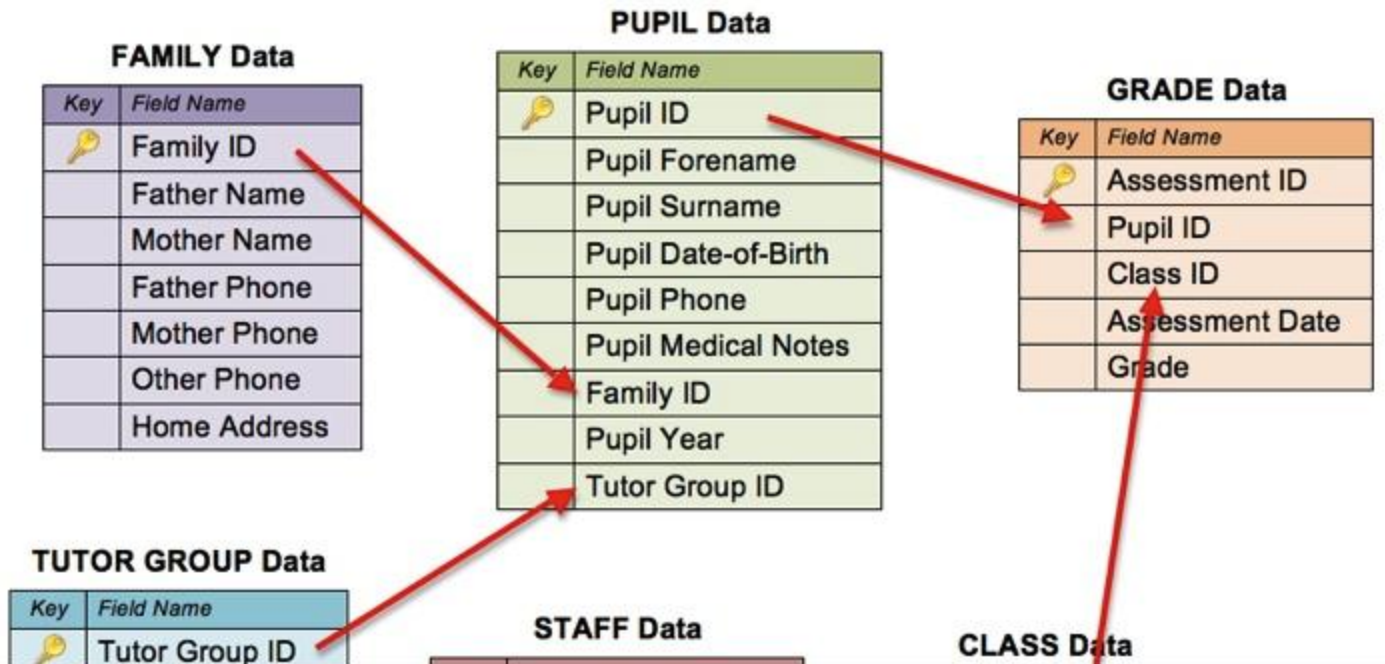
As you can imagine, School Management Systems are pretty **complex**. Most systems are based on a complex [relational database](#). The database contains **many tables** of data, each table having **many records** and **many fields**.

#	Last Name	First Name	Student ID	Gender
1	Barrett	Jessica	9800002	Female
2	Dhillon	Shauna	9800003	Female
3	Fisher	Stephanie	9800004	Male
4	Fitzgerald	Ricky	9800005	Male
5	Gee	Tasha	9800006	Female
6	Grant	Shauna	9800007	Female
7	Haulta	Brittany	9800008	Female
8	Holmes	Danny	9800001	Male
9	Katanus	Damien	9800010	Male
10	Larson	Melissa	9800012	Female
11	Larson	Steven	9800011	Male
12	Loiselle	Kimberley	9800013	Female
13	Lowther	Breanna	9800014	Female
14	Manual	Brennan	9800009	Male
15	Mcbutney	Lewis	9800015	Male
16	Mitlus	Jessica	9800016	Female
17	Mix	Amanda	9800017	Female

An Example...

An example of a part of a typical school database showing the different data **tables**, the **fields** within each table, and the **relationships** between the tables:

Pretty complicated, isn't it? And this would just be a *small* part of the overall School



Management System database!

(Don't worry - you don't have to learn this diagram - it's just an example to show you that this is not a simple database!)

If you have studied and understood the notes about **relational databases**, you will notice that many of the above tables contain **foreign keys** (primary keys from one table that are used in another table to create a relationship / link)

E.g. The PUPIL Data table contains two foreign keys: Family ID and Tutor Group ID. These foreign keys link a pupils to a specific family and tutor group

Term: Term 1		Today					
Class: Block A - Mathematics 8		Thu Sep 1	Fri Sep 2	Mon Sep 5			
#	Students	Ex	UnEx	Late	Yes	Yes	Yes
1	Barrett, Jessica	0	0	0	P	P	P
2	Dhillon, Shauna	0	0	0	P	P	P
3	Fisher, Stephanie	0	0	0	P	P	P
4	Fitzgerald, Ricky	0	0	0	P	P	P
5	Gee, Tasha	0	0	2	Late	Late	P
6	Grant, Shauna	0	0	0	P	P	P
7	Hauta, Brittany	0	0	0	P	P	P
8	Holmes, Danny	0	0	0	P	P	P
9	Katarus, Damien	0	0	0	P	P	P
10	Larson, Melissa	0	0	3	Late	P	Late
11	Larson, Steven	0	0	0	P	P	P
12	Loiselle, Kimberley	0	0	0	P	P	P
13	Lowther, Breanna	0	0	0	P	P	P
14	Manual, Brennan	0	0	0	P	P	P
15	Mohamud, Layla	0	0	0	P	P	P

Term and Class:		1	
Term 1	Description:	Chap 1 Pg 4-15	Cha
Block A - Mathematics 8	Total:	10	75
	Scale:	1.000	1.0

Stock Control Systems

Manufacturing Products

Computer-controlled manufacturing has revolutionised the way products are made. Modern factories are full of **robots**; everything is automated.



In a modern factory the only people you will see 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 human workers.

What is an Industrial Robot?

When you think of the word 'robot', you might picture a human-shaped robot with arms, legs and a head - the sort you see in sci-fi films. However this is *not* how the sort of robots used in factories look.



Robots used in factories are called **industrial robots**, and they come in a wide variety of shapes and sizes.

The most common type of industrial robot looks a little bit like a human **arm**. The robot has **joints** (like our **shoulder**, **elbow**, and **wrist**) and some sort of manipulator / device on the end of the arm (where our hand would be).

The robot's **joints** are powered by very strong **electric motors**. These motors are controlled by a **computer**.

*A scene from an old factory - no robots in sight! This type of manual labour is **repetitive** and **boring**.*

In a new factory, the same tasks are performed by robots

The robot's manipulator / device depends upon the job that the robot has to do. It could be:

- a **gripper** (like a hand, for picking things up)
- **suction pads** (for lifting sheet metal or glass)
- a **paint spray gun** (for painting things)
- a **welding gun** (for joining metal together)



How Are Robots Used in a Factory?

Robots in factories are used to:

- **lift heavy items** into from place to place
- **assemble** parts together to create things
- **join** parts together using **glue**, or by **welding** (melting metal)
- **paint** things

Robots often work in groups, one robot holding a part, whilst another robot does something to it.

Watching robots work is fascinating - they move so quickly and confidently, that it seems almost like a choreographed dance!



Watching robots work is fascinating - they move so quickly and confidently, that it seems almost like a choreographed dance!

Here are some videos of robots at work:

- [Industrial robots: how they're made and what they do](#)
- [Examples of industrial robots at work](#)
- [Two robot arms picking objects off a conveyor](#)
- [Huge robot arm handling sheets of glass](#)
- [Line of robots welding Toyota car bodies](#)
- [Demo of a huge robot arm lifting car bodies](#)
- [Mini Cooper cars built by robots](#)
- [Robots building computer power supplies](#)
- [Robots stacking trays of food](#)
- [Robots packing and stacking games](#)

Spray painting things (a hazardous job for a human - most paint is toxic)

Welding metals parts together (needs skill and accuracy)

Stacking boxes for shipping (tedious and hard for a human to



do all day)

How Do Computers Control Robots and Production Lines?

The basics of computer control are explained in the [Controlling Real-World Things](#) section.

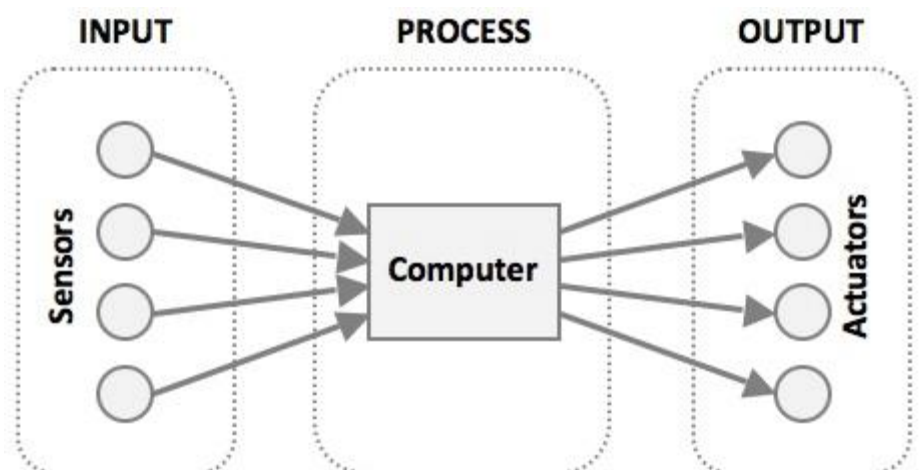
In the case of factory production lines the control system consists of:

Sensors

Sensors (**inputs** to the computer) **detect** what is happening on the production line, and **send data to the computer** so that it can decide what to do.

Examples of sensors would be:

- **Switches** / buttons - detect if something is touching them
- **Pressure** sensors - detect if something is pressing down on them
- **Light** sensors - detect if something is present (blocks the light)
- **Temperature** sensors -



detect if items are hot/cool enough

- **Liquid level** sensors - detect how much liquid is in a container
- **Cameras** - detect the shape / colour of objects

Process

computer is the **sensors**, checks if on/off various

production line



1. The was in sensor, a **light** sensor, or a **camera**) and then turn **on** the fluid control **valve**.
2. The data from a fluid **level** sensor would be checked to see if the bottle was full. When it was full, the computer would turn **off** the fluid control **valve**.
3. These steps would then be **repeated** for the next bottle, and so on.

In a typical production line, there will be hundreds of sensors and dozens of actuators, all connected to computers (often a large network of computers)

The **control software** running on the process. It takes the data from the anything needs to be done, then turns **actuators** to make things happen. For example, in a *soft-drink factory*, the involves filling bottles with fluid (drink!)

computer would make sure that a bottle place (using data from a **pressure** sensor) to turn **on** the fluid control **valve**.



Actuators

Actuators (**outputs** from the computer) are the devices that **make things happen** on the production line: robots picking things up, conveyor belts moving, etc.

Examples of actuators would be:

- **Motors** - used to make almost everything move, from the joints of robot arms, to the motion of conveyor belts.
- **Valves** - to turn on/off the flow of paint, etc.
- **Relays** (electrically operated **switches**) - turn on/off devices like welders



Why Use Computer-Controlled Robots?

The **robots** used in factories are very **expensive**. Many of the larger ones can cost as much as \$500,000. And some factories have dozens of robots.

So why would a factory owner spend so much money on these expensive machines?



There are a number of reasons that robots are used:

- Robots can work **24 hours** a day, **every day**, with **no breaks**
- Robots **don't need to be paid**

