Heriot-Watt University
School of Engineering & Physical Sciences
Electrical, Electronic & Computer Engineering

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Robokid

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Heriot-Watt University
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Robokid Project

Dear teacher,

Welcome to the Robokid project. Thank you for agreeing to use the project as part of your classroom work. We hope you and your pupils get as much fun using the project as we have had in producing it. These notes will guide you through the various tasks and activities as well as giving you some background information. You can use the material "as is" or you may wish to change and modify. Please feel free to use the project in any way that suits your own teaching goals. The project is still in development therefore don't worry if things don't go to plan, you can send an email to robokid@hw.ac.uk for help and advice or you can telephone Jim on 0131 451 3349.

We are very interested in your experiences with the material and would ask that you document these so that we can further develop the kit and the activities. All suggestions for changes and additions will be much appreciated.

Here are some notes based on comments from the 20 schools who did the project in spring 2009 :

1. The batteries are now supplied in a discharged state. They will need to be charged before the first session.
2. A number of schools have suggested that a shorter, more intense 2/3 week timescale is better than spreading it over 6 to 7 weeks. However, the decision is entirely up to you.
3. It is essential that, before the pupils start the project, the teacher should have studied the DVDs and written materials. From our feedback, the pupils have enjoyed the project when the teachers have been well prepared. To help we have included an extra kit for the teacher to use before running the activities.
4. Please don't hesitate to contact me if you are having problems.

Kind regards

Jim Herd
Tracy McHenry   August 2009

Heriot-Watt University
School of Engineering & Physical Sciences
Electrical, Electronic & Computer Engineering

Teachers Manual

Robokid
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Introduction

Welcome to the Robokid project. We hope you and your class enjoy the range of activities.

The aim of the project is to give primary P6/P7 pupils a chance to work with the latest in small robot technology without it being hidden in a faceless grey box. You are probably aware that much of modern technology is invisible and seems nothing short of magic. In fact, it is developed by many thousands of engineers throughout the world. We are keen to make sure that pupils see past the 'magic' and understand that there are many incredibly interesting careers for budding electronic engineers.

This document will introduce you to the range of activities. Please feel free to run the project in any way you see fit. We appreciate that teachers may want to run their own activities once they get some experience with the robot hardware. Don't worry if you have problems, we will be available to help.

As regards the running of the project, our experience has been that the children are very comfortable with the technology and are not intimidated by its content. With the emphasis on "Curriculum for Excellence" we would see good opportunities for the more technology savvy children to help groups that are having problems. The area with the most likelihood of problems is the initial build. To help we have a step-by-step DVD guide, a document showing the build sequence, and a fault finding guide.

Motivation behind the project

The project is funded by The Engineering and Physical Science Research Council (EPSRC) who are keen to promote science and technology to a wider audience. Robokid is one of many projects they support with generous funds. EPSRC is part of the UK Government and fund much of the engineering and physics research in UK Universities.

Preliminary notes

- There are NO dangerous voltages in the equipment. Therefore, pupils cannot get an electric shock.

- The robot cannot become dangerous. If a pupil gets the robot into what appears to be an odd mode, then just tell them to switch off and start again.
- We suggest that an adult be responsible for the charging of the batteries. (see later section on "working with the batteries")
- Please ask your pupils not to write or draw on the cardboard boxes. We plan to use the same boxes when we send the kits to other schools.
- Robot should NOT be run on carpet or carpet like floor coverings.

Project format

The project is split into a sequence of targeted activities. Associated with each activity is a set of resources as follows
1. Teacher notes with background information
2. Pupil worksheet (not all activities have a worksheet) – photocopy enough to distribute 1 per team
3. DVD describing the activity (not all activities have a DVD)
4. Additional documents
   E.g. activity 1 has two fault charts; activity 3 has a shape template.

All the paper resources for a single activity are collected together in one plastic folder in the manual.

Each activity should be done in a session, where a session is between 45 and 60 minutes. However, these times are flexible and you may find that an activity spills over to the next time you do the project.

Please send an email to robokid@hw.ac.uk to let us know when you have started the project.

Current Activities

Activity	Name	Notes	Time/Room
1	Build and test.	Watch DVD Build robot Test Learn how to steer robot	1 session Classroom and Hall/large floor area
2	Cornering	Watch DVD Run line adjust experiment and record results. Practice steering round obstacles	1 session Classroom Hall/large floor area
3	Art 1	Build covers for the robots based on a given theme.	2 sessions or more Classroom
4	Steering competition	Run an obstacle driving competition with robots and their covers.	1 session Hall/large floor area
5	Straight line adjust	Watch DVD Experiment with cornering mode Fill-in experiment sheet Practice controlling direction, speed and distance robot travels forward	1 session Hall/large floor area
6	10-pin bowling	Competition	1 session Hall/large floor area
7.	Line bump	Watch DVD Use black tape to create a shape Run robot in autonomous mode with a felt-tip pen Experiment with different modes	1->2 sessions Hall/large floor area
8.	Line follow	Watch DVD Create line with black tape Experiment with line following adjustments	1 session Hall/large floor area

More activities are being developed.

Classroom preparations

1. The class kit has an extra robot kit for you to play with. Later on, it can act as a spare if any of the kits develop a fault. In one school, they used the robot in an in-house in-service event.
2. Check that the DVDs can play on your equipment and that they can play with sufficient volume.
3. Ensure that the batteries have been charged for the first activity.

Project work areas

Parts of the project can be run in a classroom and parts in a hall or room with some clear floor space. It is difficult to generalise as classrooms vary from school to school. Competitions and driving activities really need to be done in a hall area, while construction and some of the art activities can be done in a classroom. One thing to note is that the robot does not work well on carpet, you should either use classroom desktops (can be small and lead to robots falling on the floor!) or vinyl/wood floor. The other factor that will influence where to run the different activities is the availability of DVD facilities. In the two pilot schools, Comely Park PS had SmartBoard facilities in each classroom which could display DVDs and a data projector in their hall (tricky to setup) while Bothwell PS used a mobile DVD player on a trolley that could be moved to the classroom or the hall.

Additional help

It may be useful to have another adult helper with some of the activities, in particular for activity 1. As it is the first activity, the children tend to be quite excited and if there are problems then an extra pair of hands can be very useful. For example, in one of the pilot schools, a parent with an engineering background came in to help.

Project evaluation

An essential aspect of our work is to evaluate the project. This is a requirement of our funding body, but, more importantly, will help us to develop the project material. There are three areas of assessment that we would like you to help us with

1. Numerical data.
   - Number of pupils doing the project, number of hours spent on the project, etc. We have included a form to aid the collection of this data.
2. Reaction of the pupils to the project
   - One of our pilot schools produced an assessment sheet. An evaluation sheet is included with this information pack.
3. Teacher evaluation.
   - Because of the technical complexity of the project we are very interested in what teachers thinks about the project, the way we have designed the material, and the content. Again, an evaluation sheet is included

Working with the batteries

We have included a full set of rechargeable AA batteries – sufficient for 4 per kit and some spares. Your class kit also includes sufficient chargers for all the class robots. The following points should be noted ::

- *The batteries are supplied in a discharged state. You will need to charge them before the first session.*
- Do not mix other types of batteries with the ones supplied with the kits. Especially, do not mix with non-rechargeable batteries.
- If you find that the batteries are discharging very quickly, please contact Jim and he will arrange to send you replacements.
- The supplied battery chargers work best when the batteries are quite well discharged. To make this easy, when the robot is powered-on it will tell you if the batteries need charged. This will be shown as a little scrolling message on the number display. The three possible messages are ::

Message	Power on message	Meaning
1	"robot"	Batteries are fine and pupils can use the robot.
2	"bAt_lo" for 20 seconds then "robot" message.	Batteries are getting towards the end of their charge. The robot can continue to be used, but batteries should be charged for the next activity.
3	"rEchArgE"	Batteries are ready to be charged and the robot will not function.

- The pupils will be told about these messages in the DVD for activity 2.
- Each of the supplied battery chargers can take 8 batteries at a time. You should only charge in units of 4 or 8. The battery charger shows where to place the batteries and indicates the correct orientation.

Charger with 4 batteries

Charger with 8 batteries

- The time for a full charge is about 8 hours. After 8 hours it will stop charging. This may be a problem as the charge time is longer than a school day. The chargers are rather basic and do not detect when the batteries are fully

charged, but rely on charging for a fixed period of time. Therefore, each time you switch the charger off then on, it resets the timer and can cause the batteries to overheat.

- If you are not allowed to charge the batteries overnight, then charge the batteries for as long as you can, say 9am to 3pm. This will give the batteries sufficient charge to run for quite a long time.
- Batteries vary and their ability to hold charge diminishes over time, therefore it is difficult to give exact figures on how long the batteries will last. Under ideal conditions they will last for about 2 to 3 hours of continuous use. Therefore, you should not need to charge the batteries very often.
- We have included a mains distribution block to allow all the chargers to be plugged in at the same time
- If the batteries have to be charged too often then they may be faulty. Please send me an email and I will send you replacements.

Working with the DVDs

The supplied DVDs use a relatively modern technology and should run on most DVD players. However, older players, more than 5 years old, may not be able to recognise the disc. **_We suggest that you check that the discs can play on your school facilities before running the class_**. Please let us know if you are having trouble with the discs. We will be able to supply discs using a different technology.

At the end of the project

Please do the following when you are finished using the project
- Children/teachers to complete the evaluation sheets.
- Any photographic and video material from the activity work would be much appreciated. Please can you check that you have permission from parents for us to use this footage as it may be used in project publicity.
- Check that each robot kit has
  - A built robot (please DO NOT dismantle) with four batteries
  - A switch controller, cable and screwdriver
  - Also include any bags that have survived the project
- Check that the class kit has
  - A set of battery chargers, charger power supplies and mains block.
  - A project manual
  - Switches and light sensing components (as many as possible)
  - Remnants of consumable materials (tape, pens, etc)
- Send a "project complete" email and we will arrange to have the kits collected.

Jim Herd
Tracy McHenry   August 2009

Robokid

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Activity 1 – Robot build

Aim

Build and test the Robokid robot vehicle.

Materials

ONE robot kit per team (usually 3 in a team)
Activity 1 DVD (Marked "Activity 1 and Activity 2")
Build document (Step-by-step build guide with photographs)
Pupil worksheet with list of main steps (issued after watching DVD)
Fault finding chart

Location

Build and test can be done on a desk in a classroom. Driving needs large floor area.

Background

We suggest making the following points to the pupils

- The Robokid project will allow the children to work with a small robot vehicle to do a range of challenges and tasks. The first task is to build the robot, make sure it works, and to practice driving it.
- This will give them a chance to work with some of the latest electronic technology. The electronics in Robokid is very similar to the electronics in mobile phones, MP3 players, cameras, games consoles, cars, computers and plasma screen TVs. For example, the brain of the robot is an electronic chip that is used in many modern cars and household products.
- The children will be working as a team of engineers to build, use and look after their robot. It is quite robust but will be damaged if you drop it or stand on it. So ask them to look after it and keep it in its box when they are not using it.
- Make sure they give their robot a name and take its photograph and maybe some video.
- The Robokid vehicle was specially designed by Scottish engineers at Heriot Watt University in Edinburgh specifically for this project and they will be very interested in what you and your class think about the robot and the activities. You can help make the project better by giving us suggestions on how Robokid can be improved.
- The teams need to plan their work and to take reasonable care during the build. The kit components will withstand normal handling without any problems.
- Make sure they take care when inserting the batteries.
- The robot is a simple example of small robot vehicles that are being developed for many applications. For example
  - Planet investigation (e.g. Moon, Mars)

- Underwater exploration (e.g. oil exploration)
- Clearing of dangerous objects (e.g. bombs)
- Carrying materials in factories and hospitals
- Cleaning carpets and floors

Tasks

1. Form teams

We suggest teams of 3 pupils.

2. Show activity 1 DVD

Show class the build sequence DVD (From main menu select "Activity 1 – Build"). Approximate running time is 11 minutes. This will go through the build procedure step-by-step. Through the scene selection option on the main menu you can repeat parts of the build if required.

3. Do build

- Distribute activity 1 worksheet (1 per team)
- Emphasise that they need to be careful not to lose any of the small parts and to use the cardboard box to keep the loose parts as they build the robot.
- The teacher's kit has some spares, just in case some of the bits are lost!

4. Experiments

- Learn to drive Robokid
- Make obstacle course to practice driving

Notes
1. Clear some floor space (robot does not work well on carpets)
2. Robot needs to be in mode "J0" (see glossary for meaning of MODE)
   a. Switch on (power LED is lit and buzzer sounds)
      Display = "robot" = all is OK
      Display = "bAt_lo" = recharge batteries soon, but still use.
      Display = "rEchArgE" = stop and recharge.
   b. If this does not happen consult fault chart
   c. Switch sequence for mode "J0" is "3A" (means press switch A 3 times)
      Subsequent switch sequences will be shown in this manner. For example, "A_2D_A" means press switch A once, switch D twice then switch A.
   d. Robot can now be run from the switch controller.

5. Tidy procedure

Switch off the robot
Batteries can be left in the robot
Remove cable from robot and switch controller
Put everything back in the cardboard box
Store worksheet in a project folder

Build activity issues from Phase II experience

Initial feedback from the first schools has highlighted a number of issues:

1. It may be useful to show the children the build video twice. The detailed aspects of the build are covered but they can easily be forgotten in the excitement of the construction.

2. The main issue during the build sequence has been incorrect wiring of the motors. Ask the children to do the following visual check of the motor wiring before switching ON

BLACK wire for LEFT motor should be connected to LEFT connector clamp 1
RED wire for LEFT motor should be connected to LEFT connector clamp 2

BLACK wire for RIGHT motor should be connected to RIGHT connector clamp 1
RED wire for RIGHT motor should be connected to RIGHT connector clamp 2

- On the circuit board the left side is shown by the letter "L" and the right by the letter "R".

3. Just to clarify the working of the joystick controller for mode "JO". The left switch controls the left motor and the right switch controls the right motor. The OFF position is when the switch is in the middle of the three positions.

4. The rivet for the pen holder should not be pushed hard until it is located in the hole in the board. There are spare rivets in the class kit.

5. If you have problems then please contact me.

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Activity 1 worksheet

Robot/team name _____ Kit number ____

Follow the bubbles

Unpack box

Attach pen holder with rivet

Fit front dome nut with screw

Fit Motors with rivets

Wire motors

Insert batteries

Connect switch controller with cable

Set switch controller switches to middle positions

Set POTs to ⇧ positions

Switch ON the robot

Robot buzzes and shows word "robot"

Yes

No

See teacher

Press SWITCH A THREE times for mode "JO"

Use switch controller

Learn to drive robot

Build simple obstacle course

Work as a team

- -

Tidy

Switch off robot

Remove cable

Store all bits in box

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Build procedure

Unpack

When you unpack the circuit board put the bag in the bottom of the box to protect your robot when it is built.

Kit of parts
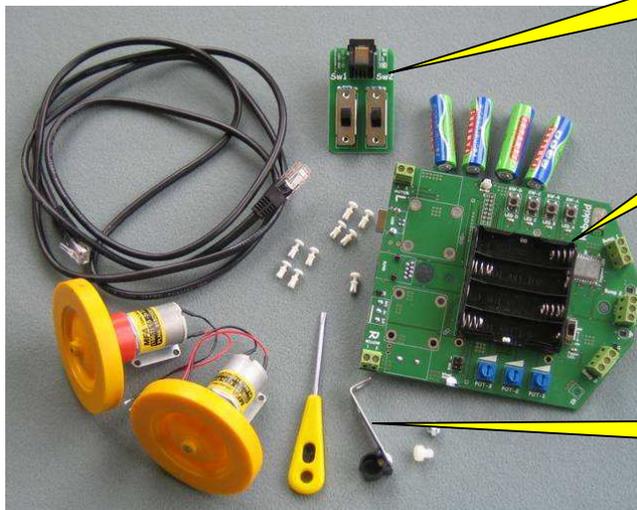
Switch controller

Robot circuit board

Pen holder

Build sequence

1. Fit pen holder

Pen holder

Plastic rivet

2. Fit front skid

Plastic screw

Dome nut

3. Fit motors

Split a rivet

Rivet "pin"

Rivet "tube"

Fit motor onto "tube"

Insert "tube"

Fit "pin" into "tube"

and push.

One rivet in

Repeat for all
eight motor rivets

4. Wire motors

RIGHT MOTOR
Black wire to terminal 1

RIGHT MOTOR
Red wire to terminal 2

LEFT MOTOR
Black wire to terminal 1

Right motor

Left motor

LEFT MOTOR
Red wire to terminal 2
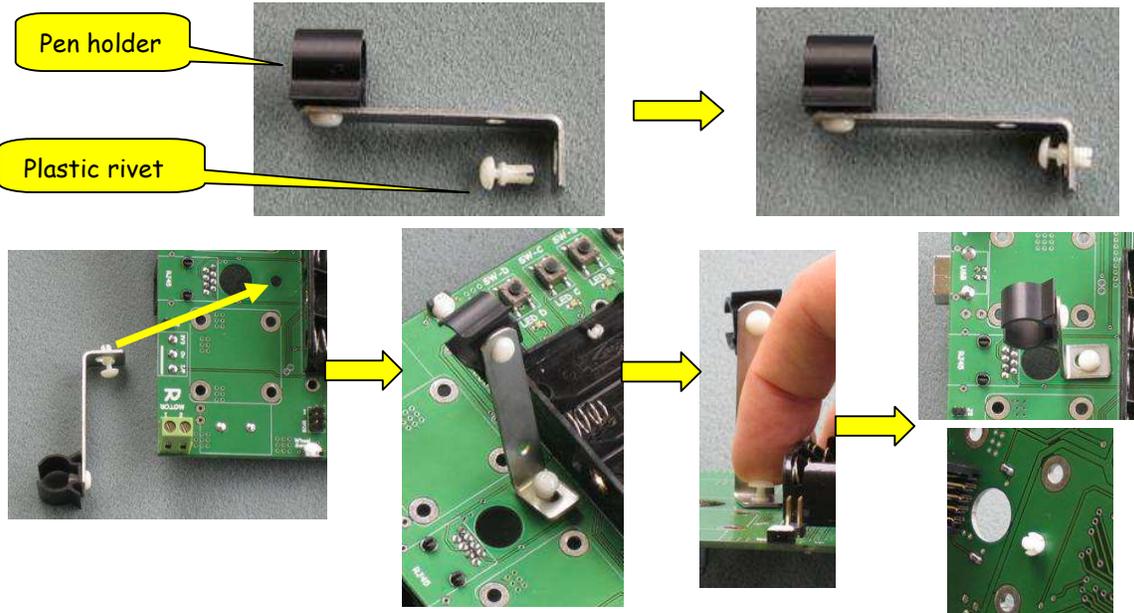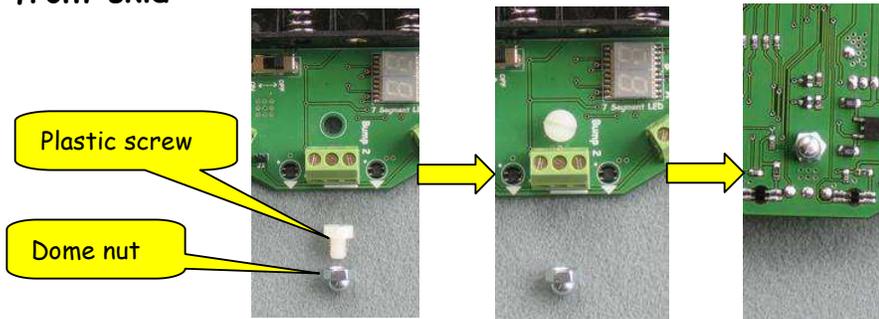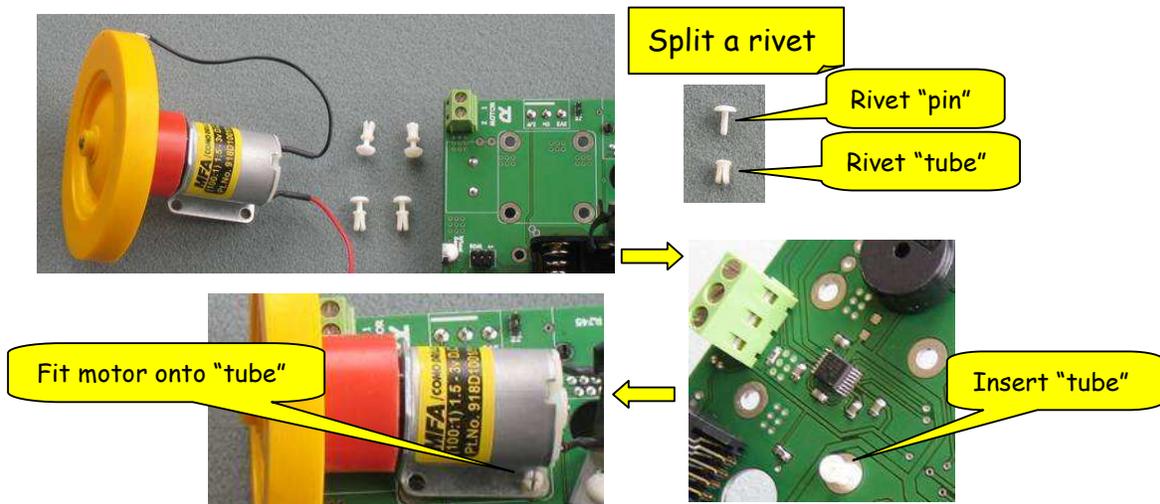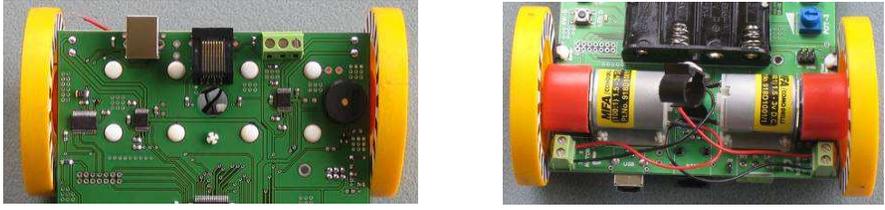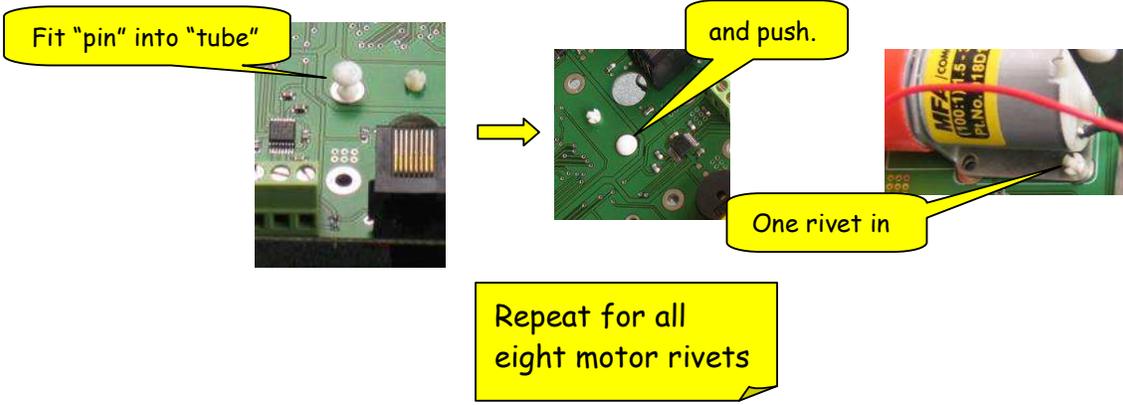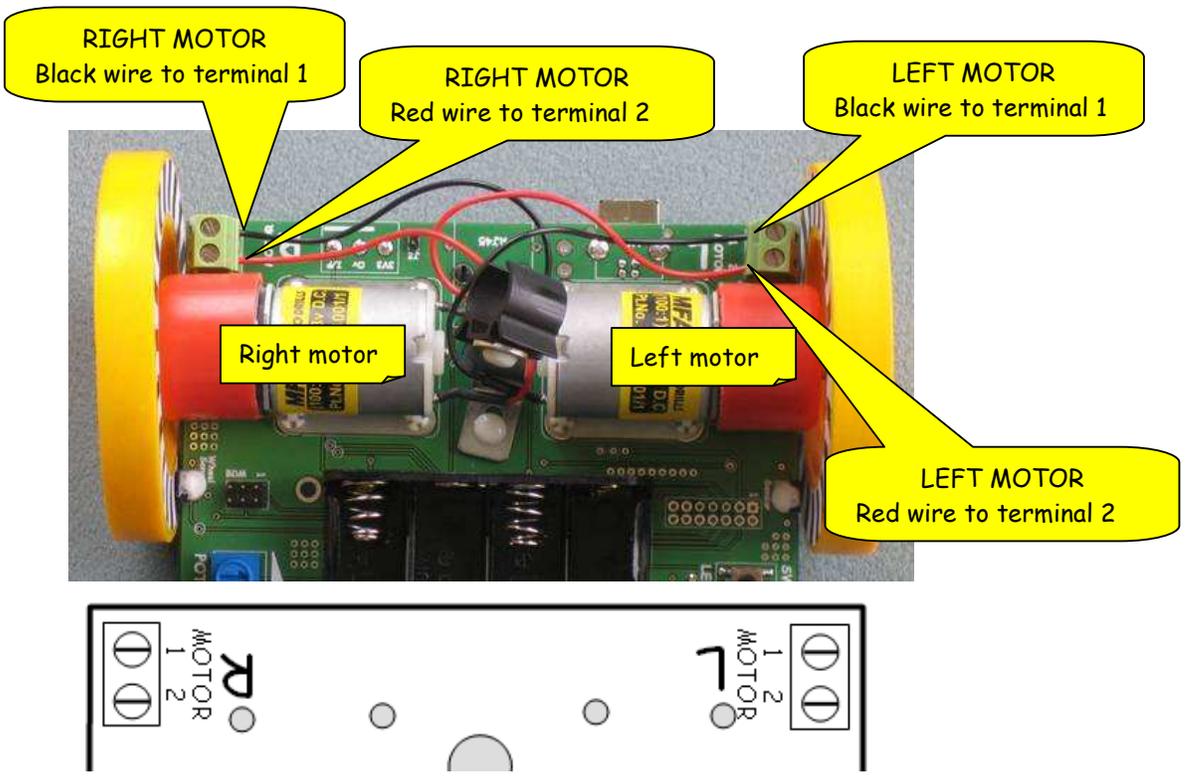
5. Connect switch controller
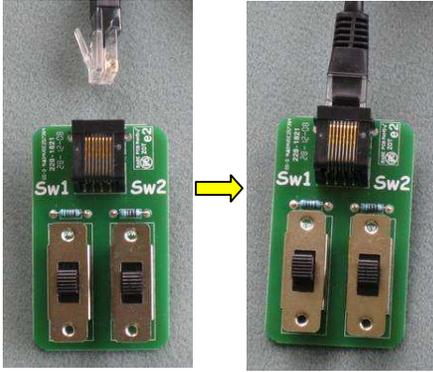
Connect one end of cable to the switch controller
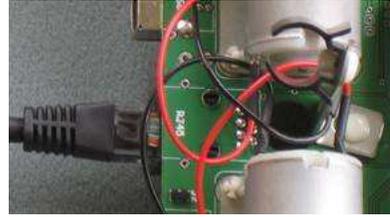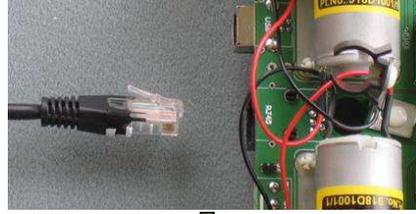
Connect other end to the robot

6. Install batteries

+ve end

-ve end

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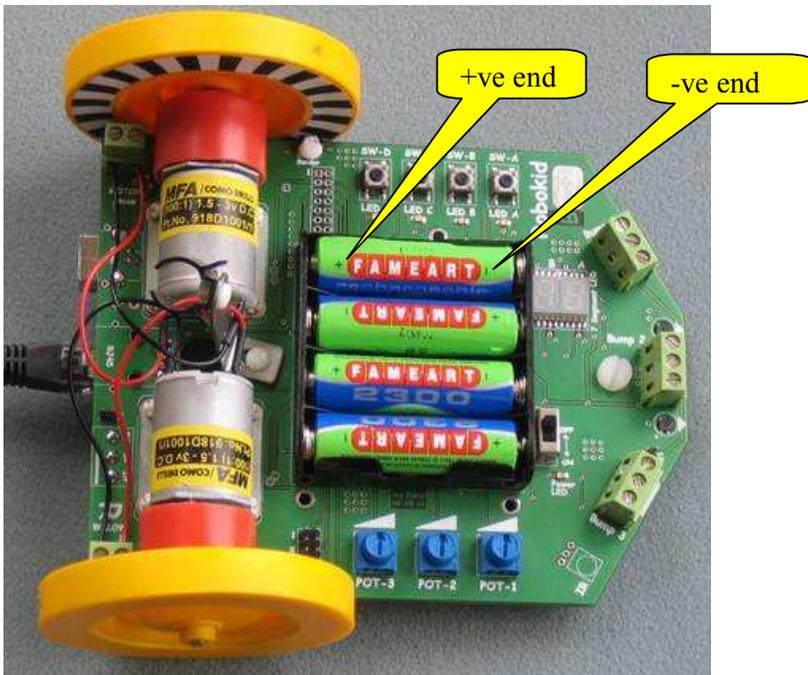
Activity 1 : Test chart 1

- Disconnect switch controller and do the following

Power ON

Power light ON ? → No → Power OFF
Check batteries for correct insertion

Yes

Power ON

Power light ON ? → Yes

No

Power OFF
Recharge batteries
Power-ON

Power light ON ? → Yes

No → FAULT
Return unit to HW

Buzzer sound ? → No → Power OFF
Power ON

Yes

Buzzer sound ? → Yes

No → FAULT
Return unit to HW

OK
Continue
Go to fault chart 2

Robokid

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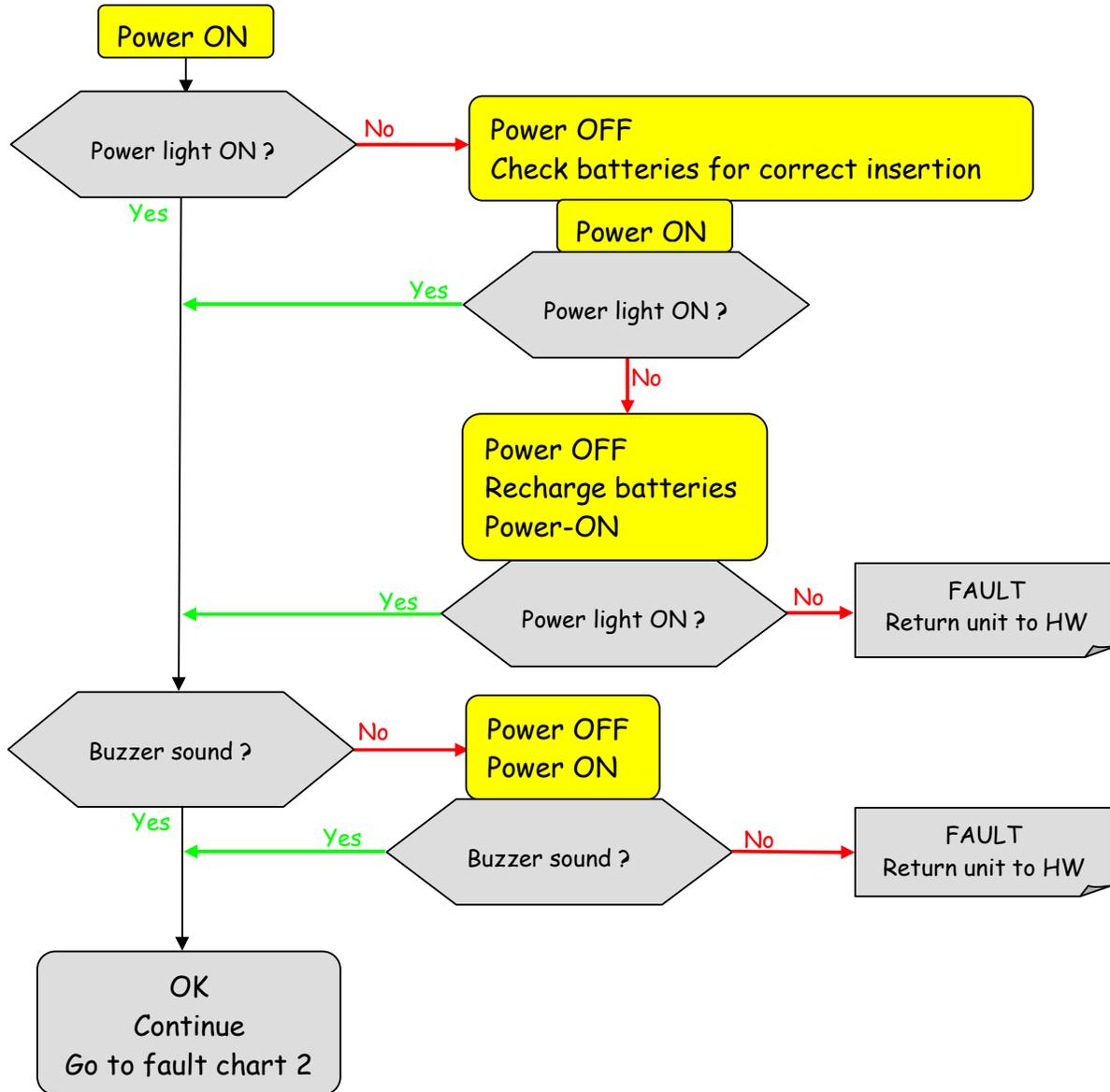
Activity 1 : Test chart 2

If you have reached this point then Robokid has been successfully powered on. Next task is to run a small test and observe the effects.

> **Run test**

> **Use the following switch sequence**
> 1. Press Switch A
> 2. Press Switch D
> 3. Press Switch A twice
>
> To get to mode shown as "A0" on the display

> **Place robot on the floor and press switch A**
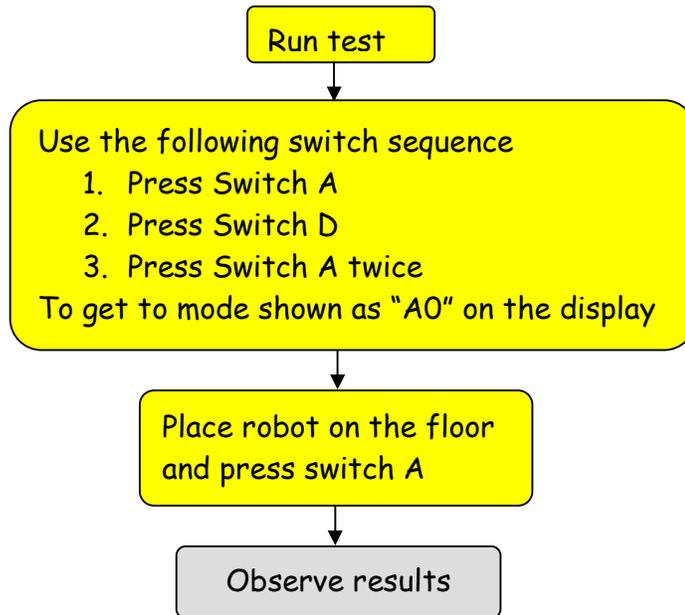
> **Observe results**

The following table gives a list of all the possible results

| Case	Effect observed	Fault	Fixes for fault
1	Robot drives forward	No	No fault, robot is correctly wired.
2	Robot drives backward	Yes	For each motor, black and red wires need to be swapped. BLACK should go to connector 1 and RED wire should go to connector 2
3	Robot spins sharply to the LEFT.	Yes	Wiring for RIGHT motor is correct. Rewire LEFT motor making sure that black wire is in connector 1 and red wire is in connector 2
4	Robot spins sharply to the RIGHT.	Yes	Wiring for LEFT motor is correct. Rewire RIGHT motor making sure that black wire is in connector 1 and red wire is in connector 2
5	Spins to LEFT but with LEFT wheel not moving	Yes	Wiring for RIGHT motor is correct. Rewire LEFT motor making sure that black wire is in connector 1 and red wire is in connector 2.
6	Spins to RIGHT but with RIGHT wheel not moving	Yes	Wiring for LEFT motor is correct. Rewire RIGHT motor making sure that black wire is in connector 1 and red wire is in connector 2
7	Robot does not move	Yes	Redo wiring for both motors making sure that black wire is in connector 1 and red wire is in connector 2

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Activity 2 : navigate

Aim

Learn about one of the driving modes and practice steering the robot.

Materials

Built and working robots
Activity 2 DVD (Marked "Activity 1 and Activity 2")
Worksheet (marked Activity 2 worksheet)
Objects to make a driving course

Location

Working out 9 switch options can be done on a classroom desk (with care)
Driving needs large floor area.

Background

- Robots can work in two different ways
  1. Many robots are connected to a controller by a wire or a wireless link and a person sends commands to the robot through this link. Good examples are the underwater robots used in the North Sea. Here, a person is on a ship and directs the robot through a long cable. A more complex example is the Mars Rover vehicle, this time the link is by radio rather than cable. Engineers on earth work out a set of moves and then send them to the robot on Mars.
  2. Newer robots are being designed which can be much more independent and can "think" for themselves. These are called autonomous robots. A simple example is the robot vacuum cleaner. It plans its own pattern of cleaning quite independent of a person.

- Activity 2 is an example of a cable connected robot that needs to be told what to do. Some of the later activities will use the robot as an autonomous robot.

- The practical aim is to become familiar with the robot and how to use the switches to put the robot into different modes. Also, the pupils will see how the robot tells them that its batteries need recharging. If they get the switches wrong then tell them to switch off and start again.

- They will use this mode in a later competition.

Tasks

1. Show activity 2 DVD

Show class the DVD (from main menu select "Activity 2 – Navigate"). Approximate running time is 7 minutes. You can scene select to repeat parts of the DVD.

2. Do activity

- Working out the 9 modes can be done in the classroom or in a hall. If doing it in the classroom on desks ask them to be careful not to let the robot drop onto the floor. Not sure we need this as it is covered under location
- Practice driving different obstacle courses.

Notes
1. On power on, get them to check the display message as outlined in activity 1.
2. They will be using mode "J1". To get there use the sequence - 2A_D_A (press switch A twice, press switch D once, then press switch A once).
3. Practicing their driving skills needs to be done in a hall area.
4. Objects will be needed to make a driving course. Anything can be used – books, water bottles, etc.

4. Tidy procedure

Switch off the robot
Batteries can be left in the robot
Remove cable from robot and switch controller
Put everything back in the cardboard box
Store worksheet in a project folder

Activity 2 worksheet – Navigate

Aim : Experiment with simple robot vehicle steering.

Task

1. Connect cable and switch controller to robot
2. Set your switch controller switches to the OFF position (see picture).
3. Power-on the robot and select MODE "J1" by pressing "2A_D_A" (press switch A twice, switch D once and switch A once.)
4. Now run the robot to work out the effect of the controlling switches.
5. The two switches on the controller each have 3 positions which give NINE possibilities. Fill in table 1 below with the NINE possibilities using the symbols in table 2.

right switch → left switch ↓			
	↺		⇑

Table 1: Nine possible switch controller positions

Effect	Symbol
Slow forward	↑
Fast forward	⇑
Spin left or right at slow speed	↺ ↻
Spin left or right at fast speed	◖↺ ↻◗
Turns left or right	↖ ↗
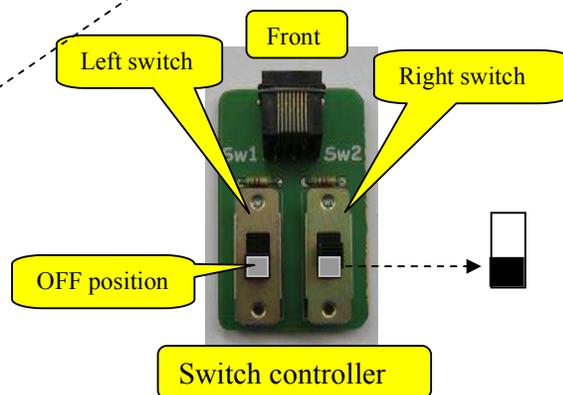
Table 2: Symbols required for filling out table 1

6. Lay your robot storage box on the floor and try to steer your robot around the box. See how close you can go without hitting the box.
7. In a later activity you will participate in a competition using this method of steering.

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Activity 3 : Cover design

Aim

Design and make a cover for the robot.

Materials

Template for simple cover.   (part of teachers pack)
Pictures of example covers   (part of teachers pack)
Art materials

Location and Activity Time

Classroom activity.

Background

- Time to give your robot some character.
- Cover is to be based on one of two themes
  - Animal or insect
  - Machine
- Get the children to think about what design features their machine would have. For example, the lunar rover has an aerial and satellite dish to send and receive signals. It has an on-board camera to take pictures and film of the surface of the moon. It also has two grabbers to allow it to collect moon rock samples.

Tasks

1. Plan activity

- Team to work together to decide on
        Choice of theme, animal or machine
  Create paper/pencil designs showing different ideas and concepts.

2. Make cover

- Before doing a lot of decorative work, get the team to check that the cover fits on the robot and can be easily moved to access the switches.

3. Test

- Run robot in mode "J1" (as per activity 2) to check that it does not interfere with the operation of the robot.
- Take pictures and video of all the covers.

4. Tidy

As per earlier activities.

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Activity 3

Example covers

1. Machine example :: Lunar rover
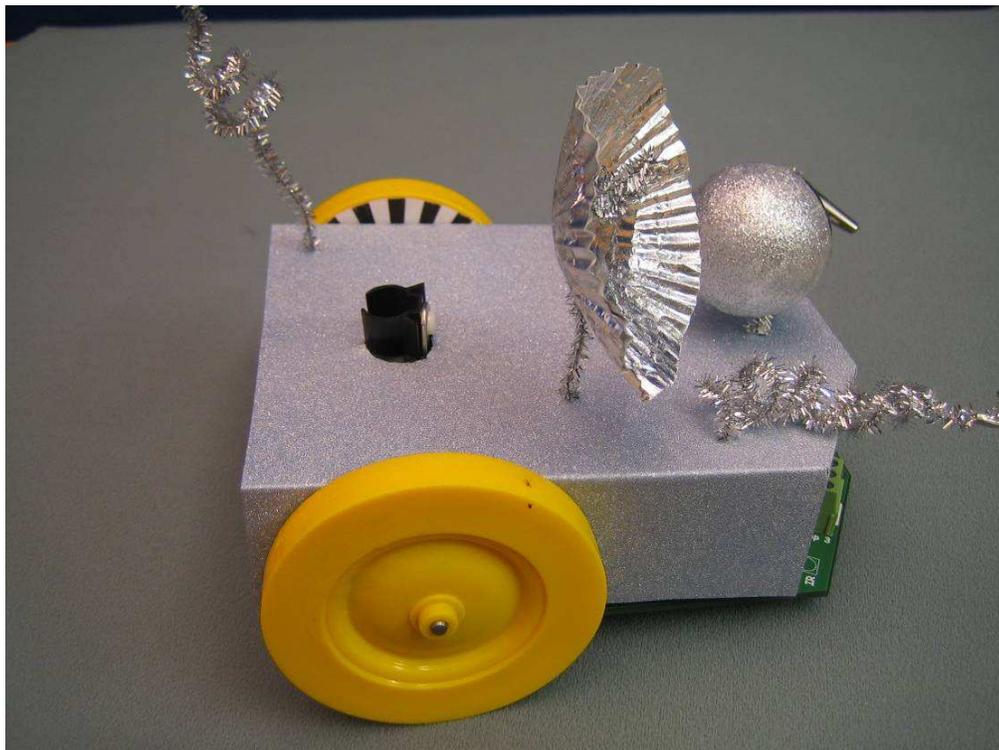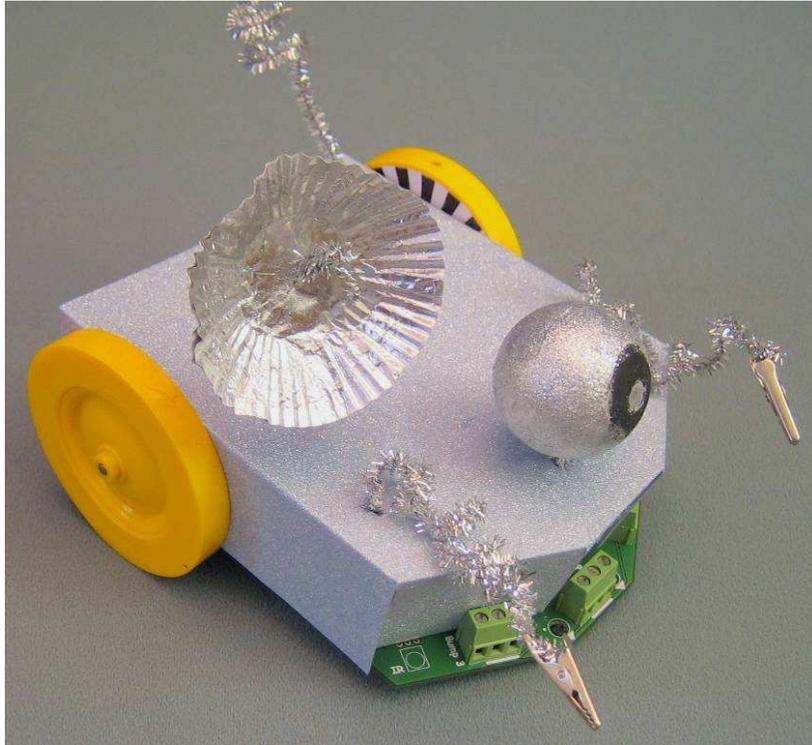
2. Animal example :: Ladybird

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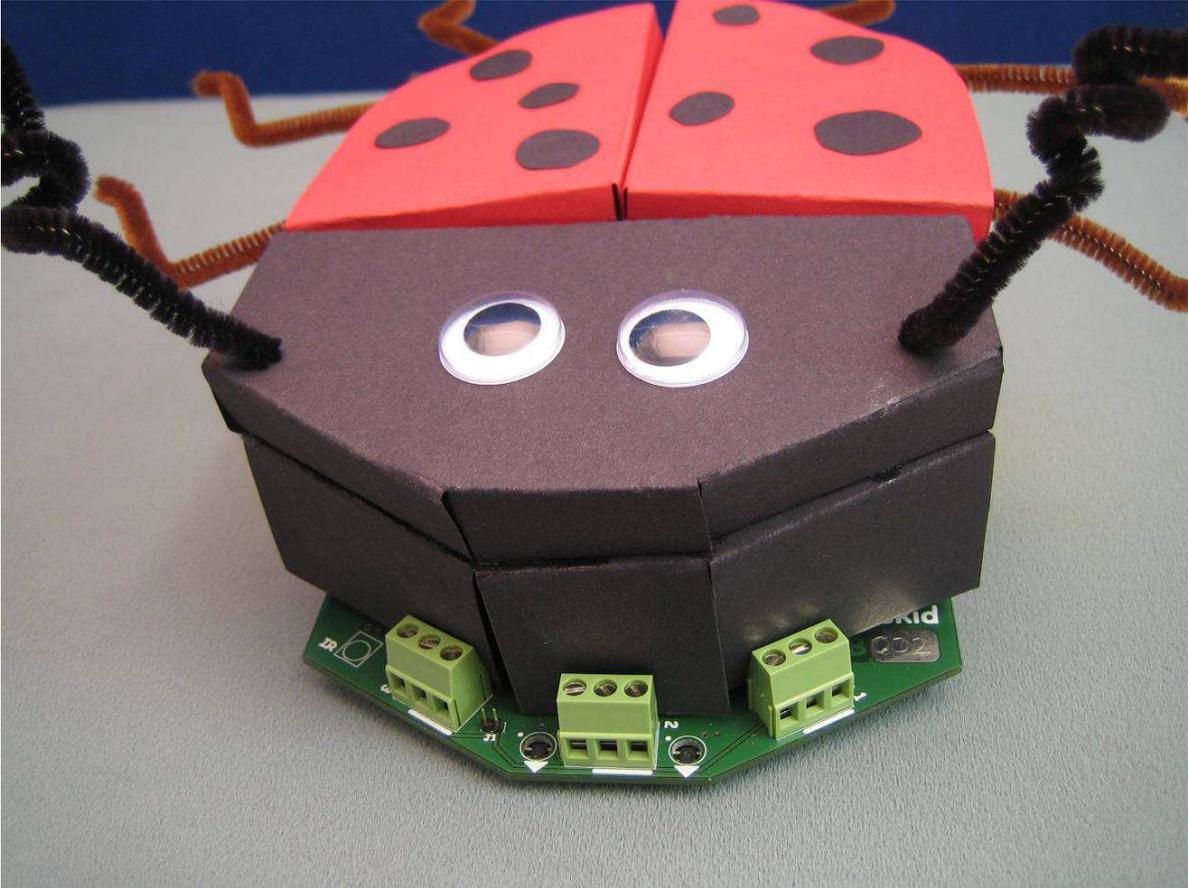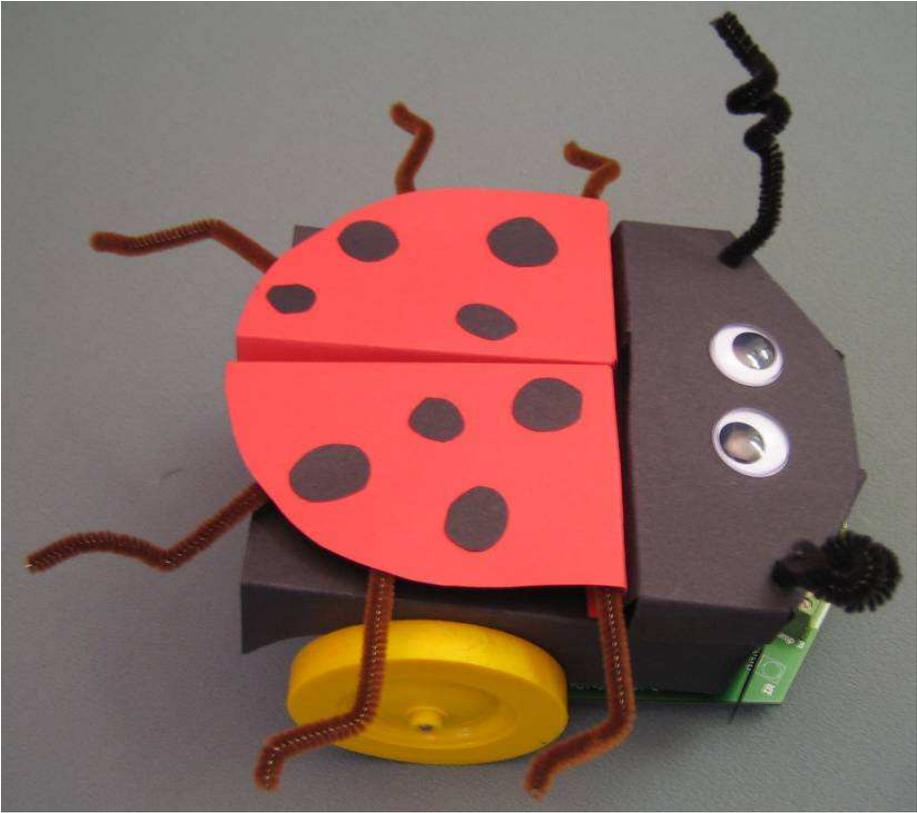
Activity 4 : driving competition

Aim
Class competition

Materials
Working robots
Obstacles (e.g. robot storage boxes)
Stop watches

Location
Requires large floor area.

Tasks

1. Driving competition
- Everyone likes a competition.
- The aim is to get the teams to use their driving skills. During practice, we encourage team members to cooperate and help each other. With the task requiring quick dexterity, some pupils find it easier than others.
- In previous school robot events we have used a figure-of-eight course for the team competition. It contains enough variation to make it interesting but stops short of being too difficult. However, please choose whatever course you think is suitable. We would be interested in other types of courses.
  - For example, the course could include a ping-pong ball which each team member would have to hit during their run.

2. Alternative Football competition

- By building a cube catcher at the front of the robot, the teams can then catch and manoeuvre a small cube (ping-pong size) to a goal. Cubes are better than balls as they don't roll away.
- The class kit contains a number of plastic coated wires (about 7cm in length that can be used as catchers. These can be screwed into any of the front bump terminal blocks, as in the following diagram
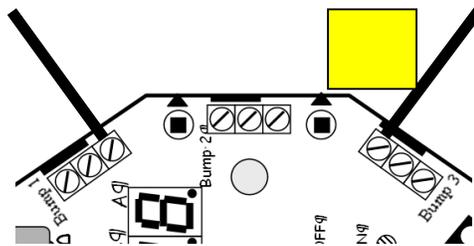
- The competition can consist of timing how long a team takes to collect three balls and get them into a goal area.
- The teams can be given the choice of joystick mode – mode "J0" (has reverse but no curve) or mode "J1" (curve but no reverse).

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Activity 4 : Driving competition details

Here is a suggested format.

1. Build a competition arena using four robot cardboard boxes and two strips of black tape.
    a. We have suggested a figure-of-8 course, but any format of course would be suitable.

Box 2

Box 4

Figure-of-8 path of robot

Box 1

Box 3

Start/finish line
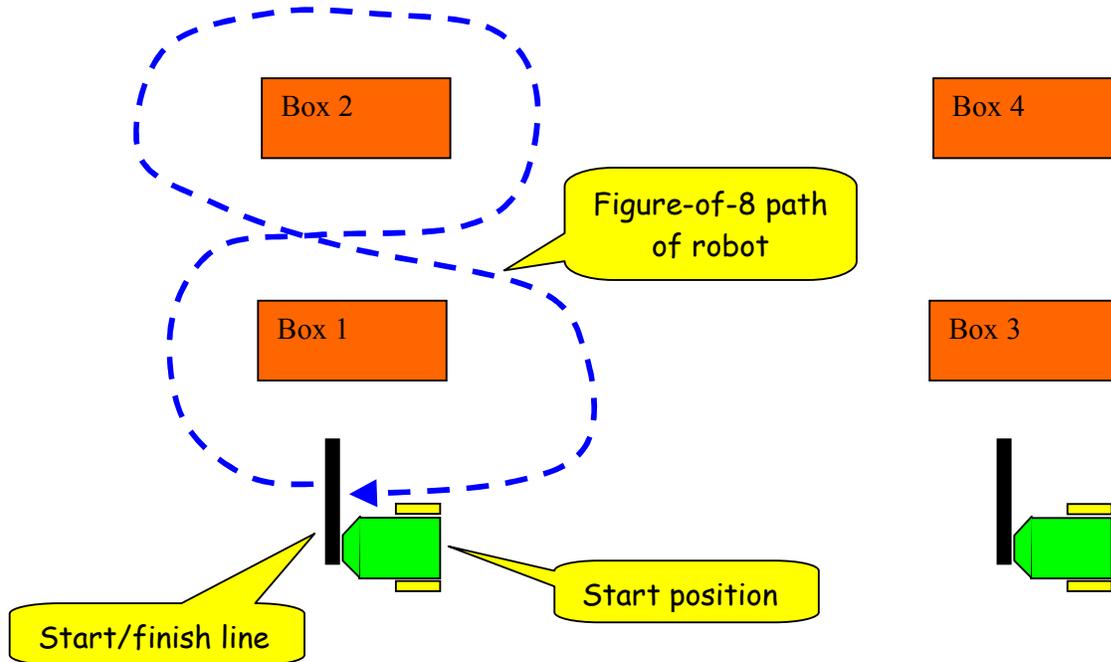
Start position

2. Two teams would race at once.
3. For each team
    a. Set your robots into mode "J1" and place at the start positions
    b. When ready, the referee will issue a go command and will start a stopwatch.
    c. The first member of the team will drive a figure–of-8 path round the boxes. When reaching the finishing line the second member of the team will take over and repeat the path.
    d. Finally, the third team member will repeat the path.
4. The referee will stop the stopwatch when the robot touches the finishing line. The times would be recorded for each team (maybe a bonus deduction of a few seconds for winning a heat)
5. Start with a league system where each team get 2 or 3 goes. The best four teams would then run a semi-final/final head-to-head runs to find an eventual winner.

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Activity 5

Aims

Introduce autonomous (see glossary) mode.
Work out how to get robot to go in curved and straight lines by adjusting the speed difference between the two wheels.

Materials

Working robots (switch controller disconnected)
Activity 5 DVD (Marked "Activity 5")
Black tape to mark out a straight line (4 rolls in class kit)
     This is standard 19mm tape available from DIY stores
Activity worksheet (marked "Activity 5 worksheet : lines and curves")

Location

Straight line work can be done on a desk or on a floor area.
10-pin bowling practice requires a large floor area.

Background

- This is the first activity where the robot is not directly controlled by the switch controller. The robot will be working in autonomous mode where the computer has to make decisions about what to do. The aim of much of current robot development is to make useful autonomous robots. That is, robots that can be given a task, which they do without a human operator having to direct its every move. An interesting example is the robot vacuum cleaner.

- The basis of this activity is that although components are manufactured to be identical, they are never exactly the same. For example, the motors used in the robot are made in the same factory and on the same machines, but are slightly different. The result is that when the two motors are given the same battery voltage, the two motors will run at slightly different speeds. The result is that the robot moves in a curve rather than in a straight line. This is a well known effect. The solution is to get the computer in the robot to make a slight adjustment to one of the motors to get both motor speeds to be as equal as possible.

- This idea of using a small computer in a product to compensate for problems in the components is now very common. In fact, every product in a modern household has a computer similar to the one in our robot.

Tasks

1. Show activity 5 DVD

- Show class the DVD (from main menu select "Activity 5 – Lines and curves"). Approximate running time is 6½ minutes. You can scene select parts of the DVD.
- The DVD will explain how to adjust the robot to move in a curved or straight line.

2. Do activity

- Mark out a straight line using tape on the desk or on the floor (lino or tiled only!) Take care if using desks – robots can get damaged if they fall on the floor.
- Vary POT-2 positions, observe the effect on the robot and complete worksheet.
- Get teams to experiment with changing POT-1 and POT-3 settings.

Notes

1. As this activity can be done in a classroom or in a hall there are different POT-3 settings for working on a desk or on a floor.
2. After switch on check the display message

   Display = "robot" = all is OK

   Display = "bAt_lo" = recharge batteries soon, but still use.

   Display = "rEchArgE" = stop and recharge
3. Power on and use robot in mode "A0" (switch sequence A_D_2A)
4. When the robot display shows "A0" (no flashing) they can press the A, B and C switches.
   - Pressing switch A will cause the robot to perform the move forward.
   - Pressing switch B instructs the robot computer to read and remember the three POT values. (speed, differential (see glossary) and time).
   - Pressing switch C will exit this MODE.
5. POTs control the following –

   POT-1 – varies speed

   POT-2 – adjusts speed of one wheel compared to the other.

   POT-3 – varies the time the robot moves forward (2 to 8 seconds).

3. Tidy procedure

As per previous activities

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Activity 5 worksheet : lines and curves

<u>Aim</u> : **Getting your robot to go in curved and straight lines**

<u>Task</u>
1. Remove robot from its box and make sure the switch controller is not connected.
2. If you are working with the robot on a desk
    a. Mark out a 60cm straight line using the black tape
    b. Set POT-1 and POT-3 to the following :
        i.   POT-1 ⇧   POT-3 ⇦
3. If you are working with the robot on the floor
    a. Mark out a 120cm straight line using the black tape
    b. Set POT-1 and POT-3 to the following :
        ii. POT-1 ⇧   POT-3 ⇧
4. Power on the robot and select MODE "A0" by pressing "A_D_2A"
5. When the robot display shows "A0" (no flashing) you can press the A, B and C switches.
    a. Pressing switch A will cause the robot to move forward.
    b. Pressing switch B instructs the robot's computer to read and remember the three POT values. (speed, differential and time)
    c. Pressing switch C will exit this MODE.
6. Place your robot at the start of your black line and using the switch information do experiments to fill out Table 1

POT-2 setting	Setting	Observed direction
⬊	LOW	
⬆	MEDIUM	
⬈	HIGH	

Table 1   POT-2 observations
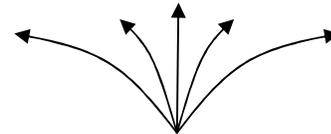
7. Using information in table 1 work out the setting for POT-2 to make your robot go as straight as possible. Record the arrow position below.

POT-2

8. You can now experiment with the effect that the other POTs have on the way the robot behaves.
    a. POT-1 controls the speed
    b. POT-3 controls the amount of time the robot runs (from 2 to 8 seconds)
9. Understanding what effect the three POTs have will help you in the next activity – 10-pin bowling.

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Activity 6 : 10-pin bowling

Aim

- Have some fun applying the knowledge gained in activity 5.

Materials

- Working robots (switch controller disconnected)
- Sets of skittles (e.g. empty water bottles)

Location

Large floor area space.

Background

- Robots don't always move in straight lines. In fact, moving in curves round obstacles can be quicker than moving in straight lines only, and can use less battery energy. Thus allowing the robot to work for longer.
- Curves can be created by moving the wheels at different speeds. These curves can vary from tight circles and spins to long slow arcs.

Tasks

1. Do activity

- Get group to set up a set of skittles about 100 centimetres from a start point. For example

Start point

Example set of 6 skittles

About 100 cm
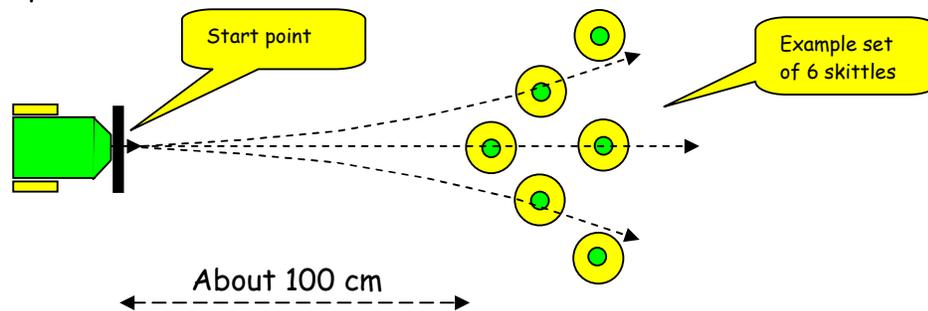
- The robot MUST always start pointing straight ahead. This is to ensure that the children have to adjust the POTs to get the robot to take a curved path.
- Allow groups to practice using the three POTs to set different curved paths. Encourage them to take notes on the outcome of various settings.
- Complete the activity by having a competition with one skittle set-up for the whole class. Each team to get two tries to knock over as many skittles as possible. Please feel free to define your own competition and rules. It's all about having some fun.

Notes:-

1. After switch on check the display message -

   Display = "robot" = all is OK

   Display = "bAt_lo" = recharge batteries soon, but still use.

   Display = "rEchArgE" = stop and recharge.

2. Power on and use robot in mode "A0" (switch sequence A_D_2A)

3. When the robot display shows "A0" (no flashing) the A, B and C switches are active and can be pressed. (shown by the flashing lights)

   - Pressing switch A will cause the robot to move forward.
   - Pressing switch B instructs the robot's computer to read and remember the three POT values. (speed, differential (see glossary) and time)
   - Pressing switch C will exit this MODE.

4. POTs control the following –

   POT-1 – varies speed

   POT-2 – adjusts speed of one wheel compared to the other.

   POT-3 – varies the time the robot moves forward (2 to 8 seconds).

5. Please take some photos and video and send it to us.

2. Tidy procedure

As per earlier activities

Activity 7 : line bump

Aim

To run the robot so that it detects and reacts to black tape lines

Materials

Working robots
Black tape and Berol Broad felt-tip pens (1 pen per team)
Square sheets of white paper (cut from rolls provided in the class kit)
Activity 7 DVD (Marked "Activity 7 and Activity 8")
Activity worksheet (Marked "Activity 7 worksheet")

Background

Background : General

- A robot needs sensors to find things out about its environment.
- What sensors (senses) do people have?
  Eyes (sight), ears (sound), nose (smell), fingers (touch), skin (temperature), tongue (taste)
- What sensors (senses) does Robokid have?
  Eyes (sight), switches (touch), battery checker (hunger).
- This activity will concentrate on using two of the robot "eyes".

Background : Experiment 1

- The two optical sensors at the front of the robot can detect the difference between black tape and white paper. These two "eyes" are located at the front of the robot and look down at the floor. They work by sending out some infra-red light and looking at what bounces back. A lot bounces back from white paper, but very little returns from the black tape. The robot computer converts the result to a number and uses it to plan its operation.

  sensor

- Our eyes cannot detect infra-red light so we will not see the beam. In fact, this light is used by TV remote controls to pass signals to your TV.
- The light is called "infra-red" because it is just above the red light of the visible light spectrum.
- Some animals can see infra-red light. For example, some snakes have little infra-red eyes (called pits) as well as normal eyes.
- Experiment 1 shows the robots basic avoidance strategy. As soon as it detects the line it stops, reverses for a small period of time, then spins for a small period of time before heading off in a new direction. As it always uses the
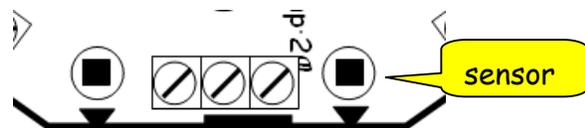
same avoidance mechanism, shapes drawn on the sheet will have regularity to them. However, the final pattern will be heavily dependent on the shape of the black tape perimeter. Try to get each team to use a different shape.

Background : Experiment 2

None required

Background : Experiment 3

- Mode "b0" is a rather predictable mode, in that the robot executes a fixed sequence and always turns and spins in a repeatable manner.
- If this was a bug trying to get away from a predator, this type of behaviour would not be a good survival approach.
- Mode "b1" introduces randomness into the robot's decision making. It is as though the robot has an internal dice which is used to produce random numbers. These random numbers are used to determine the robot's actions whereas in mode "b0" the behaviour was determined by the settings of the POTs. Animals have this randomness quality built into their brains.

Background : Experiment 4

- The sensor does not see "blackness", it measures the amount of infrared light that is reflected.
- Black felt-tip pen and black biro ink look like white paper to the sensor!
- Photocopier ink is detected as "black". Not sure about black poster paint.

Tasks

1. Experiment 1

- Get a sheet of white paper – no greater than 60 centimetres in length
- Create a closed shape with the black tape
- Set robot into mode "b0" (power-on then A_2D_2A)
- Place in centre of area and check that it works.
- If all is OK insert a Berol Broad felt tip pen in pen holder
    Make sure that the tip of the pen is touching the paper
- Press switch A to start
- Robot will stop for the following reasons
    1. If it has been running for 2 minutes (this is called a time-out)
    2. If switch A has been pressed and held for a couple of seconds. Pressing switch A will restart
    3. If switch C has been pressed and held for a couple of seconds. Exits the mode – shown by flashing "b0" message
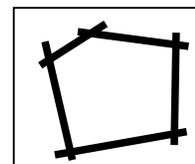
2. Experiment 2

- Switch B can be pressed to change how the robot reacts. The things that can be changed are set by POT-1, POT-2 and POT-3.

  > POT-1 :: Sets the amount of reverse when robot detects the black tape
  > POT-2 :: Sets the amount of spin after the robot has reversed
  > POT-3 :: Sets the speed difference between the two motors. A greater difference means that it moves in a tighter curve.

- Try changing the parameters and looking at the results
- Create a multi-colour picture by swapping pens with other groups.

3. Experiment 3

- Reverse paper and create new shape
- Get the teams to run the "bug bump mode" – Mode "b1" (A_2D_A_D_A)
- Press switch A to start
- Robot will stop as in experiment 1
- This mode introduces randomness into the robots decision making by making each decision reliant on a random values. The effect is if the robot has an internal dice which is used to get random reverse and spin times.
- Get the teams to compare two drawings, one from the predictable mode and one from the bug mode.

4. Experiment 4

- How does the sensor work?
- Try some simple tests with other things that are black

  > Black felt-tip pen
  > Black paint (ensure it is dry before starting the robot)
  > Black ink
  > Black photocopier ink

- Try some other materials.

5. Tidy procedure

As per normal.

6. Additional Notes

- Under some circumstances, the robot may move outside the perimeter area. Just tell the children to lift and replace in the area.

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Activity 7 worksheet : line bump

Aim : Experiment with the line detecting robot modes

Task

Experiment 1

1. Create a continuous line on a sheet of paper using black tape. Make sure there are no gaps.
2. Get your robot. The cabled switch controller should be disconnected.
3. Place your robot in centre of area and power-on. Select mode "b0". Switch sequence is "A_2D_2A".
4. Now press switch A to start. If all is OK the robot will bump its way around the area set by the tape. It will stop after 2 minutes or if you press and hold switch A or switch C for a few seconds.
5. Insert felt-tip pen and press A again. What kind of pattern has the robot drawn?

Experiment 2

1. Now experiment with the POT settings

   POT-1 :: Sets the amount of reverse when the robot detects the black tape

   POT-2 :: Sets the amount of spin after the robot has reversed

   POT-3 :: Sets the speed difference between the two wheels. A greater difference means that it moves more in a tighter curve.

2. Swap pens with another group to get a multi-coloured picture.

Experiment 3

1. Turn paper over and make a new shape for experiment 2.
2. Place your robot in centre of area and power-on. Select mode "b1". Switch sequence is "A_2D_A_D_A"
3. Now press switch A to start. If all is OK the robot will bump its way around the area set by the tape. It will stop after 2 minutes or if you press and hold switch A or switch C for a few seconds.
4. How is this different from bump mode "b0"?
5. Note that the POTs have no effect in this mode.

Experiment 4

1. Design an experiment to see if you can use other black materials in place of the black tape. Try Black felt-tip pen, black biro, black photocopier ink, black poster paint, others????
   (POSTER PAINT MUST BE DRY BEFORE RUNNING THE ROBOT)
2. Discuss the results with your teacher.

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Activity 7 : flowchart of robot activity

```
                    ┌──────────────┐
                    │    Start     │
                    └──────────────┘
                           │
                           ▼
                           ●◄─────────────────┐
                           │                  │
                           ▼                  │
                  ┌─────────────────┐         │
                  │      Move       │         │
                  │     forward     │         │
                  └─────────────────┘         │
                           │                  │
                           ▼                  │
                     ╱───────────╲            │
                    ╱    Line      ╲    NO     │
                    ╲  detected ?  ╱───────────┘
                     ╲───────────╱
                           │ YES
                           ▼
                  ┌─────────────────┐
                  │   Do reverse    │
                  └─────────────────┘
                           │
                           ▼
                  ┌─────────────────┐
                  │    Do spin      │
                  └─────────────────┘
                           │
                           └──────────────────┐
```

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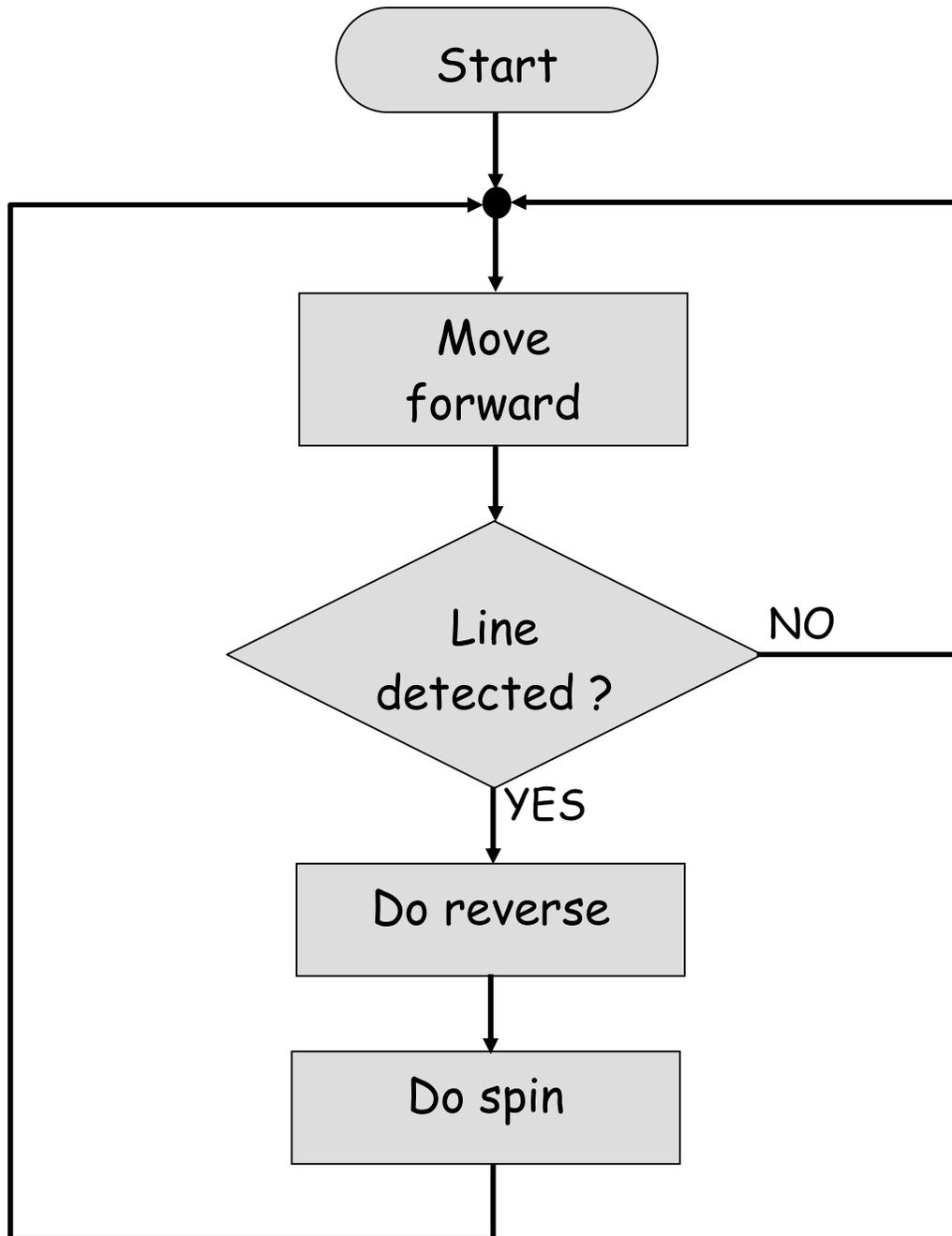
Activity 7 : Black photocopier line

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Activity 8 : line follow

Aim

To run the robot to follow a black curved line.

Materials

> Working robots (switch controller disconnected)
> Three sheets with printed track. (photocopy one set per team)
> Sellotape to tape track sections together
> Two small strips of black tape to cover the gaps (2 centimetres long)
> Activity 8 DVD (Marked "Activity 7 and Activity 8")
> Activity worksheet (Marked "Activity 8 worksheet")

Background

- Activity 7 introduced the robot's "eyes", sensors that could detect infra-red. This activity will use them to follow a black line. In fact, it tries to follow the edge between the white paper and the black tape.
- The tape can define a "path" from a start point to a destination. Quite a few robot vehicles in factory floor applications either follow taped lines on the floor or wires embedded in the factory floor. In the future, robot cars will follow lane markings and the edge of the road through the use of cameras as their sensors.
- The attached flowchart shows the robot's plan for following the line. The method is quite simple and it is possible for the robot to lose the line. Examples include
  o Curve of line becomes too great
  o Line is too narrow
  o Robot is moving too fast
- Through the experiments, the children will be able to tune the robot's plan to make it better.

Tasks

1. Experiment 1

1. Experiment 1 will use the robot's default setting to follow a black line.
2. Teams make the path using the three supplied sheets of paper. Just line up A←→A, B←→B and sellotape together. You may need to lightly tape the sheets to the floor to stop it slipping when the robot runs. We have found that our photocopier does not copy to the edge so there will be a small gap where the sheets touch. A small piece of black tape can be used to fill the gap. Don't use black felt-tip pen as the IR sensors don't see it as black.
3. Set the robot into mode "F0" (switch sequence "A_3D_2A").

4. Place robot at the beginning of the line with the two sensors on either side of the line. Then press switch A to start.
5. If it wanders off the line or reaches the end of the line pick up the robot and press switch A to stop the motors.

2. Experiment 2

- Experiment 1 is extended by allowing changes to be made to the way the robot tries to track the line. POT1, POT2 and POT3 can change the robots characteristic
  - POT1 changes the speed of the robot. In general, the faster the robot moves the more likely it will be to wander from the line.
  - POT2 changes the speed difference between the two wheels when it needs to turn. By default, it stops one wheel to force the robot to drive in an arc. POT2 allows this to be a slow down rather than a stop. This experiment shows that this can lead to a smoother track.
  - POT3 is not required and MUST be set to its 12 o'clock position.
- Adjusting POTs 1 and 2 will give different effects. The worksheet gives details of the tests.
- Remind them to press switch-B to get the robot to read the POT values.

3. Experiment 3

- Teams experiment to find the best settings for the track.

4. Experiment 4

- Test the robot's ability to go round tighter curves.
  - Additional photocopy sheets with a range of curves are included.
  - You can make your own with the supplied tape and ordinary white sheets of paper. Or use a word processor and create lines with a size of 54pt which gives a width of about 19mm.
  - You could mark out tape tracks on the floor. This is tricky to do without getting bumps and ridges that push the robot off course. Also, it can use up large amounts of black tape. However, it is fun!

5. Other possible experiments

- Create a loop track and get groups to chase each other round the loop. The team with the best POT settings will eventually catch the other robot and win.
- If activity 7 showed that black poster paint was as good as black tape them teams could paint a track through a set of obstacles. Remember to make sure the paint is dry before running the robot.

6. Tidy procedure

As per earlier activities

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Activity 8 worksheet : line follow

Aim : Experiment with robot following a curved black line

Task

Experiment 1

1. Tape the three path sheets together. Line up the two As and the two Bs to form a correct path. Use two small pieces of black tape (each about 2 cm) to cover the gap between the sheets.
2. Get your robot. The cabled switch controller should be disconnected.
3. Place your robot at the beginning of the line (either end) with the front two sensors on either side of the line. Select mode "F0". Switch sequence is "A_3D_2A".
4. Now press switch A to start. If all is OK the robot will work its way along the black line. If it reaches the end of the line or wanders off the line then pick it up and press switch A.
5. Watch how it zigzags along the line.

Experiment 2

1. This experiment will use the POTs

   POT-1 :: Sets the speed of the robot

   POT-2 :: Sets the amount of turn when the robot detects the black line

   POT-3 :: Unused in this experiment but <u>MUST</u> be set to its 12 o'clock position – that is, pointing to the battery.
2. Do the following tests and record your results

Experiment	POT-2	POT-1	Observed result
1	1 o'clock	10 o'clock	
2	11 o'clock	10 o'clock	

Experiment 3

1. Now try adjusting the settings to get the robot to go as fast as possible without losing the line. Record your best settings

POT-2   POT-1

Competition

Make an oval track and start TWO robots on opposite sides. The winner is the robot that catches the other one up.

Start point 1

Oval track

Start point 2

Activity 8 : flowchart of line follow activity
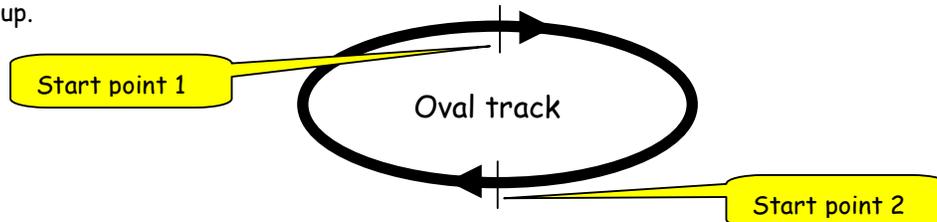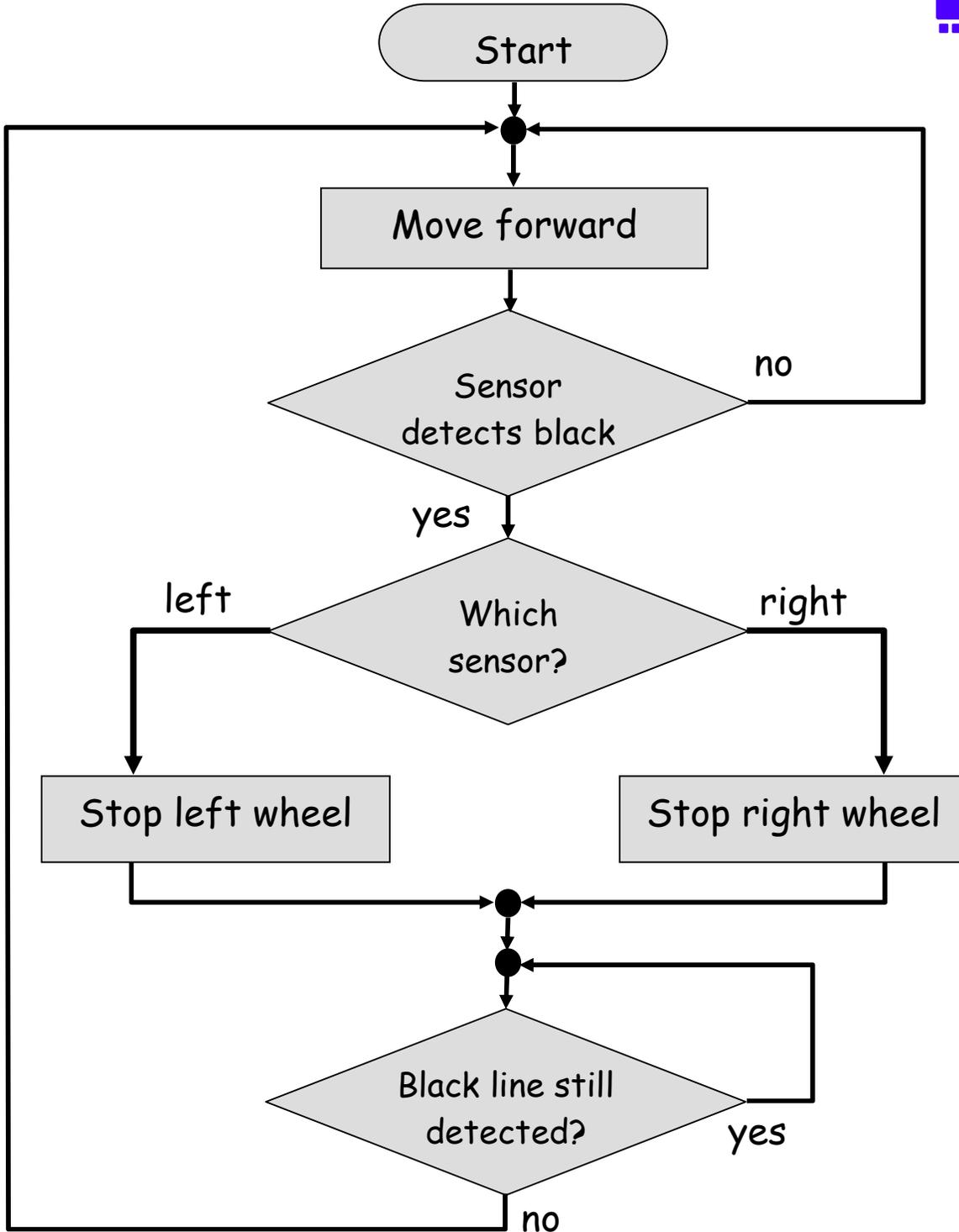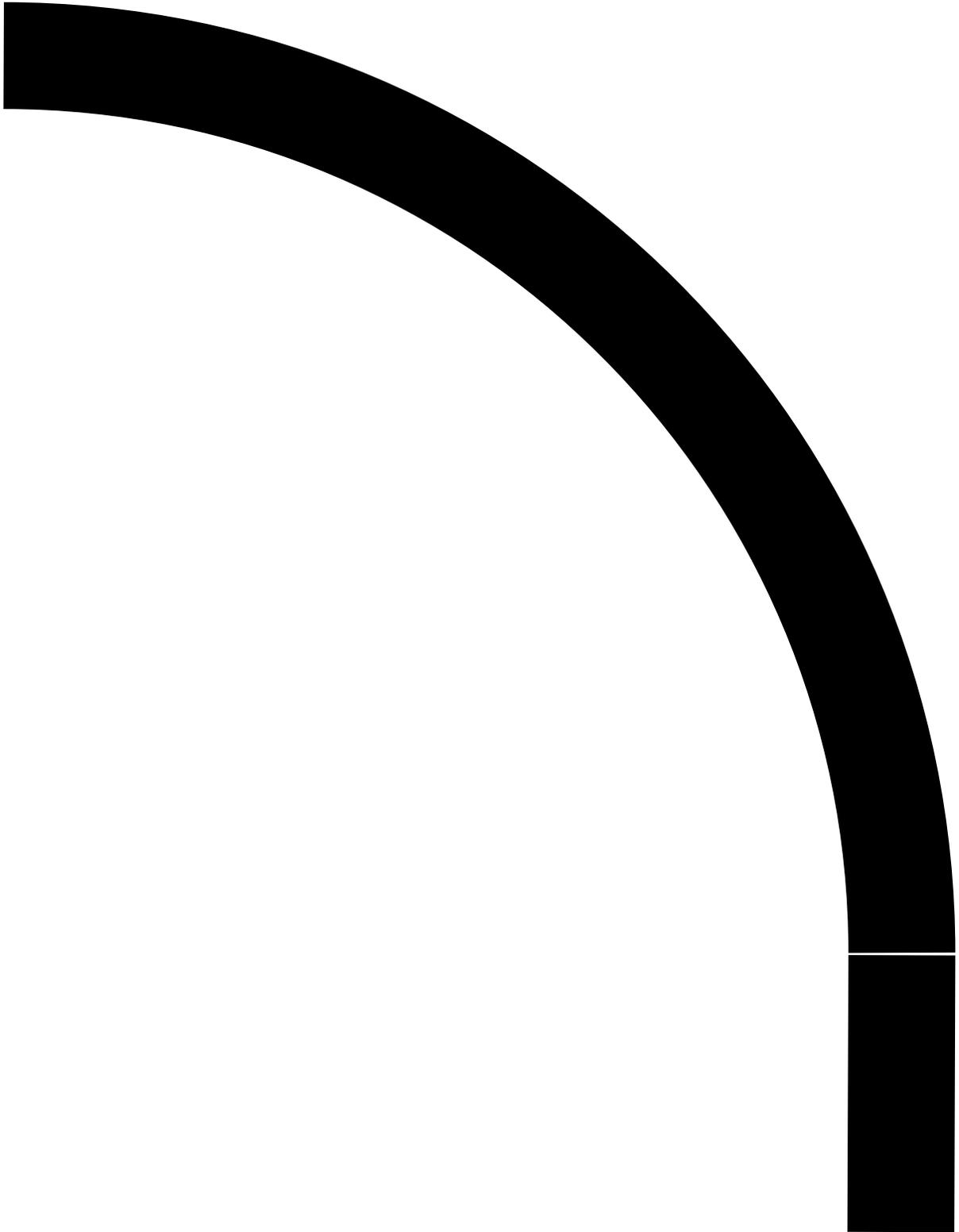
16cm radius arc

12cm radius arc
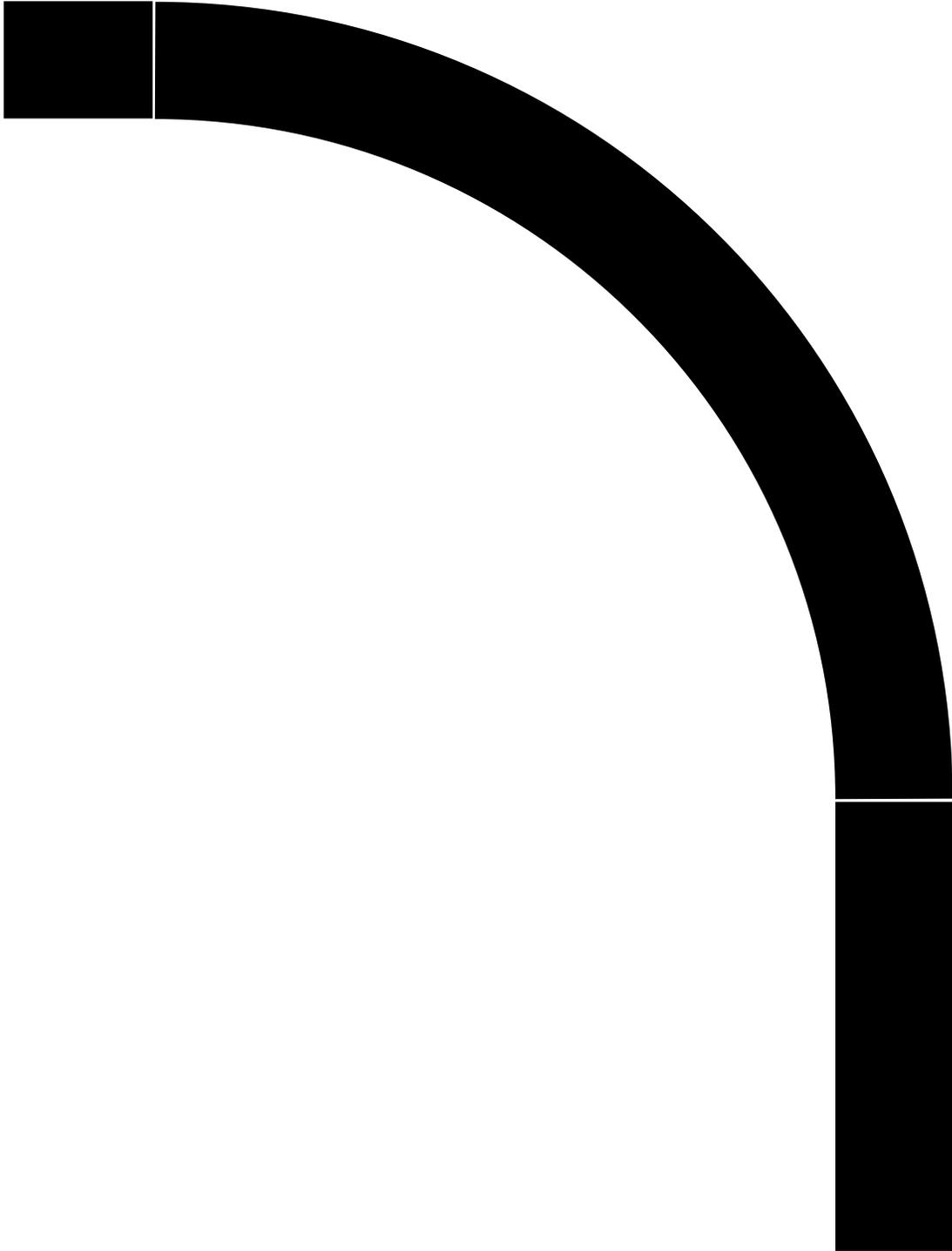
8cm radius arc
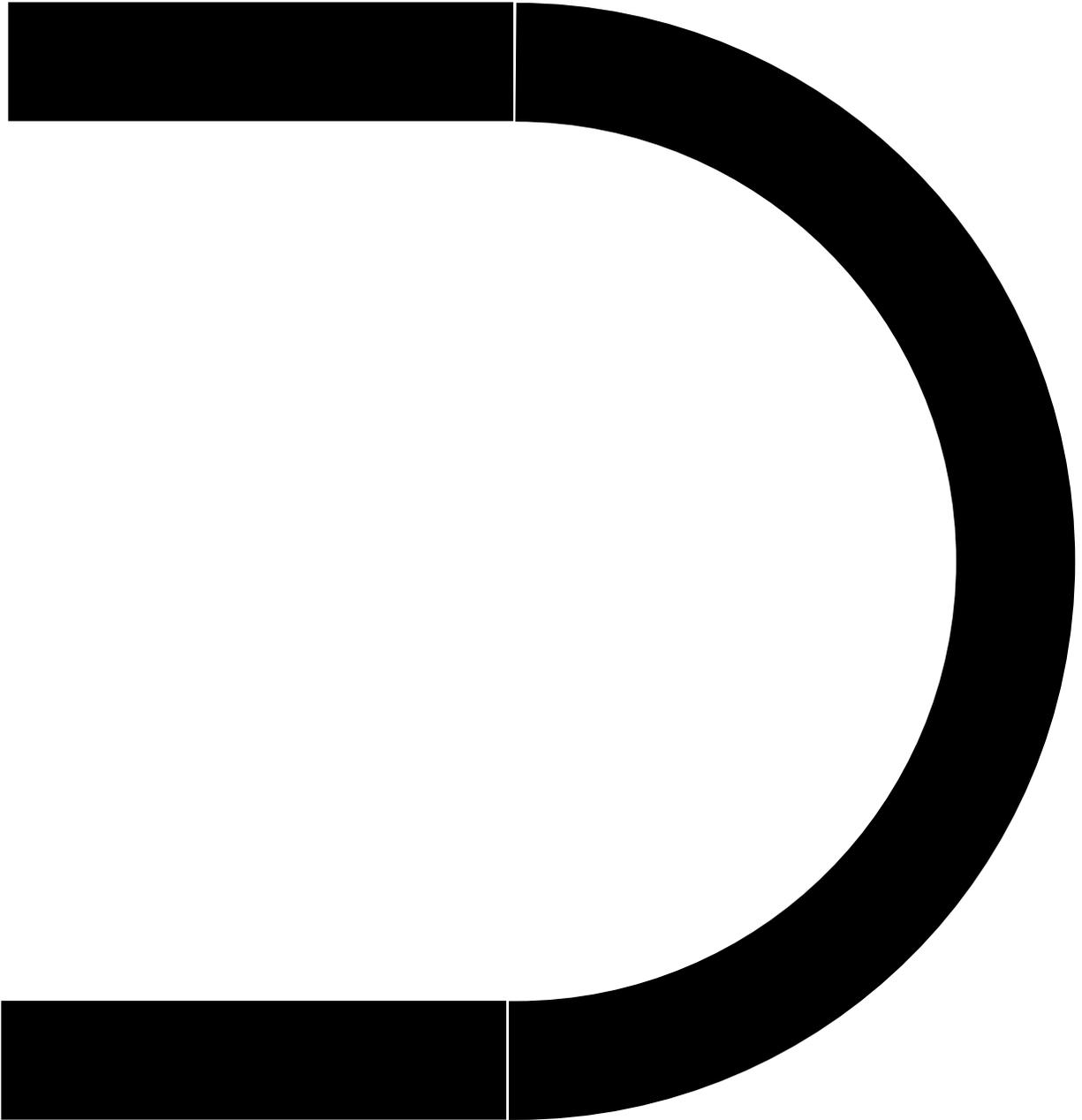
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Heriot-Watt University
School of Engineering & Physical Sciences
Electrical, Electronic & Computer Engineering

Evaluation

Dear teacher,

It is an integral part of our funding agreement that we evaluate the project. In many ways this can become a box ticking activity that gets ignored. We don't want this to happen and are very interested in using the evaluation information to make significant changes to the project for the future. We've had good fun building the project are too close to make the right evaluations. You and your pupils input will be very important to help us to progress the material for the next phase.

Kind regards

Jim Herd
Tracy McHenry

April 2009

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Class contact log

School_____

Class_____   Class size_____

Could you please log the number of hours spent on the project.

Date	Number of hours	Description

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Pupil evaluation form

Name_____

School_____ Class_____

Have you enjoyed working with Robokid (1→5)

1. Not at all   2. A little   3. OK   4. Quite good   5. Really enjoyed

How challenging was the project

1. Too easy   2. Bit easy   3. About right   4. Bit difficult   5. Too difficult

I have learnt something about electronics and robotics

1. None   2. Not much   3. A bit   4. Some   5. Lots

I would like to know more about robotics

1. Not at all   2. Some   3. Don't know   4. Yes   5. Lots more

I would recommend this project to other pupils

1. Definitely not   2. not really   3. Don't know   4. Yes   5. Definitely yes

---

What was your favourite activity and why?

What was your least favourite activity and why?

Any suggestions for changes or improvements

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Teacher evaluation form

School_____

Name_____

What do you think the children's favourite activity was and why?

What was your favourite activity and why?

What do you think the children's least favourite activity was and why?

What was your least favourite activity and why?

Was the project enough of a challenge for all ranges of abilities?

Did you feel that any children struggled with the material?

What aspects of the supplied material (DVDs and documents) was the most helpful?

What aspects of the supplied material (DVDs and documents) was the least helpful?

Have you any recommendations for changes/additions to the documentation

Have you any recommendations for changes/additions to the activities

Any other comments

Before the project, I felt comfortable with running a technology project

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

After completing the project, I feel comfortable with running a technology project

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

The material was of good quality

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

The DVDs were useful

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

The documentation was easy to follow

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

The equipment stood up to being handled by the children

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

The robots were reliable

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

The class kit had everything I needed

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

The children enjoyed the project

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

I enjoyed the project

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

I would like to run it again next year

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

Would you recommend the project to other teachers

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

The project relates well to Curriculum for Excellence

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

The project was well supported

1. Strongly disagree   2. disagree   3. No opinion   4. agree   5. Strongly agree

Robokid

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Glossary of terms

Term	Description
Connector **Terminal**	Name given to the screw points where wires can be connected to the circuit board. Often referred to as terminals. The robot has 16 screw terminals. Four sets of 3 for the front and rear bump sensors and two sets of 2 for the motor connections.

Circuit board	Technology to create electricity carrying wires on a board. The wires are made of the metal copper and run on both sides of the board. The normal colour for a circuit board is green. The electronic components are then soldered onto the board to make electrical connections.
	
	The kit contains two circuit boards.
	    1. the main robot circuit
	    2. the switch controller board

Differential	The robot has two motors. Although they are well made with identical materials they are never exactly the same. Therefore, when we set the same speed on the two motors, the robot does not keep a straight path. It moves on a curve because one motor will be slightly faster than the other. The DIFFERENTIAL adjustment allows the user of the robot to input a small adjustment to compensate for this fact. Activity 5 allows the children to experiment with this feature and in an exaggerated form is used for the associated 10-pin bowling competition.
Mode	The robot can work in many ways. Each of these ways is called a MODE. For example mode "J0" uses the switch controller to allow the user to drive the robot forwards, backwards, spin left and spin right. The switches A, C and D are generally used to move between moves (although they sometimes have other uses) **Switch-A** :: start running the current flashing mode **Switch-C** :: exit from the current running mode **Switch-D** :: step to next mode

POT	**Pot** is short for potentiometer. There are three blue pots on the board named POT-1, POT-2 and POT-3. Each pot can be turned from an 8 o'clock position to a 4 o'clock position. Minimum position Maximum position The computer is able to read the position and convert it into a number from 0 to 255. In the modes where adjustments are possible, pressing SWITCH-B will cause the robot to read all three pots. For example, in many modes POT-1 will set the speed.
Solder	Solder is a metal that melts at a low temperature and is used to connect components to wires and circuit boards.
Algorithm	Recipe to solve a problem. Usually based on a sequence of simple steps.
Flowchart	Simple method of describing an algorithm using s set of graphical symbols. The two main symbols are The rectangular box describes a step The diamond box describes a test that has two outcomes – 1. YES the test is TRUE 2. NO the test is FALSE
Infrared	Our eyes see only part of the full spectrum of radiation. The bit we see goes from visible violet to visible red. Just above visible red is radiation called infrared radiation. Usually referred to as IR radiation. Some animals see infrared (eg snakes) and we have developed special cameras that can see it. Nature programmes on TV now regularly use infrared cameras to watch animals at night, as animals emit IR radiation in the form of heat. The most common use of IR is in the remotes you use with your TV and audio systems.
Sensor	Electronic component that converts a physical quantity (e.g. light, heat, position, etc) into an ectrical signal that can be read by the computer
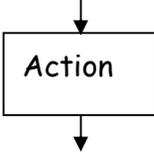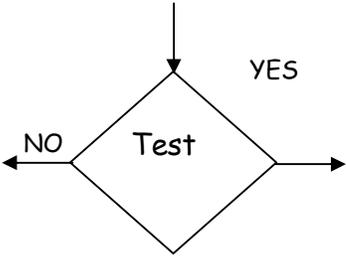
Strip sequence	Set of commands that are input from two strips of black and white lines on a card. A strip will look like this

Appendices

1. Content of teachers kit
2. Content of robot kit
   a. Kit component identification
3. Component layout
   b. Top side of robot circuit board
   c. Bottom side of robot circuit board
4. Robot modes
5. Switch/pot usage
6. List of modes and switch sequences

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School of Engineering & Physical Sciences
Electrical, Electronic & Computer Engineering

Robokid Project
Teacher's kit

Item	Number	Notes
Charger units	6	Charger for 8 AA batteries
Charger power supplies	6	
Mains power strips	1	6-way
Rechargeable AA batteries	56	4 per kit plus spares
Pack of spare components	1	20 spare rivets, 2 dome nuts, 2 plastic bolts
Pack of bump switches	1	Total switches = 40
Pack if bits to make bump switches	1	Bits of wire etc
Pack of light detectors (LDRs)	1	40
DVDs	3	
Teachers manual	1	In ring binder
Roll of paper	1	Wallpaper width
Pack of Berol Broad pens	12	
Roll of black tape	2	19mm wide
Robot kit	1	Teacher practice kit

Notes
1. Above kit numbers are for classes of 33. Smaller classes will have proportionally less items.

Robokid Project
Pupil kit

Item	Number	Notes
Robot circuit board	1	Wrapped in antistatic bag
Motors	2	
Switch controller	1	Wrapped in a bag
Controller to robot cable	1	
Rivets	9	All the same size
Dome nut	1	
Plastic M5 bolt	1	In a plastic bag
Pen holder	1	
Screwdriver	1	

Robokid Project
Pupil kit

Item	Number	Description	Picture
Circuit board in special bag	1	Board holds all the electronics of your robot vehicle	
Switch controller	1	Simple controller to steer robot	
Motor with plastic wheel	2	Drive system for the robot	
Plastic rivet	9	8 used to fix the two motors to the circuit board 1 used to fix pen holder to the board	All rivets are the same size
Dome nut	1	Provides a front "wheel" for the robot	
Plastic screw	1	To fix dome nut to the circuit board	
Pen holder bracket	1	Allows robot to carry a marker pen.	
Controller cable	1	Connects switch controller to the robot	
Screwdriver	1	To screw cables and components onto circuit board	
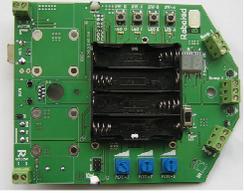
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Top side of robot board

2 conectors for wires from LEFT motor

4 display lights

4 input switches

2 character display

Connectors for one of 3 front bump sensors

SW-D   SW-C   SW-B   SW-A

LED-D   LED-C   LED-B   LED-A

Robokid

B

B   A

Bump 2

MOTOR
1   2

MOTOR
1   2

POT-3   POT-2   POT-1

OFF

ON

Bump 3

Power On/Off switch and power on light

2 connectors for wires from RIGHT motor

3 POTS to change how the robot works

Infra-red signal receiver

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Bottom side of robot board

Connectors to allow the connection of a rear bump sensor

Sound buzzer

Line tape sensor

Hole for pen

Robot "brains" - a small computer

Hole for front skid point

Line tape sensor

Connector for cable to go to switch controller

Heriot-Watt University Robokid

USB connector for access to more advanced robot features

Robot modes : Mindmap view

Robokid robot modes

- **r0** — joystick modes
  - **J0** — forward/backward
  - **J1** — cornering
  - **J2** — compound
- **r1** — Activity modes
  - **A0** — Run forward
  - **A1** — Run backward
  - **A2** — Run spin right
  - **A3** — Run spin left
  - **A4** — Run test
- **r2** — bump modes
  - **b0** — Line bump
  - **b1** — Bug line bump
  - **b2** — Wall bump
- **r3** — Follow modes
  - **F0** — Line follow
  - **F1** — Light follow
- **r4** — Program modes
  - **P0** — manual strip scan
    - **S0** — play sequence
    - **S1** — scan strip
  - **P1** — powered strip scan
    - **S0** — play sequence
    - **S1** — scan strip
  - **P2** — key input of timed commands
    - **S0** — play sequence
    - **S1** — input sequence fron keys

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Robot modes : Table view

Mode	Name	Description
"rx"	General robot modes	"r0" → "r4"
"r0" ⅃	Joystick modes	Modes that use the switch controller (mode robot is switched on)
"J0"	Forward/backward mode	
"J1"	Cornering mode	
"J2"	Compound mode	
"r1" ⅃	Simple activity modes	
"A0"	Run forward	
"A1"	Run backward	
"A2"	Spin right	
"A3"	Spin left	
"r2" ⅃	Bump modes	
"b0"	Line bump	Bump perimeter formed by black tape
"b1"	Bug line bump	Bump perimeter formed by black tape
"b2"	Wall bump	Bump against solid objects using switches
"r3" ⅃	Follow modes	
"F0"	Follow black tape line	
"F1"	Follow light	
"r4" ⅃	Programming modes	
"P0" ⅃	Program robot with strip sequence	Sequence specified as black/white strips is input by pushing the robot by hand
"S0"	Play sequence	
"S1"	Read strip sequence (manual)	
"P1" ⅃	Program robot with strip sequence	Sequence specified as black/white strips is input by running the robot along the lines.
"S0"	Play sequence	
"S1"	Read strip sequence (motorised)	
"P2" ⅃	Program robot with switch sequence	Sequence specified through four switches
"S0"	Play sequence	
"S1"	Collect sequence	

Notes
1. The name "xx" are the characters shown on the little display on the robot. Because this display is very simple (and cheap) it shows characters in a mix of upper case and lower case. For example, the letter 'r' can only be sown as lower-case and the letter 'a' can only be sown as upper-case.

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Use of 4 push switches in each of the modes

Mode	Switch-A	Switch-B	Switch-C	Switch-D
Power on	Start	--	--	--
r0-r4 (flashing)	Accept mode	--	--	Next "r" mode
J0-J2 (flashing)	Accept mode	--	Back to "r" mode	Next "J" mode
J0-J2 (no flash)	Stop/restart	Read POTs	Back to "J" mode (flashing)	--
A0-A4 (flashing)	Accept mode	--	Back to "r" mode	Next "A" mode
A0-A4 (no flash)	Start/stop	Read POTs	Back to "A" mode (flashing)	--
b0-b2 (flashing)	Accept mode	--	Back to "r" mode	Next "A" mode
b0-b2 (no flash)	Start/stop	Read POTs	Back to "A" mode (flashing)	--
F0-F1 (flashing)	Accept mode	--	Back to "rx" mode	Next "A" mode
F0-F1 (no flash)	Start/stop	Read POTs	Back to "A" mode (flashing)	--
P0-P2 (flashing)	Accept mode	--	Back to "r" mode	Next "P" mode
S0 (no flash)	--	--	--	--
S1(no flash)	--	--	--	Start/stop scan

Notes
1. Table entries shown as "--" imply that pressing the switch will have no effect.
2. Note that the switches mostly have the same effect in most of the modes
    Switch A
        Accept current flashing mode
        Start or stop current activity
    Switch B
        Read set of 3 POTs
    Switch C
        Exit mode
    Switch D
        Step to the next flashing mode e.g. J0→J1→J2→J0→ etc

Robokid
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List of robot modes and switch sequences

Mode	Description	Switch sequence	Notes
J0	Forward/backward/spin driving with switch controller	3A	Used in activity 1
J1	Forward/curve/spin driving with switch controller	2A_D_A	Used in activity 2
J2	Forward/backward/left/right driving with switch controller	2A_2D_A	
A0	Drive forward for a period of time	A_D_2A	Used in activity 5 Used to diagnose build errors
A1	Drive backward for a period of time	A_D_A_D_A	
A2	Spin right for a period of time	A_D_A2_D_A	
A3	Spin left for a period of time	A_D_A_3D_A	
A4	Run test sequence	A_D_A4_D_A	
A5	Run demo sequence	A_D_A5_D_A	
b0	Detect and reverse away from lines made from black tape	A_2D_2A	Used in activity x
b1	Same as "b0" but avoid lines in a manner more like a mouse or a bug	A_2D_A_D_A	Used in activity 5
b2	Detect obstacles with bump switches and reverse away.	A_2D_A_2D_A	Used in activity 5
F0	Follow a black line on the floor	A_3D_2A	Used in activity x
F1	Follow a light source	A_3D_A_D_A	
P0/S0	Read a program sequence from a strip of black and white strips. User pushes the robot along the strip.	A_4D_2A	
P0/S1		A_4D_2A_D	
P1/S0	Read a program sequence from a strip of black and white strips. Robot drives itself along the strip	A_4D_A_D_A	
P2/S1	Read a program sequence from the switches	A_4D_A_D_A_D	

Notes
- All sequences assume a power-on starting point
- The switch sequences use a shorthand notation

A = press switch A
B = press switch B
C = press switch C
D = press switch D

Press switch A

e.g. A_2D_A3_D_A

Press switch D twice

Press switch D three times

Robokid
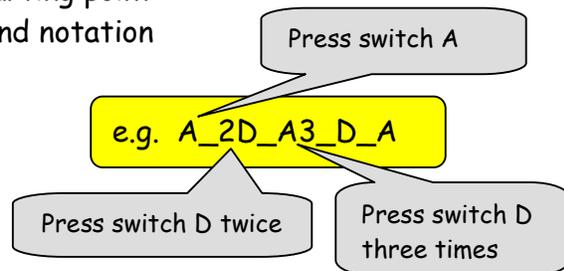
Purpose of POTs in each of the modes

Mode	Description	POT-1	POT-2	POT-3
J0	Forward/Back control	Speed	Differential	--
J1	curve control	Speed	Differential	--
J2	F/B-L/R control	Speed	Differential	--
A0	Run forward	Speed	Differential	Run time
A1	Run backward	Speed	Differential	Run time
A2	Spin left	Speed	Differential	Run time
A3	Spin right	Speed	Differential	Run time
A4		Speed	Differential	Run time
b0	Line bump	Reverse time	Spin time	Differential
b1	Bug line bump	--	--	--
b2	Wall bump	Reverse time	Spin time	Differential
F0	Follow line	Speed	Differential	Sample time
F1	Follow light			
P0	Program 1			
P1	Program 2			
P0/S0	Play strip sequence			
P1/S1	Collect sequence by pushing robot			
P1/S1	Collect sequence by letting robot run	Speed	Differential	--