COMMUNICATING IDEAS

Why Use IT to Help Communicate Information?
We often have ideas or information that we wish to communicate with others, either personally, or as part of our work.

Examples of **personal** communication: You may want to tell your friends about a party that you are having, or you may want to let others know how about the impact of climate change.

Examples of **business** communication: In business, you may want to tell the world about a new product that your company has just created (this is called **marketing**), or you have information that you need to pass on to all of the employees in the business.

In all of these examples, IT can be used to help pass on the message.

Producing and Editing Pictures
The production of graphics and pictures has been revolutionised by the use of IT. Image editors such as PhotoShop allow computer users to easily manipulate images in many ways:

- **Crop** (cut off bits that you don't want)
- **Resize**
- **Distort** (e.g. bend, twist, stretch, etc.)
- Alter **colour** (e.g. brighten, make black & white, etc.)
- Add **effects** (e.g. shadows, glow, texture)
- Add **graphics** (e.g. lines, circles, borders, etc.)
- Add **text**
- Etc.

High quality hard-copies can be obtained using colour laser printers or ink-jet printers.

It used to be the case that to produce images and graphics for posters or magazine, would take highly trained artists many hours.

*Photos would be taken using old **film** cameras, the pictures would be printed onto **paper**. Effects could be applied during the printing by using clever darkroom techniques, but this took a lot of skill.*

*After printing the photos could then be edited by actually cutting/pasting with **glue** and **scissors**, or by adding lines, colour, etc. using **paint**, etc.*

There was no 'undo'!

Today, with image editors like PhotoShop, anyone can produce and edit images. A user at home can do in seconds what would have taken a professional editor many hours to do.
*The tiny coloured **dots** that make up a digital image are called **pixels**.*

*You make have heard this term in connection with digital cameras. A typical **camera** takes a 12 **megapixel**image, which means the image is made up of 12 million tiny dots!*

Desktop Publishing

Desktop Publishing (DTP) is a system of software and hardware that allows a user to create and print documents such as:

- books
- posters
- flyers
- magazine
- newspapers
- etc...

DTP software is WYSIWYG
(What You See Is What You Get - meaning that the document looks the same on the screen as it will when it's printed).

Document layout is produced using 'frames' - areas of the page that can contain text or images.

Text in frames can 'overflow' into other frames. Images can be added from scanners or digital cameras, then cropped, rotated, resized, etc. Where text and images overlap, text can be 'wrapped' around images.

*The **mid-1980s** saw the first affordable DTP systems, using DTP software running on the newly available **GUI** PCs, and printing using some of the first laser printers.*

*Before DTP was available, if you wanted to produce a printed document, you would have to pay a**professional designer** and **printer**to do the work for you. And, unless you planned to print thousands of copies of your document, the price was often too **expensive**.*

*Now, with relatively **cheap DTP software** and a good quality **laser printer**, it is easy for anyone to produce their own posters, etc.*

People can now publish documents literally from their own desktop!

Website Design

A website is a collection of web 'pages' that provide a mixtures of content:

- Text
- Images
- Animations
- Video
- Audio
- Hyperlinks (to jump to other content)

Websites are a fantastic way to communicate with people since websites can be accessed by literally millions of people.

However in some ways websites are not as good as printed documents for reaching people. Fore example, to view websites:

- You need a **computer** (expensive)
- You need an **Internet connection** (not always available, and it can be expensive)
- You need some **training** to know how to use a computer (you don't need training to use paper!)

The World Wide Web has transformed information communication. For many people, most of the information that they consume each day comes via the Web, rather than as printed documents.
Websites use many of the techniques that printed documents have used for hundreds of years: headings, columns of text, etc.

However, the fact that modern websites can contain interactive, animated content makes them very different to printed documents.

The original Web when it was invented back in 1991 was a very different place to totday. At that time webpages were very basic with just text and a few pictures. (The Internet then was far too slow to stream video or audio.)

Below is the very first webpage ever created...

Multimedia Design

'Multimedia' refers to documents / software applications that contain a mixture of:

- text
- images
- animations
- video
- audio
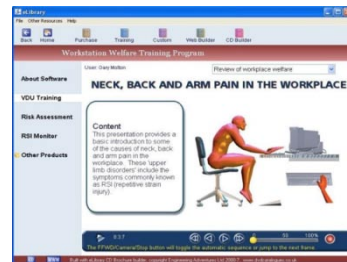
Multimedia applications are commonly used for **training** / **education**. Compared to learning from a textbook, multimedia applications allow students to see animations, videos, etc. This can bring a subject to life and make it much easier to learn.

*The modern **Web** has become a multimedia experience, with streaming video, streaming audio, animations, etc.*

Creating Music

In the same way the it is now very easy to create printed documents using IT, it has also become easier to create and edit music with the help of computers.
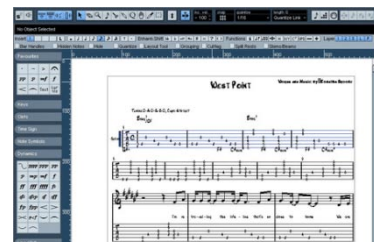
To produce a **musical score** (sheets of written notes), you no longer need to write every note down by hand. You can use a WYSIWYG editor to write the music on the computer, edit it, print copies, etc.

Once you have music data in a computer you can use the computer to play back the music (converting the digital data back into sound with an ADC). You can add effects to the music, simulate thousands of different instruments, add new 'tracks' of music over the top, etc.

It is possible to play music into a computer and the notes will be recorded - note as sound, but as digital music data.

*Your analogue music is converted into digital data using an analogue-to-digital convertor (**ADC**).*

*A computer can be used to control musical instruments (or it can be controlled by instruments) using a system called Musical Instrument Digital Interface (**MIDI**).*

Most musical keyboards have MIDI connections, as do many electric guitars.

Interactive Communication

Communication does not need to be **one-way** as it is in many of the above examples. When people create images, documents, music, etc. they are communicating their message, but they are **not listening** to the responses that other may have.

With the rise of the Internet, and especially with the recent '**Web 2.0**' websites, such as **wikis**, **blogs** and **social networking** sites, communication has now become very **interactive**.

By 'interactive' we mean that people can **respond** the information that they are given, add **comments**, **alter / improve** it, **rate** it, etc.
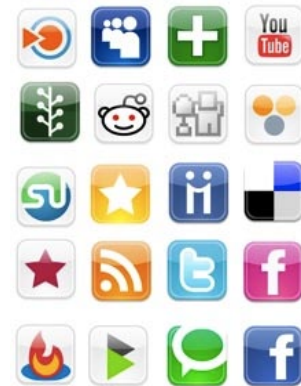
HANDLING DATA
Why Use Computers to Keep Records?
Even if you don't work for a huge business, It can be useful to use computers to keep track of data.

Data that is stored on a **computer** (as opposed to data written on paper) can be easily:

- **organised** / **sorted** in different ways
- **displayed** / **printed** in a variety of styles and layouts
- **searched** for specific things
- **updated** - adding / changing / deleting items
- **backed-up** - a copy can be made with just a few clicks
- **stored** / **moved** - a memory stick is much smaller than a cupboard full of paper!

Computerised databases can help organise even the most disorganised person!

What Might You Store on a Computer?
Your Address Book
Most people need to keep track of lots of telephone numbers, postal addresses, e-mail address, etc.

We can use a computer (don't forget your phone is a computer too!) to help keep this data organised in an address database.

A typical computerised address book might store:

- Name
- Address
- Phone number (home)
- Phone number (mobile)
- Phone number (work)
- E-mail address
- Birthday
- Photograph
- Etc.
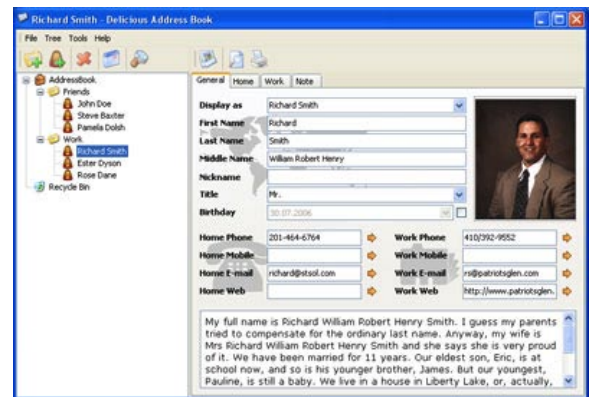
Most address book applications have features that help you organise the records so that you can quickly access the ones you want:

- Place your entries into **groups** (e.g. 'Family', Friends', 'Work', etc.)
- **Search** (by name, groups, address, etc.)
- **Synchronisation** with other devices (computer, phone, PDA, etc.)

A few years ago, before we had PCs and mobile phones to tore this information in, most people would have used a little address book.

However, this type of book was easy to lose (no back-up), a pain to update (you have to cross out names, tear out pages, etc.) and slow to search through.

An electronic address book is much easier to keep up to date!
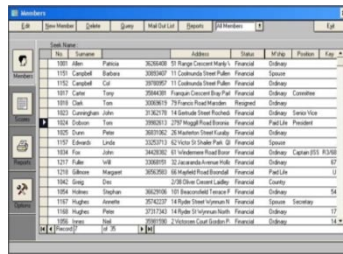
Club / Society Records

Clubs / societies need to keep track of their members. A **membership database** allows the club / society to easily contact members, check that they have paid any fees, etc.

A typical computerised membership database might store:
- Membership number
- Name
- Address
- Phone number
- Fees to charge
- Have fees been paid (Y/N)
- Etc.

If a **letter** needs to be sent to every member of the club / society, the **names** and **addresses** of the members can be taken from the membership database and automatically placed onto a letter. This is called a **mail-merge**.

A mail-merge is a very easy way to automatically create lots of letters that seem to be personally written for each person, but in fact are all the same letter, just with the name and address changed.

If this was your football club, you'd want to know a few facts about your club members. Using a computer to keep hold of their details is much easier than using paper.

Results of Surveys

Many groups / organisations undertake surveys to try to discover what people like / want / think.

Surveys can be performed using **paper questionnaires**, and then the results entered into the computer by:
- **Typing** data in
- **Scanning** the paper forms, using **OMR** technology

Alternatively, results can be entered into the computer **directly**, using an on-screen form (e.g. if using a tablet PC)

The survey results are best stored on a computer so that they can easily be analysed. Survey results on a computer allow:
- Data to be quickly and easily **queried** (filtered)
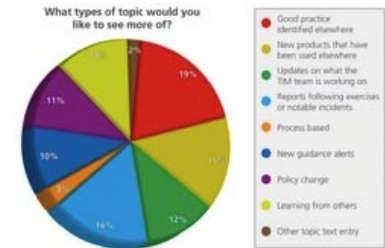- **Charts** to be easily created
- Summary **reports** to be created

Sales Records for a Tuck Shop

It's important, when selling things, and dealing with cash, to keep track of the numbers involved.

A computer **spreadsheet** is an good way to record which items you have sold, and also to perform **calculations** on the data (calculate totals, averages, etc.).

A typical sales spreadsheet might contain the following columns:
- Item code
- Item description
- Item cost
- Number sold
- Total cost
- Profit made

Doing calculations manually can lead to mistakes. When money is involved, it's best to let a computer do the work!

School Reports

A school would typically keep data on student **academic performance** in a computerised **database**. This would allow the school to easily track how students were doing as the year progressed, as well as making the creation of printed reports very easy (compared to hand writing every report)

A typical school report database might contain:
- Student ID
- Name
- Tutor group
- Grades for Term 1
- Attendance for Term 1
- Comments by teachers for Term 1
- Grades for Term 2
- Etc.

Most database programs allow data to be presented in attractively design**reports** that can include headers and footers, school logos, etc.

You might think that your report is written just for you, but often this is not entirely true...

Many school reporting systems allow teachers to select pre-written comments from a 'comment bank'. So those 'personal' comments on your report are actually from a database - they were just the comments that best matched you!

School Library Database

Even a small library, such as the one in a school, needs to keep track of which books are available, and who has borrowed any of them.

A typical school library system would store the following information:

Books
- ID number
- Title
- Author
- Publisher
- Fiction? (Y/N)
- Genre

Loans
- Book ID
- Borrower ID
- Date borrowed
- Returned? (Y/N)

Borrowers
- ID number
- Name
- Class
- Date of birth
- Fines to pay

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.

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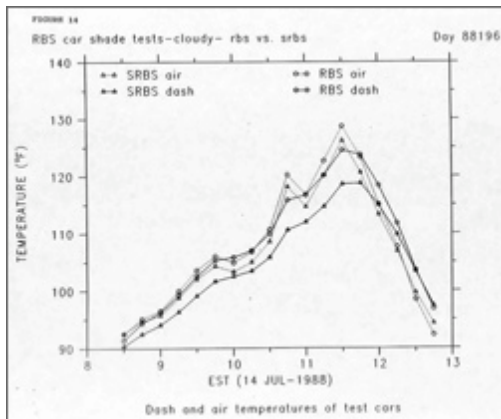
Weather stations
Often these are placed in very **remote** areas to collect data about **rainfall**,**temperature**, **wind-speed**, **wind-direction**, etc. Data needs to be gathered all day, every day. This data can then be used by weather forecasters to help predict the weather over the coming days.

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 twno commands n times

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

FORWARD 20
RIGHT 90
FORWARD 10
RIGHT 90
FORWARD 10
LEFT 90
FORWARD 10
RIGHT 90
FORWARD 10
RIGHT 90
FORWARD 20
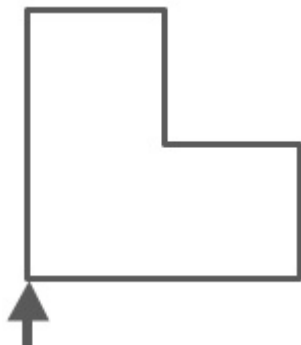
LEFT 90
REPEAT 6
FORWARD 10
RIGHT 60
END REPEAT
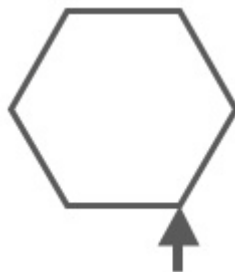
FORWARD 20
RIGHT 90
FORWARD 10
RIGHT 90
FORWARD 5
PENUP
FORWARD 10
PENDOWN
FORWARD 5
RIGHT 90
FORWARD 10

CONTROLLING REAL WORLD THINGS

How Can Computers Control Things?

A computer control system, like any **system**, is made up of three parts...
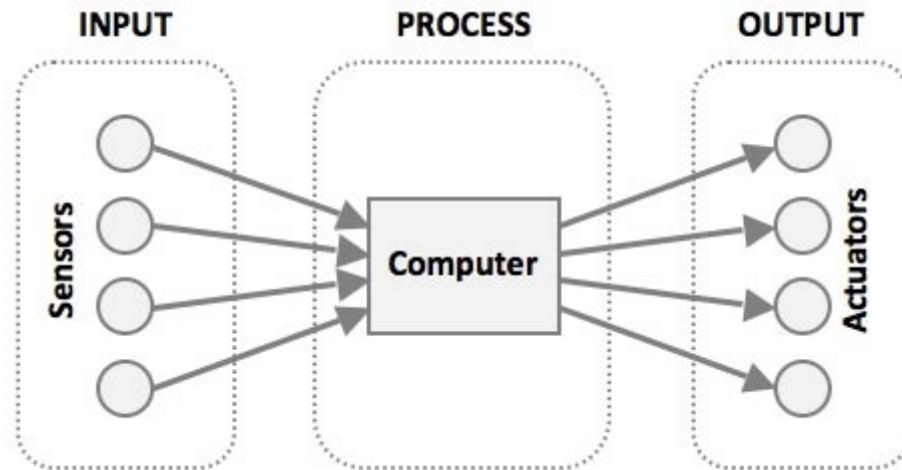
1. **Input** devices called **sensors** feed **data into** the computer
2. The computer then **processes** the input data (by following a set of**instructions**)
3. As a result of the processing, the computer can **turn on or off****output** devices called **actuators**.

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...

A **sensor** is a device that **converts** a **real-world property** (e.g. temperature) into **data** that a computer can **process**.

Examples of sensors and the properties they detect are...

Sensor	What it Detects
Temperature	Temperature
Light	Light / dark
Pressure	Pressure (e.g. someone standing on it)
Moisture	Dampness / dryness
Water-level	How full / empty a container is
Movement	Movement nearby
Proximity	How close / far something is
Switch or **button**	If something is touching / pressing it

*Note: many sensors are **analogue** devices and so need to be connected to the computer using an **analogue-to-digital convertor**.*

Actuators

A normal PC has no way of **affecting** what is happening around it. It can't turn on the lights, or make the room hotter. How do we change what is happening around us? We use our **muscles** to move things, press things, lift things, etc. (and we can also make **sound** using our voice).

A normal PC has no muscles, but we can give it some. In fact we can give it the ability to do lots of things by connecting a range of **actuators** to it…

An **actuator** is a device, controlled by a computer, that can **affect the real-world**.

Examples of actuators, and what they can do are...

Actuator	What it Can Do
Light bulb or **LED**	Creates light
Heater	Increases temperature
Cooling Unit	Decreases temperature
Motor	Spins things around
Pump	Pushes water / air through pipes
Buzzer / **Bell** / **Siren**	Creates noise

*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 Thing?

It is often far better to have a system that is managed and controlled by a computer rather 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 employee 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
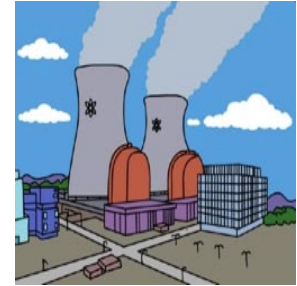
An Example Control System - An Automated Greenhouse

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 se 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
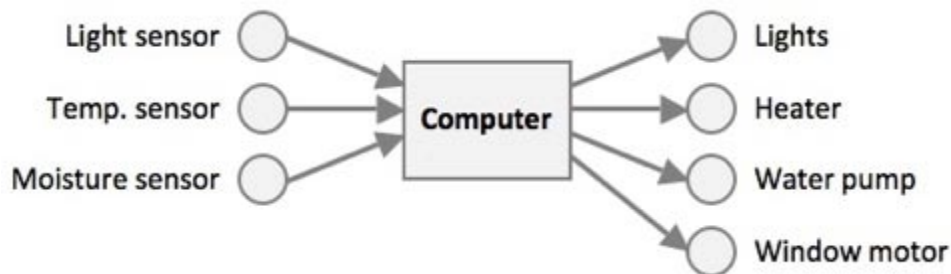
The process for this system would be...

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**

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, rewound, etc.)
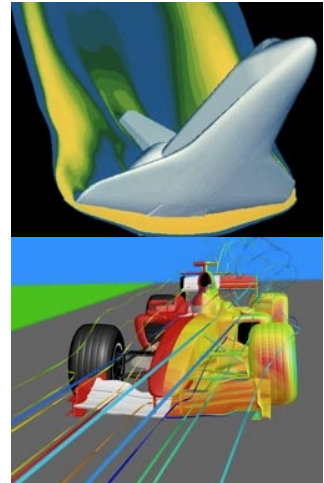
Examples of Computer Modelling
Designing Safer Cars
A computer model of a **car** can be used to test **how safe** the **design** of the car is in a **crash**.
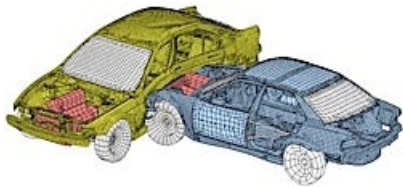
The virtual car can be crashed **over and over again**, the effects investigated and the **design easily changed** until it is as safe as possible.

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.*