TwinDeck 1210 Drawing machine

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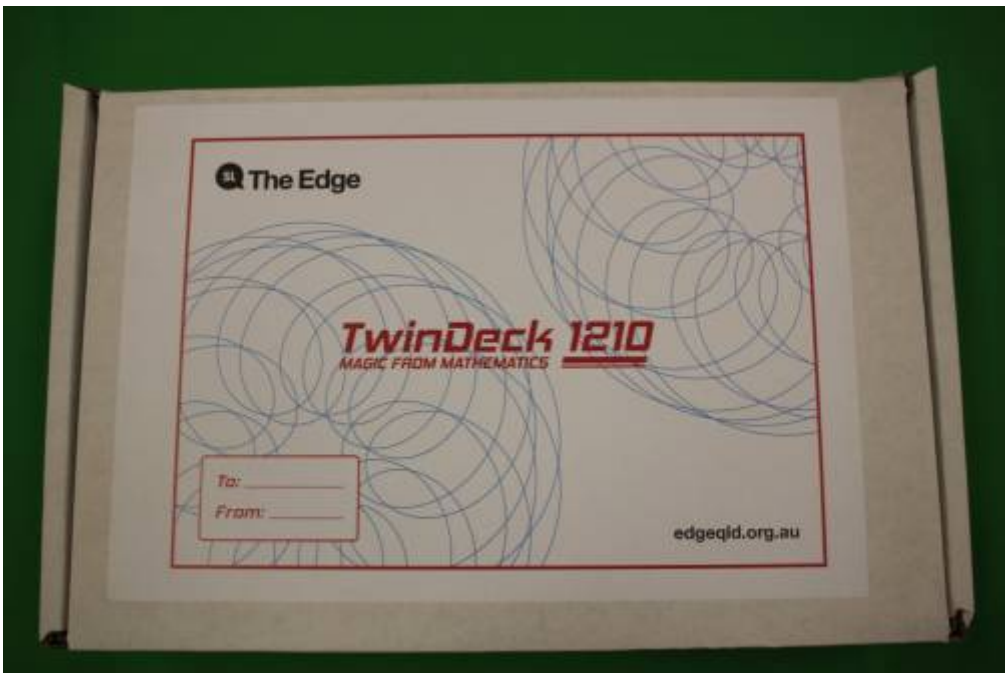


Summary

Use laser cut parts, bolts, nuts , washers, electronic components, a small DC motor and patience to construct a machine that draws Guilloche patterns of almost infinite variety.

The motor has variable speed control as well as forward and reverse options. Different combinations of the acrylic gears are used to change the relative speed and direction of two drawing gears. Pantograph arms are employed so the drawing can be made at a distance, and on a medium of your choice. The size and orientation of the drawing can be modified by altering the configuration of the pantograph, and additional complexity is available if the ring gear and planet gears provided are used.

This workshop was devised by Peter Musk for Christmas, 2017.

Rationale

This workshop was devised as a way to explore the 'M' in STEAM. The complexity of the patterns produced are determined mainly by the relative speeds (gear ratios) of the connected drawing wheels, which are a function of the number of teeth on each gear. When the ratios are a simple factor, less complex patterns are produced and as users explore this device this pattern will emerge. Prime numbers of teeth on the gears give the most complex patterns.

The pantograph mechanism also works by the ratio of arm length between fixed points, which determines the degree of magnification.

The mathematical explanation of these patterns has been well resolved (though it is complex), and interested participants can be guided to deeper understanding as required.

Materials

New parts purchased from Ali Express:

	Description	Cost	Quantity
	TT 3V-12V smart car motor	$1.50	1
	MT 3608 DC-DC boost module	$0.48	1
	PWM variable speed motor controller	$5.50	1

Additional materials:

- 1 x A3 sheet 3mm clear acrylic (for cutting gears)
- 1 x A2 sheet 4mm plywood (to construct console)
- 10 x 3mm pop rivets (with pins removed) Size 5.3/4
- 2 x 3mm pop rivets (with pins removed) Size 5.2
- 1 x USB cable (recycled from dead computer mouse)
- 2 x 10mm o-rings (to hold pen in place)

- 6 x 25mm M3 countersunk screws
- 12 x 15mm M3 button head screws
- 10 x M3 washers
- 6 x M3 locknuts (for pantograph)

Tools

Assembly during the workshop required

- hot glue guns
- small Philips screwdrivers

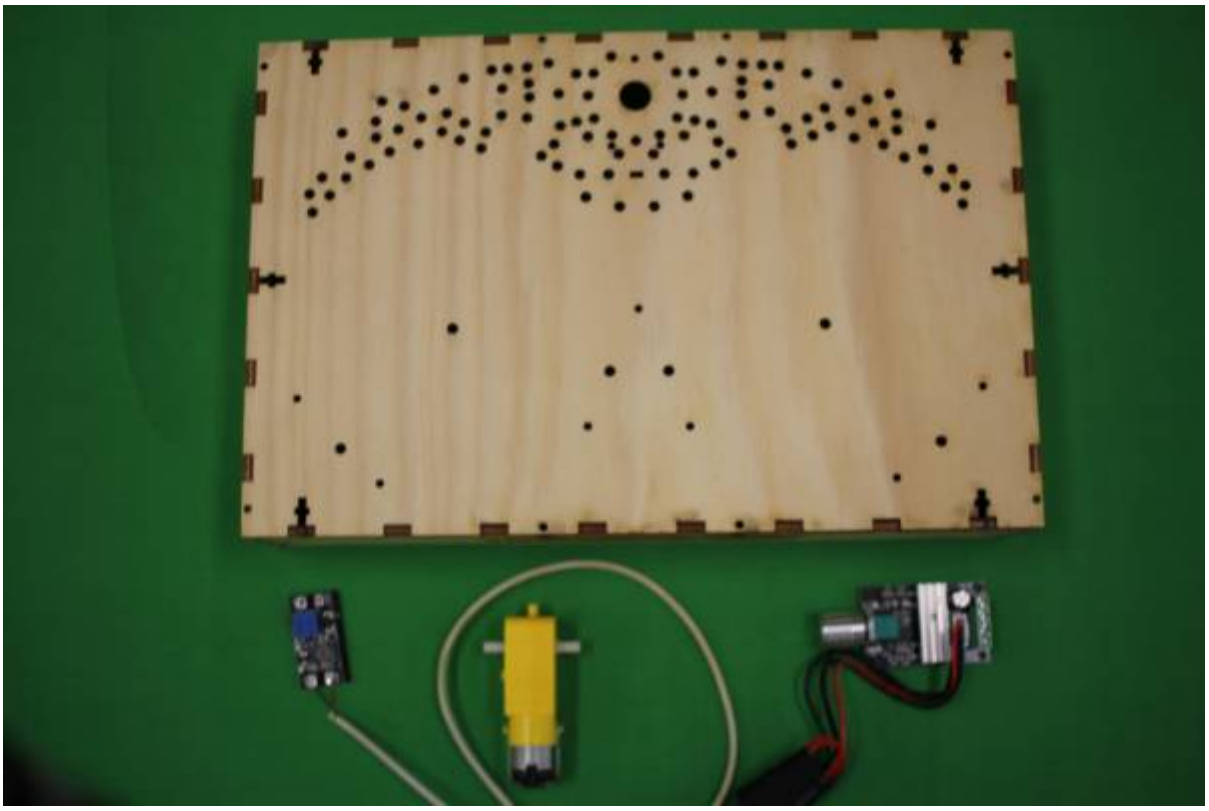
Instructions

Step One:

Assemble the console sides and top using the 15mm M3 screws in the slots provided around the case. You will need to mount the internal support (for the speed controller) as this is done, locating the lugs into the slots in the console sides.

Do not attach the base at this time.

Step Two:



Add the electronics (using hot glue as required.

The speed controller has 4 holes that match the support, and should be held in place with screws. The reverse button should push through the slot provided and lock into place.

You will need to remove the speed control knob (it pulls off) to mount from the inside. Fix in place with the threaded washer and knob.

The motor is held in place with longer screws, but you will need to remove the flexible cover (and discard it).

Step Three:

The instructions for use (see below) explain how the gears are placed, and how the pantograph arms deploy. In trials it was found that the pantograph was a bit too long for easy use, so consider reducing the length, or using a single arm (instead of joining the two halves of each side).

The pop rivets go through the center hole of each gear, and locate into holes in the top of the console. Put a washer underneath to reduce friction. If the movement is unstable, consider replacing these with M4 screws, but do not overtighten.

Design Files

Graphics for gift packaging:

twindeck1210_packaging.pdf

Graphics for engraving onto the top of the plywood console:

twindeck1210_plywoodb_aa1600.ai

Laser cutfiles for console, gears, pantograph arms and supports (AI and Corel formats):

twindeck_cutfiles.zip

(one file shows an example of how to layout gears and pantograph supports)

SVG versions of design and cutfiles:

twindeck_svg.zip

Development notes

Recycled parts

Power for the motor in this device comes via a USB connection (standard 5V). This was chosen to avoid the need for batteries but required preparation prior to the workshop.

Cutting the USB cable and connector from a defunct piece of equipment provides a reasonable length of cable and a functioning connector for zero cost. The exposed wires were stripped , and soldered to the appropriate connections on the DC-DC boost board.

Testing involved using a multimeter to monitor the DC output while adjusting the in-built trimmer on the boost board (a small potentiometer manipulated with a fine screwdriver), so the output voltage from the USB connection was set to exactly 5V.

This preparation allows the use of parts recycled from a variety of eWaste (Apple cables run at slightly higher than 5V, for example), and simultaneously allows for checking for faulty USB connectors (which were discarded).

User Guide

The following User Guide hand-out was developed for this workshop explaining the operation and assembly of the device:

twindeck1210_user_guide.docx

Going Further

There are several free software pattern generating programs available on the web, which may be useful for guiding your choices to achieve a particular type of design.

http://www.eddaardvark.co.uk/python_patterns/spirograph.html Gives a detailed and thorough explanation of the mathematics behind these patterns, as well as an excellent, free pattern generator program.

https://www.fountainware.com/Funware/SuperSpiro/SuperSpiro.htm Provides a pattern generator which is similar to the twin-deck design, and illustrates the extra complexity possible with this approach.