



# EI Globe Plotter

## *Drawing the world*

*Text & pictures by Michael Brandl*

The Globe Plotter draws nearly the entire world on a blank white ball. For this robot the coordinates of the continents were prepared as a zigzag line, drawn with a green felt tip pen. After the continents are drawn the robot switches colors from green to black. With this pen the continents are labeled: AS for Asia, AF for Africa, NA for North America, SA for South America and EU for the European Union. After switching to the blue pen the oceans are labeled, PAC for Pacific, ATL for Atlantic, IND for Indian Ocean.

There is a video of the Globe Plotter in action at ....

<http://www.youtube.com/watch?v=JNMakRRgSG0>

The Globe Plotter uses one NXT intelligent brick on which all the coordinates of the globe are stored. Two motors are

used for tilting and rotating the ball. The third motor has two functions. It selects the desired color to draw with and it lifts the pen when not needed.

One touch sensor is attached on the frame to detect the initial position of the three felt tip pens.

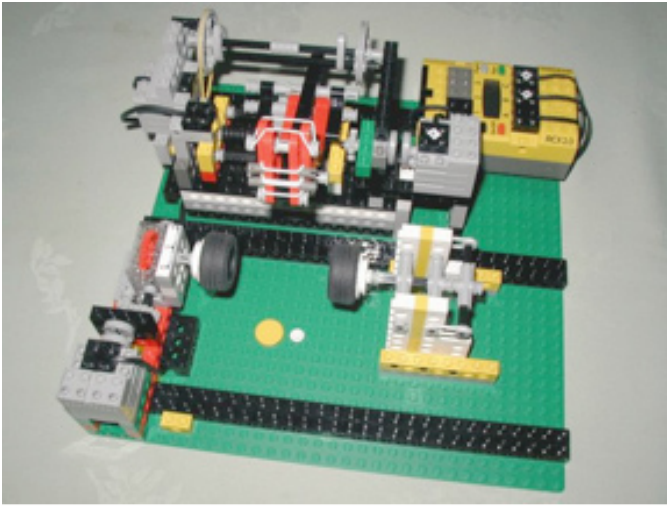
When the globe is finished it is mounted on a special holder made out of LEGO Technic elements.

### **The background:**

For many years now I have been working with “spherical plotters” made with LEGO® MINDSTORMS. It is always fun to print some text or drawings onto a spherical object.



It all started in 2004 with my first **RCX Egg Plotter**.



<http://lego.brandls.info/legrob-eiplotter.htm>

This robot wrote "HAPPY EASTER" to an egg and has been a great success with all children at exhibitions. It could be built with a single RIS Mindstorms kit plus an additional motor (the RIS kit came with only 2 motors) and to minimize the number of sensors needed it incorporated a stepper motor that was 100% LEGO®.

The egg was turned in 48 steps by a motor that drove a single crank which was held in the lower position by a rubber band. When the motor turned at least 185 degrees and was floated (not simply stopped because that would break the motor), the rubber band completed the turn to 360 degrees. In this way it was possible to make a full turn using a simple software solution, without the need for additional (touch or rotation) sensors, time after time (leaving enough time for the rubber band to complete the turn).

With the new Mindstorms NXT 1.0 I built the **NXT Egg Plotter** in 2006.

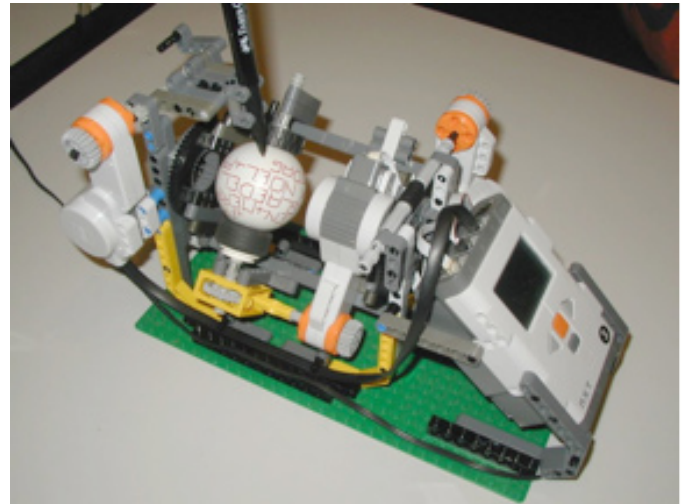
It was built while beta testing the NXT and decided to re-engineer the Egg Plotter, using the elements of a single NXT set. This turned out to be a lot easier than in the previous version as the NXT's servo motors made putting both the egg and the felt pen in their precise position much easier and the NXT-G software allowed for the easy treatment of text files for drawing the different letters.



<http://lego.brandls.info/roboer/legrob-eggplotternxt.htm>

However, although NXT motors can be programmed to turn with 1 degree precision, they also have quite some slack (partly due to backlash produced between the encoder and the output, and partly because of the way error correction is handled which can result in the motor overshooting before returning to the specified position) so the individual letters could occasionally appear distorted.

In 2008 I enhanced the design of the previous robots and build the **Xmas Ball Plotter**, capable of putting text and drawings on a Christmas balls or Easter eggs.



<http://lego.brandls.info/roboer/legrob-xmasplotter.htm>

Although the principle is the same, the Xmas Ball Plotter was built in quite a different way when compared to the RCX and NXT egg plotter. Instead of moving the pen from left to right, it is in a fixed position and it is the ball that is rotated and tilted. In this way, the distance and angle of the pen with reference to the ball, is always the same.

During exhibitions, the first Xmas Ball Plotter would write Merry Christmas in five languages (German, English, Danish, French and Dutch) but the program is easy to tweak and virtually any text can be printed on the ball by adding the individual letter descriptions (contained in simple text files) to the text file the NXT-G program draws on to write the words on the ball. After writing each letter the ball is slightly tilted, and in this way the text is written in a spiral.

I have also drawn different designs on blank balls ... a Jack'O'Lantern at Halloween, a Star Wars™ Death Star at a comic convention, Christmas balls with alternating text, Easter eggs with drawings of the Easter Hare, there are no limitations!

## Getting the world on a globe

When I built my first Egg Plotter I exchanged ideas with my long time friend and LEGO enthusiast Andreas Dreier. He was particularly helpful in the design of the system to draw letters on the egg. It uses numbers to indicate the direction the pen (or the egg) needs to move:

```
7 8 9
  \|/
  \|/
4 ---+--- 6
  /|\
  /|\
1 2 3
```

The remaining number are used for the pen up (0) and pen down (5) commands. This idea has served for both Egg Plotters and the Xmas Ball Plotter

If you would like to have a closer look at this technique, the program and building instructions for the Xmas Ball Plotter are available from my website.

It was again Andreas who suggested a way to control the three felt tip pens as part of a brainstorming exercise before building the Globe Plotter.

Getting the world on a globe is quite bit more complex than just drawing letters. Although the principle is the same (using numbers to indicate the movement of the globe and the pen), the drawing is of course a lot bigger. I discussed this with Andreas and he wrote PatternManager, a software that helps create the drawing and letters for the globe and lets you include additional lines to connect all the elements into a complete description of all the movements the robot needs to make in order to complete the drawing on the globe.

### The Builder:



Michael "Mike" Brandl is a huge LEGO® MINDSTORMS fan of the early days.

In 1999 he got his first LEGO Mindstorms set and was fascinated by the clever design from the first day on. Since then he has built and published many robot designs as you can see on the website he runs: <http://lego.brandls.info>

He was invited to be part of the MPD, a select group of people who were invited to beta test the NXT. After that he has continued collaborating with LEGO MINDSTORMS in the MCP.

Mike lives in Vienna, Austria (Europe) and you can find him attending several LEGO exhibitions through Europe during the year...



Andreas Dreier, his long time brainstorm partner, hosts a website for `nxtRICeditV2`, software that helps you create RIC files that can display stationary and moving images on the display of the NXT. <http://ric.dreier-privat.de/Docu/index.htm> #

