LEARNING WITH *MINDSTORMS*

Website created by Audrey Maughan (GDPE331)

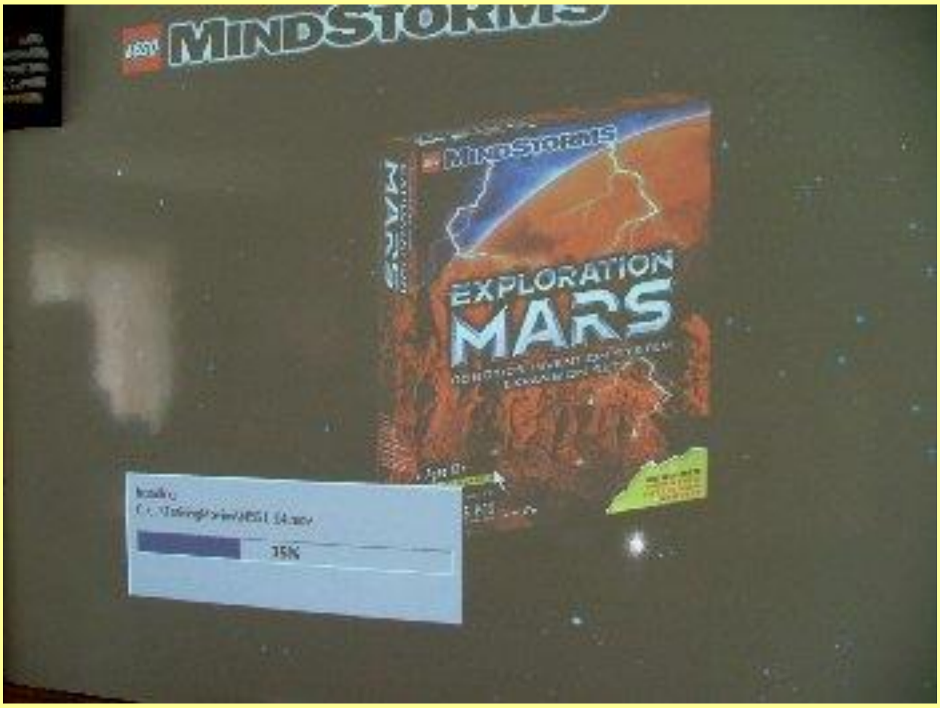
July 7, 2004

1: Preparation

In preparation for this assignment I elected to bring the Mindstorms kit to the coal-face (the classroom) for its inaugural outing. We opened the kit together and examined its contents. It became almost immediately apparent who was going to be most comfortable with this learning tool and it wasn't me! The children set about the task with a sense of optimism and fun and without fear of failure. I, on the other hand, remained cautious. My own earliest formal learning experiences were not of a hands-on nature. This, coupled with my residual fear of anything technical, led to my being a hesitant participant.

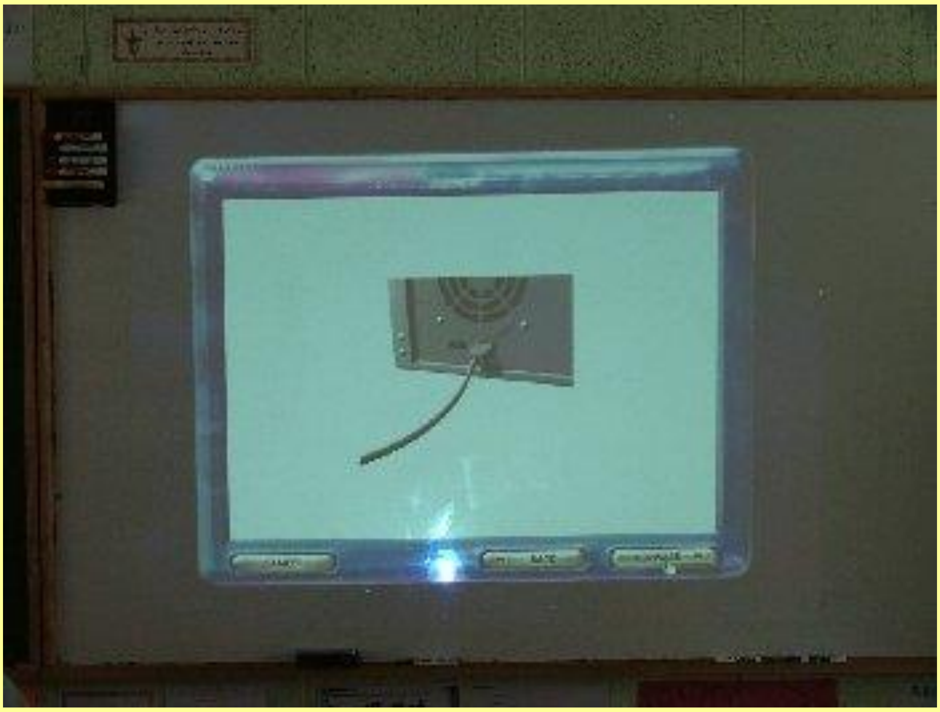
First, I showed the construction kit.
Note the enthusiasm on all the faces!

I explained the computing element of the system.



First, we installed the software on a laptop computer.

I used a data projector so the whole class could follow the steps.



We connected up the USB tower to the computer.

At last the children could get their hands on the bricks!

We checked that the tower was communicating with the RCX.

We checked the range of data transfer.

The signal was quite strong!

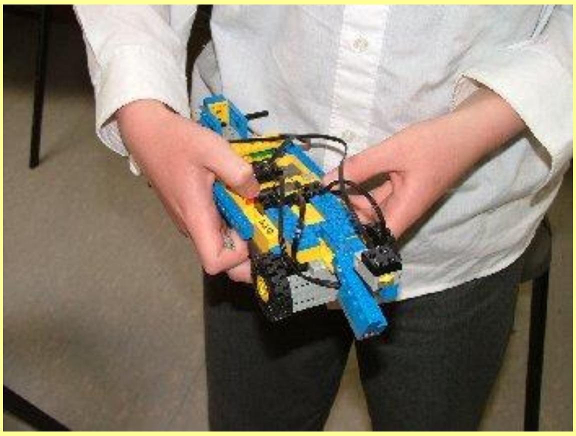
It was time for the training missions!

Many hands make light work!

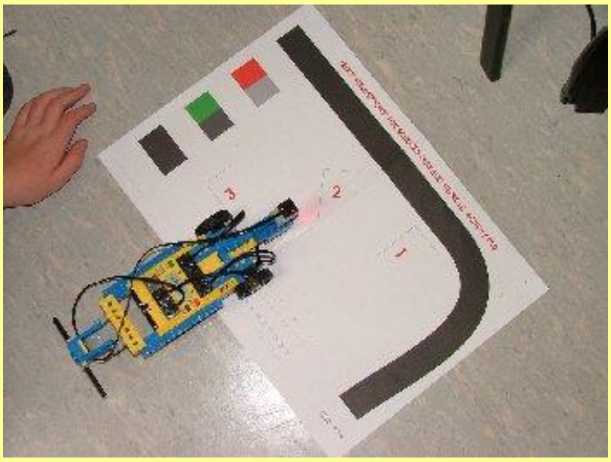
But too many cooks...
I had to intervene to make sure all was done correctly.

Well, it looked just like the one on the directions!

We checked out its movement.



This is the robot from another training mission.
It had a light sensor attached.



Success!
The robot turned when it came to the black line.

2: Making Robot

With regard to designing and building a robot as 'an object to think with', I had 'hatched' a plan! Imagine an injured bird finding a way into a shed or garage looking for refuge and feeling frightened in the strange environment. What would it do? After a short brainstorming session with the children, we agreed that the bird would most likely move from the open space to be near a wall. We took this a step further and decided that the bird would feel even safer if it got itself into a corner of the shed.

... And SMART BIRD was hatched.

Smart Bird Hatching!

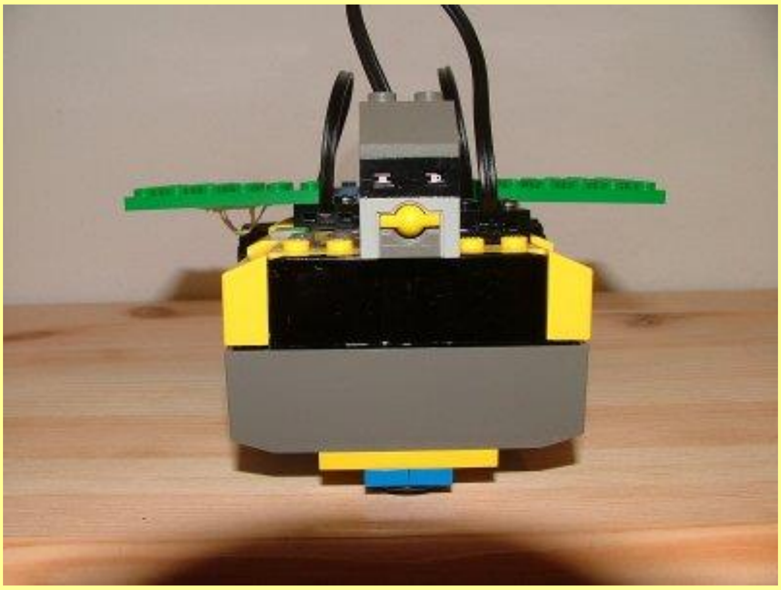
A group of children started construction in another room.

We designed the SMART BIRD robot with one sensor (a touch sensor) to allow it to stop on contact with an obstacle - in this case the wall - before continuing its programmed manoeuvre. The touch sensor is employed twice in the program to assist SMART BIRD in finding a safe corner.

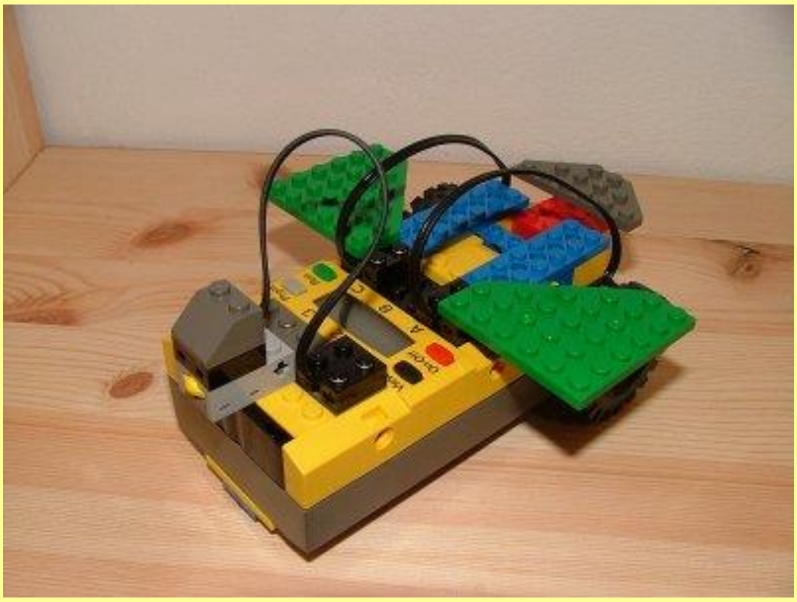
SMART BIRD robot is basic in design. There is a simple chassis on which the RCX and the two motors sit and two medium-sized rear wheels which are appropriate for completing the programmed tasks. SMART BIRD also has a small rounded lego piece which allows the RCX unit to move smoothly over most surfaces. The touch sensor which, when looked at from the front, successfully mimics SMART BIRD'S head including eyes and beak, is placed so as to jut out past the RCX's front surface in order to make first contact with the obstacle. Two short wings were added primarily for aesthetic purposes. They were kept short so as not to hinder the turning movements.

Would our bird move?

We built and programmed SMART BIRD using a Lego Mindstorms kit with a few extra bricks from my son's toybox! The SMART BIRD program contains one long stack of commands condensed by the use of 2 'MY BLOCKS' , TURN and TURN 2, for the two turning movements.



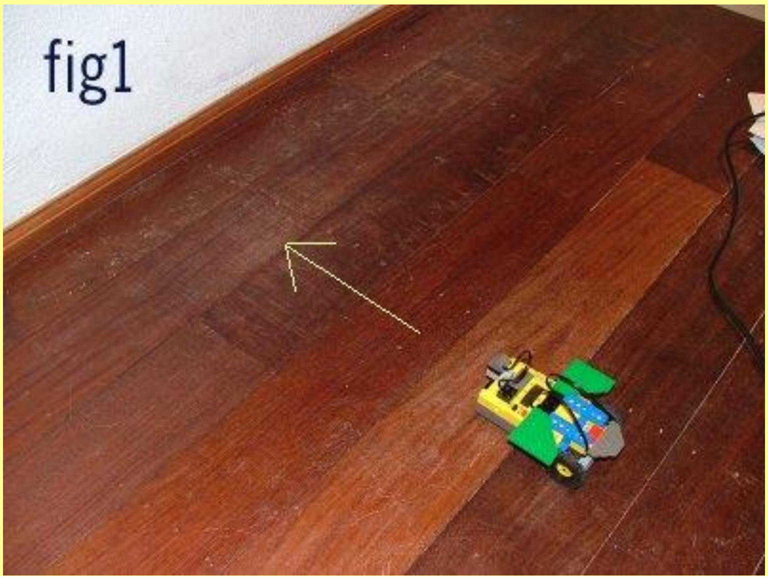
Et voilà!



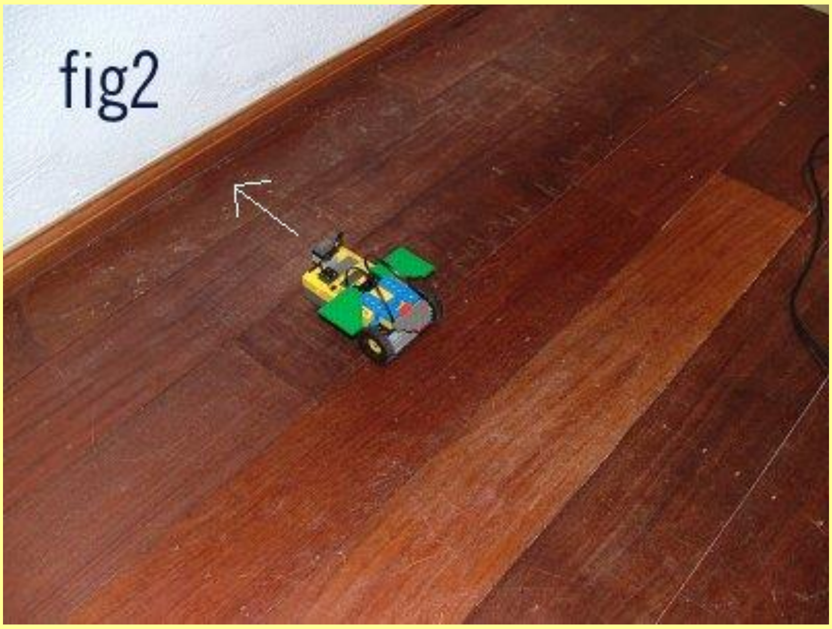
Our bird was ready to fly...

...or crawl quietly into a corner.

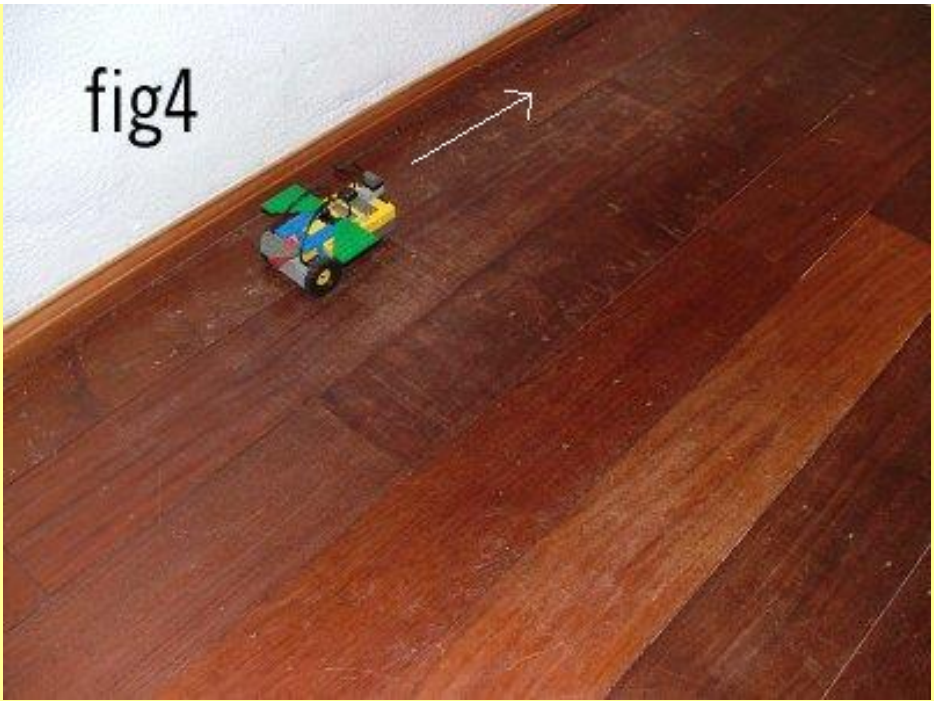
Smart Bird in Action!



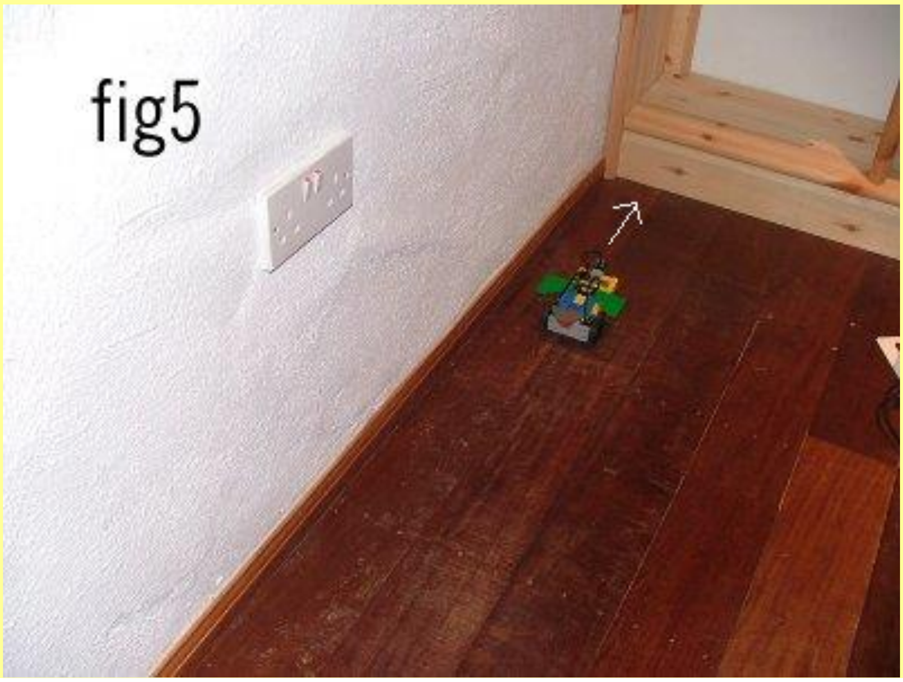
The first portion of the stack commands SMART BIRD to move forward slowly until it reaches the wall in front of it. The touch sensor is the first piece to make contact and is thus activated causing SMART BIRD to stop.



The next sequence of command blocks makes SMART BIRD reverse slightly. The correct balance between motor power and wait time helps to execute this task effectively.



The next section of the command chain (in a My Block called TURN) makes SMART BIRD execute a 90 degree right turn.



The next section of the program is a repeat of the initial forward, stop and reverse requests executed at the beginning of the program.

SMART BIRD'S next turn is effected using a 'My Block' called TURN 2. This time a right turn of approx 135 degrees is required so that SMART BIRD can end up by reversing exactly into the corner. This is achieved by increasing the value on the 'Wait for' small block from the 1.1 seconds used in the 90 degree turn to 1.4 secs for a 135 degree turn.

The final section of this command stack effects a short reversing movement by SMART BIRD before he comes to a standstill.

The Program

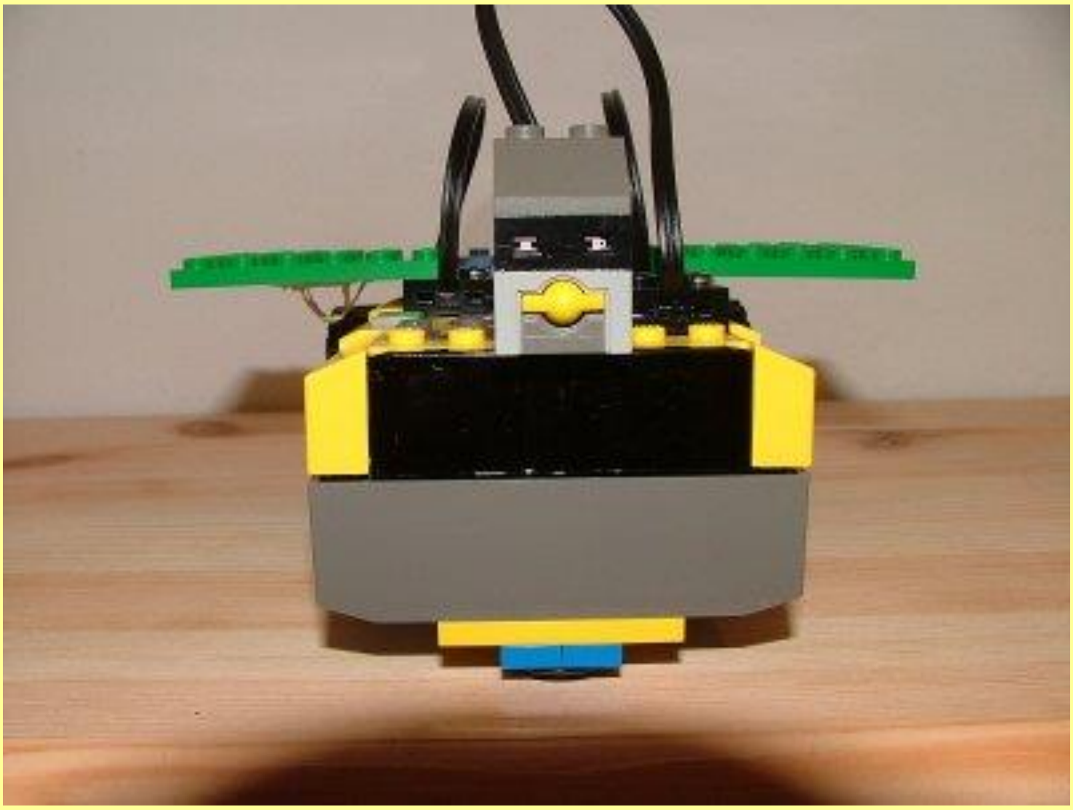
As the program was rather long, I've exploded it into five chunks to enable viewing on one screen. The course of the program is marked out by the white arrows.

Here's the complete program stack minimised.

3: Reflections

This project assignment, at first consideration, seemed to me to be completely daunting and 'undoable'. What would I be able to do with this box of Lego bricks and a computer? How was I to build and program an 'object to think with' and relate the outcome to something in 'real life' that is capable of interaction with its own environment?

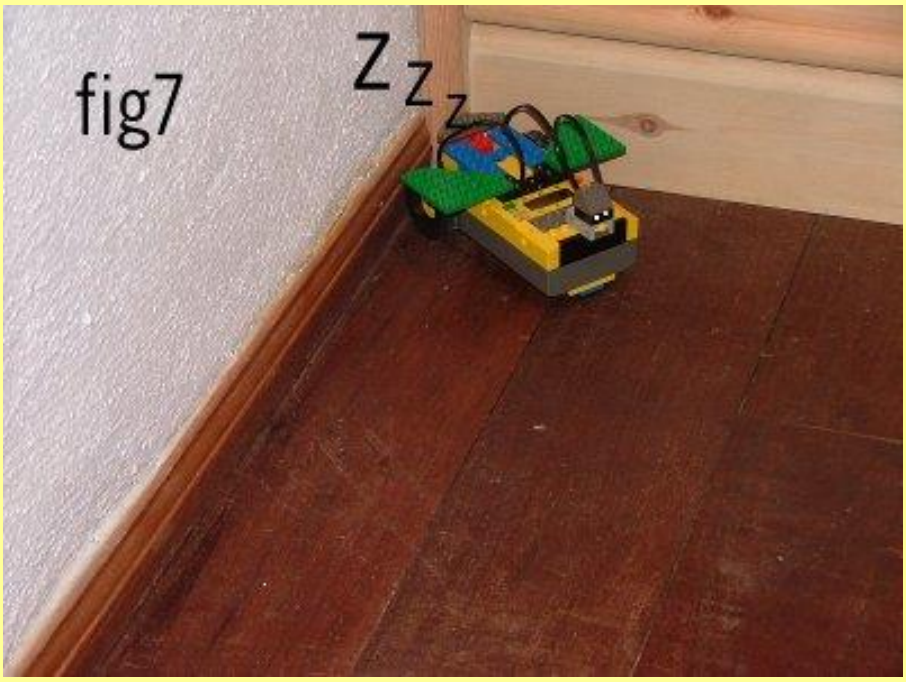
Lego? Children! 'That's it!' I thought. Bring the project to the classroom and learn 'by doing with' the children how to construct a robot, any robot, to begin with. The children (a combination of 5th and 6th class pupils), eyes widened at the sight of the colourful Lego, opened my eyes as they took to the various tasks like the proverbial 'ducks to water'. During this period of trial and error I was enthralled by how quickly they completed the tasks, noting that their collaborative work seemed to effect speedy results. The barriers I had internally constructed towards the assignment began to be broken down bit by patient bit.



While the children were examining the various effects of using the different sensors I was quietly formulating a plan for our robot and its program, having gained confidence in my own ability to follow the computer instructions and construct an interactive robot. The resultant robot, SMART BIRD, is designed and programmed to be a representation of a small injured bird and how it might instinctively behave if it found itself in the centre of a rectangular room. SMART BIRD was now our 'object to think with' and our window to the world of robotics and programming.

To effectively program SMART BIRD to perform the required tasks, it was necessary to help the children focus more carefully on the finer points of programming. They were happy to program using 'Big Blocks' only and to by-pass the bulk of the training missions. Together we decided to pay close attention to all of the step-by-step training missions before making any attempt to use the 'Small Blocks' or 'My Blocks'.

Constructing the robots for each training mission was crucial to the learning outcome and an enjoyable part of the learning experience.



The program had to be written, re-written, tried and tested many times before success was achieved.
Finally, having suffered the frustrations of working alone on this assignment, I was reminded of the benefits of reaching out for assistance when needed.

4: Critique

Mindstorms is a very useful and highly effective learning tool both inside and outside the classroom. Its colourful bricks provide the initial stimulation. Its user-friendly interface is clear and easy to follow. It promotes learning by 'trial and error' and by 'doing' and encourages frequent 'higher-order' thinking.

Its technology can be successfully used in an 'intellectual partnership' as a 'mind tool' and applied to the teaching of a wide variety of lessons e.g. a science lesson on the instinctive behaviour of animals, in this instance that of our poor, injured SMART BIRD. A **mind tool** is ' a way of using a computer program to engage learners in **constructive higher order critical thinking** about the subjects they are studying.' **(Jonassen)**

Vygotsky would have been thrilled to witness the children increasing their confidence levels and command of the skills with no more than a guiding hand from the teacher. I noted that the more capable children passed on their expertise in a casual manner to those less well able. This was an example of **Social**

Constructivism : *"All that they need to succeed is structure, clues, encouragement and so forth"*

"Children don't get ideas: they make ideas. Better learning will not come from finding better ways for the teacher to instruct, but from giving the learner better opportunities to construct" So said **Seymour Papert** on the subject of **Constructionism**. The "object to think with" provoked by the design of Smart Bird brought about high levels of learning in all the children.