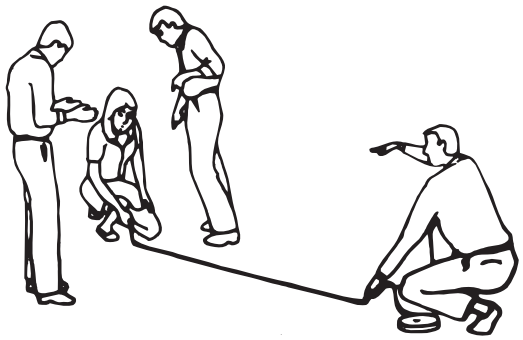
WHAT IS CONTROL?

This section introduces the language of control through a group activity that uses control.

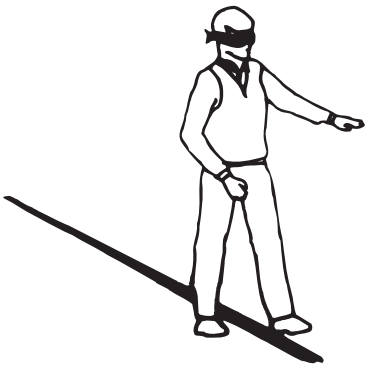
You will need some space and one or two volunteers to solve this control problem; the volunteers are going to be controlled by the rest of the class.

1. Mark out a distance of 5 to 10 metres on the floor or ground.



2. Blindfold your volunteers. Their task now is to walk the marked distance as accurately as possible.

The only rule is that they are not allowed any help from the rest of the group.

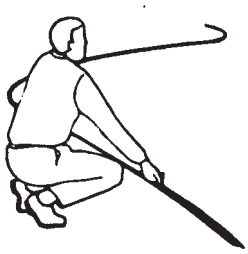


3. Measure and record how close to the finish line they end.

4. Your walkers were probably not very accurate.

Discuss in your group ways of improving the accuracy.
Define how accurate you want the walker to be.
Remember you are still not allowed to actually help them while they walk.
Try out your ideas and measure the accuracy to see if has improved.

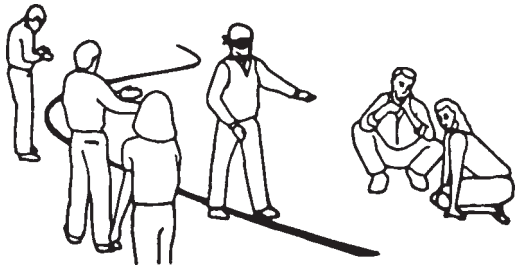
5. Mark out a more difficult course - like a dog-leg.



See if your walkers can mange this new course accurately.

6. Now discuss in your group other ways of improving the accuracy by giving help to the walkers.

This time the only rule is that the walkers must wear blindfolds.



Try out your ideas on the new course and measure the accuracy to see if it has improved.

Write a report of this activity; make sure you include the following things:

- What you did in steps 1 and 2; how accurate the walkers were.
- How you tried to improve the accuracy in step 4.
- What you did in step 5.
- What accuracy limits did you set for the walker? Was the walker within this accuracy limit?
- How you tried to improve the accuracy in step 6 and the difference it made to the accuracy.

DESCRIBING A CONTROL SYSTEM

When the blindfolded walker was guided by instructions, he or she was being controlled. When a car is manufactured, each stage in the process is accurately controlled. In general, when anything is being controlled, the stages in the process taken together are called a control system.

It is usual to draw control systems as block diagrams. A block diagram that you may be familiar with is this one:

Almost all control systems have these three stages:

- an input stage where information is put into the system;
- a process stage - where the information is processed;
- an output stage which causes something to happen outside the system.

The boxes or blocks represent the different stages of the control system. The arrows show the direction of flow of information between the different stages. For example, a light sensor drawn as a block diagram would look like this:

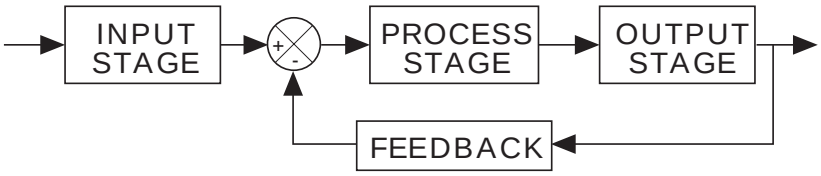
- Draw a block diagram similar to the one above for a temperature sensor.
- Draw a block diagram for a lamp.
- For the blindfolded walkers the information into the 'control system' was the route they had to walk along.
- Draw a block diagram to show what you think was happening when a blindfolded walker was walking without any help.
- What do think the input stage was? The process? The output?
- What information or signals were going in and out of these stages?

OPEN LOOP CONTROL

An important thing to notice about your block diagram is that the information flow is in one direction - from the input to the output. The walker doesn't get any information back about how far they have actually gone. This kind of control system is called an **open loop control system**.

CLOSED LOOP CONTROL

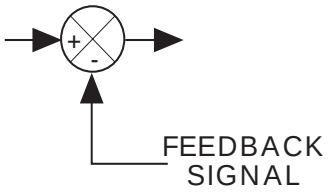
When you started giving the walkers help, you 'fed' back to them information about where they were compared to where they were supposed to be. This new flow of information should be shown on the block diagram.



There are a few things to notice about this diagram:

- Information is now flowing in both directions - from the input to the output, and from the output to the input.
- There is a new block (the feedback stage) that takes the information coming out of the system and feeds it back to a comparison element.

This is the symbol for a comparison element:



The comparison element compares two signals - the actual output of the system (e.g. the direction of the walker) with the desired output (e.g. the correct direction).

- The flow of information back from the output and the feedback stage together are called the feedback loop.

If there is a difference between these signals, it means that the actual output is not the same as the desired output. When this happens, the signal coming out the comparison element changes, and tries to correct the output (e.g. to change the direction).

This kind of control system is called a **closed loop control system**.

- Draw a block diagram to show what you think was happening when a blindfolded walker was being helped.
- What do think the feedback stage was?
- What information was being fed back?
- Which signals was the comparison element comparing?
- What information or signals were going around the feedback loop?
- Write down what you think the main differences between open loop and closed loop control systems are.

OPEN LOOP OR CLOSED LOOP?

Here are some common systems. Each of these involves some control.

Draw a block diagram for each one.

- *A ball valve in a cistern.*
- *A central heating system.*
- *An electric fire.*
- *Street lamps.*
- *House lights.*
- *An electric cooker - the hot plates*
  the oven.
- *Volume control on a TV, stereo or radio.*
- *Remote control for a TV set.*
- *Joy stick used with computer games.*
- *Speed control on a sewing machine.*

For each system answer these questions.
This is best done in a group. You can talk about each one.

- What is the input?
- What is the output?
- Is there any feedback?
- What provides the feedback?