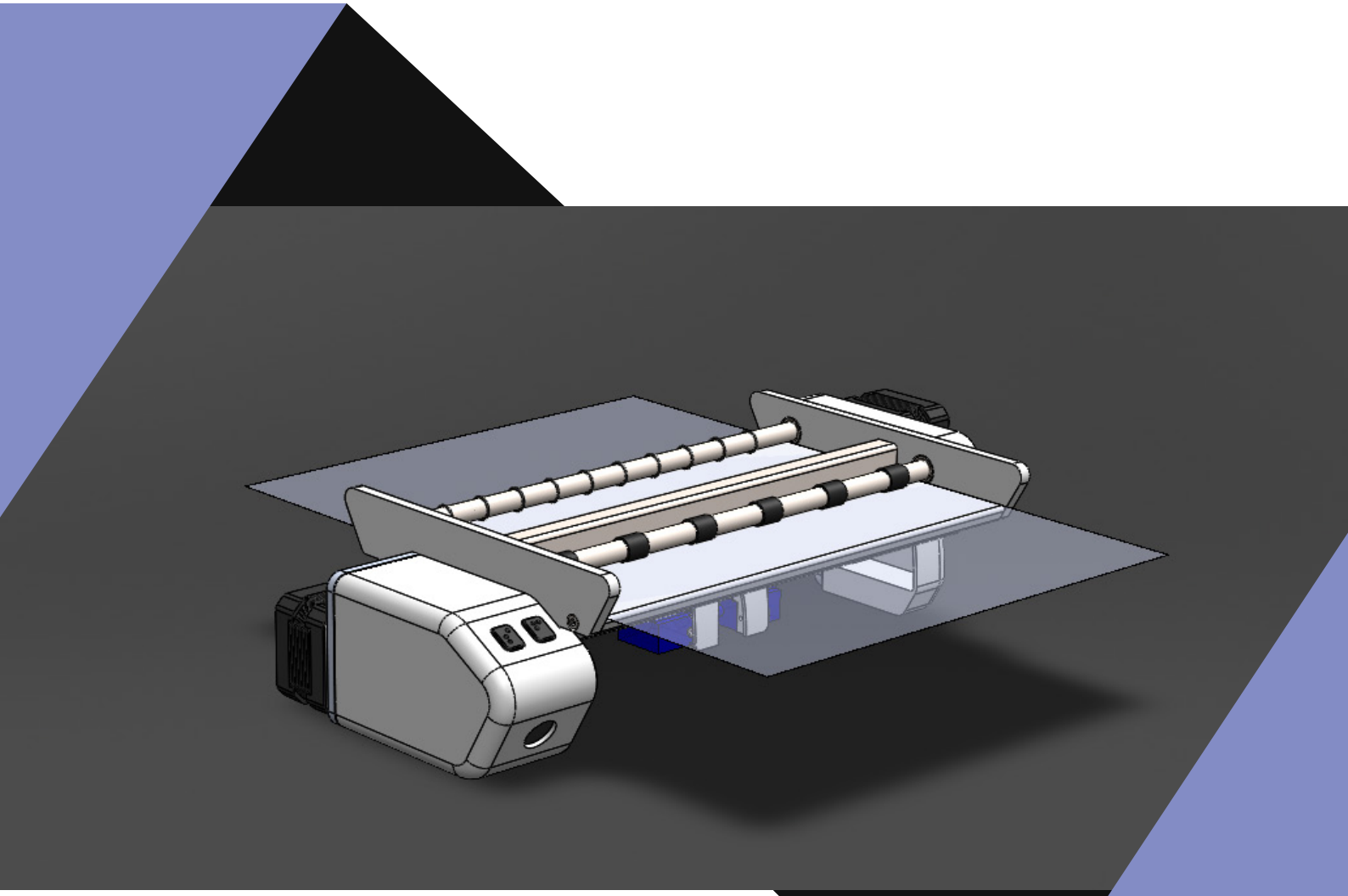


PROJECT BRAILLE PRINTER

Sept. 16, 2022

By Simon Tillema

A Braille Printer?

Commercially available braille printers are expensive and often large in size. There are just a few open-source models available, which are large, slow, unreliable, and do not produce clear braille.

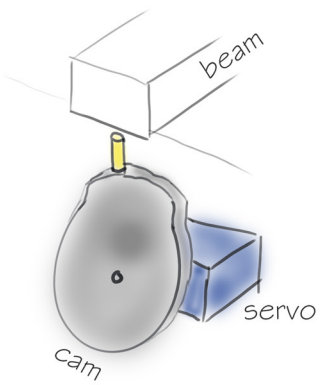
The model I developed is better in all respects. it can print all six dots at once; it prints clearly readable braille; is very reliable and is built as compact as possible. With a simple computer program, everyone can use the plug-and-play printer.

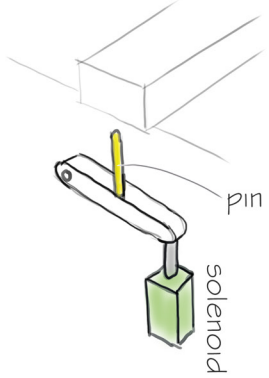
I also developed this braille printer for my fiancée in light of her visual impairment. This apparatus makes it easier for me to have written communication with her. Her feedback was indispensable throughout the development process.

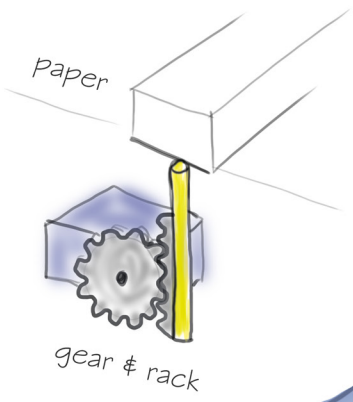
The first text printed (with the first prototype) for my girlfriend was something along the lines of *Do you want to marry me?* Fortunately she said ***YES***.

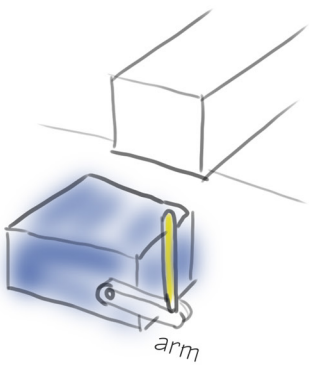
You can follow this project on GitHub!
https://github.com/SimonTil/Brailleprinter

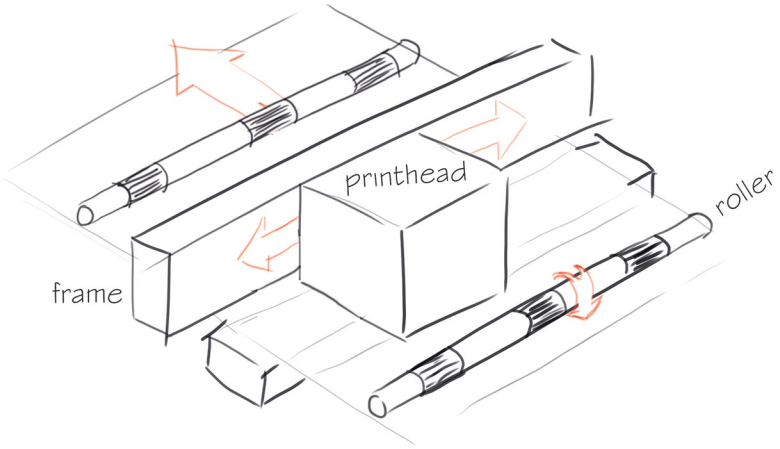
Ideas, Ideas, Ideas

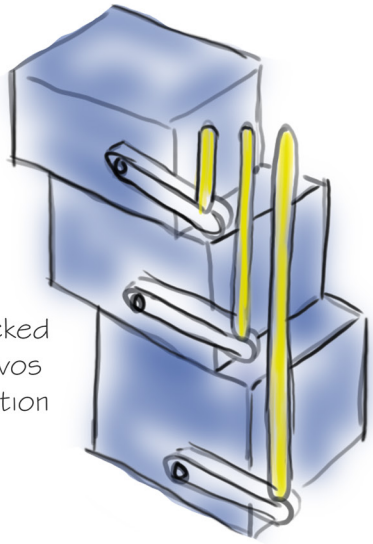


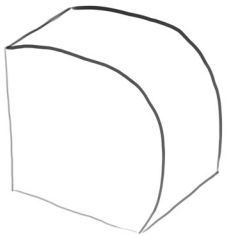


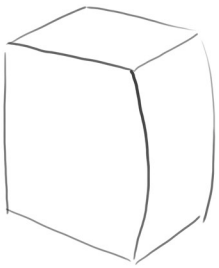




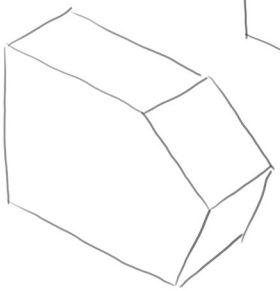


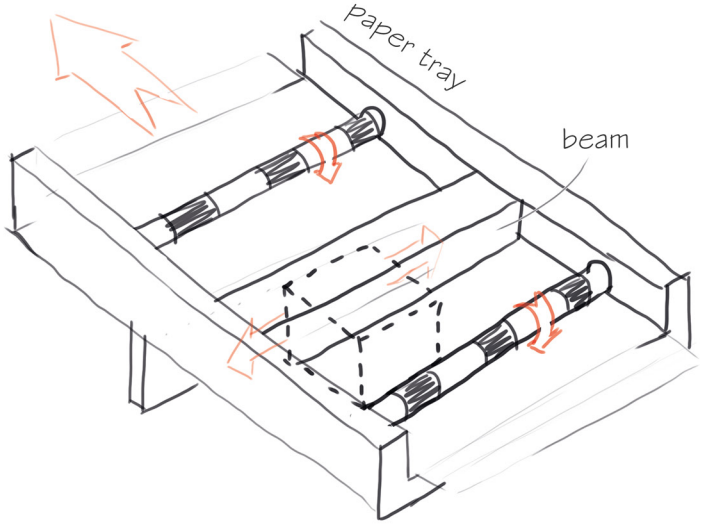


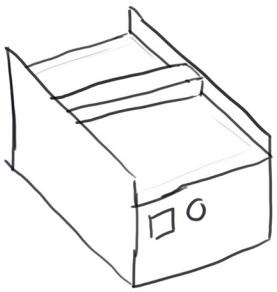


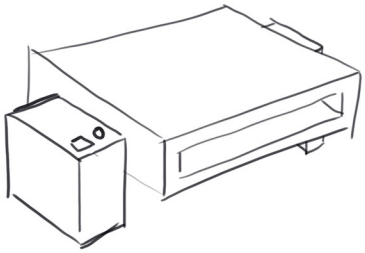


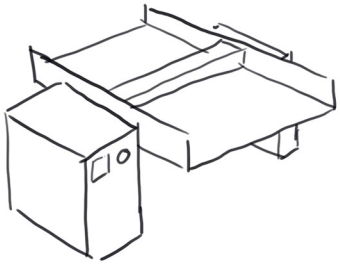
controller box shapes



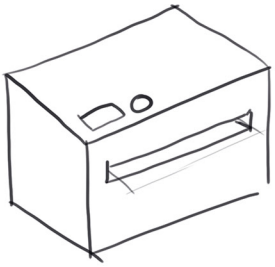


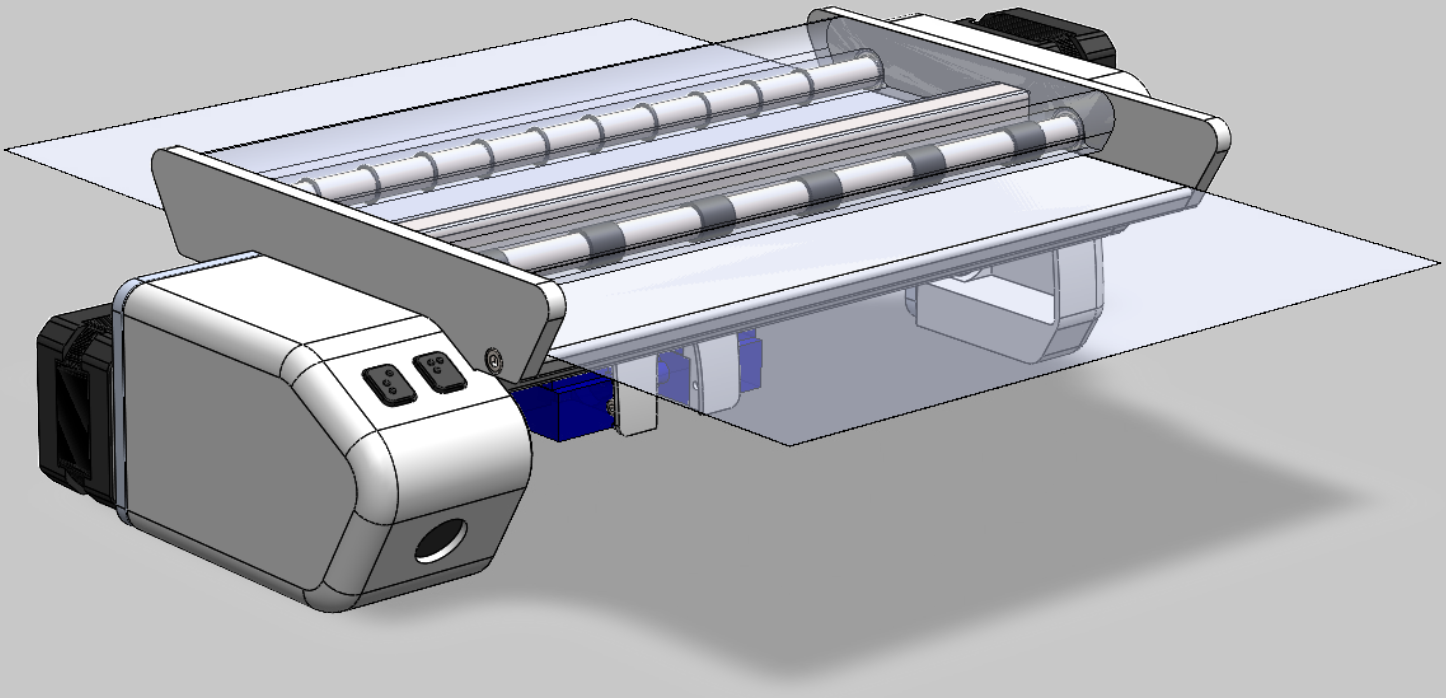




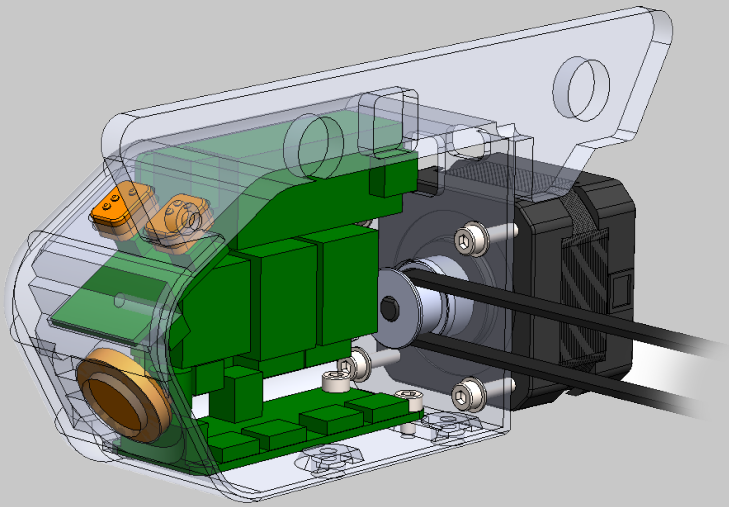


printer shapes





The Final Design

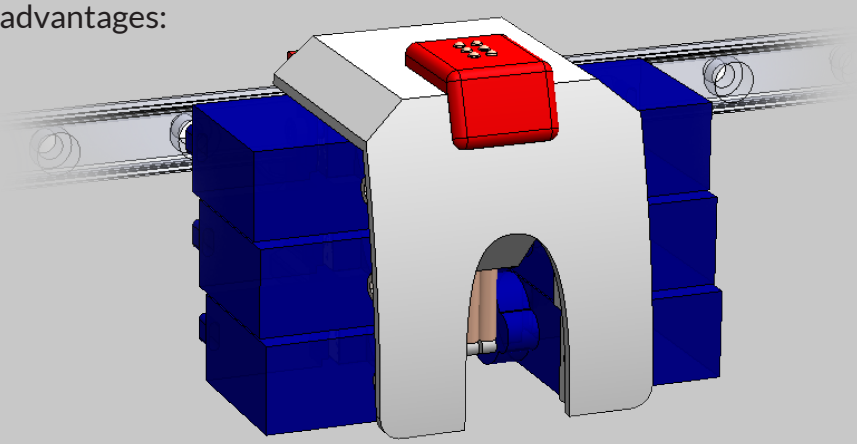


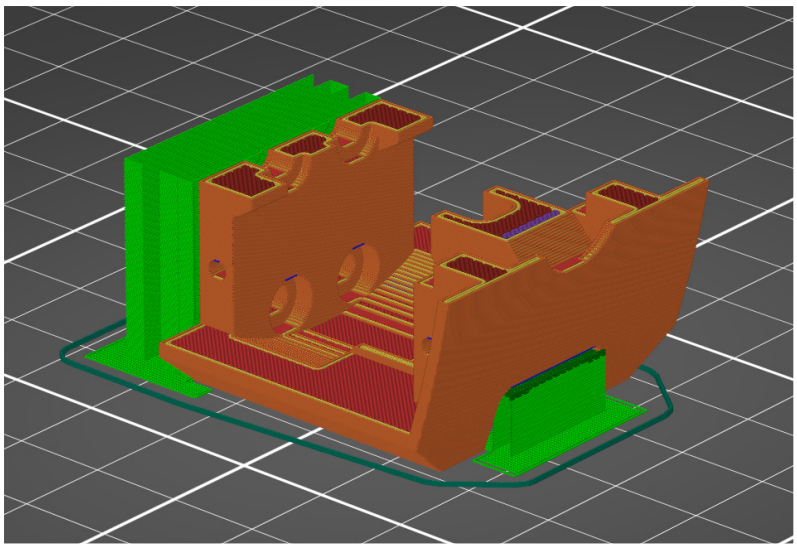
Quite a lot of electronics:

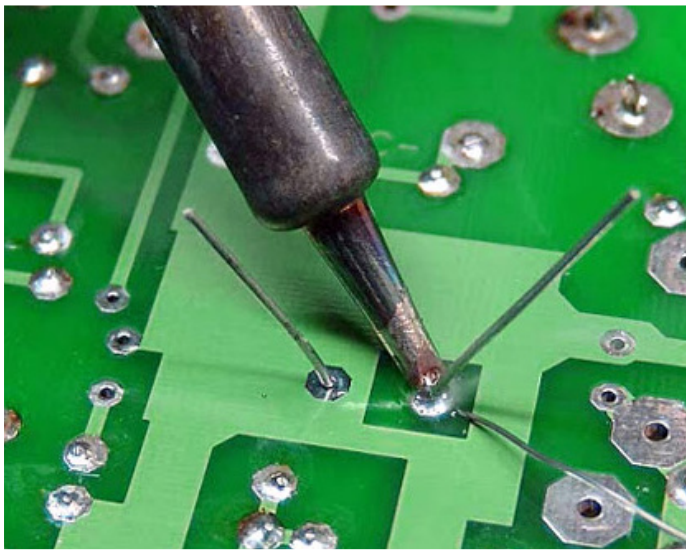
- Arduino Nano (ATmega168p)
- 2 stepper motors
- 2 stepper drivers (A4988)
- Adafruit PWM expansion board
- 6 servo motors (SG90)
- 2 switches + 2 buttons
- Speaker

The printhead has plenty of advantages:

- Lightweight, but strong
- Precise and reliable
- Wear-resistant
- 6 pins at once
- Free of maintenance
- Sophisticated design



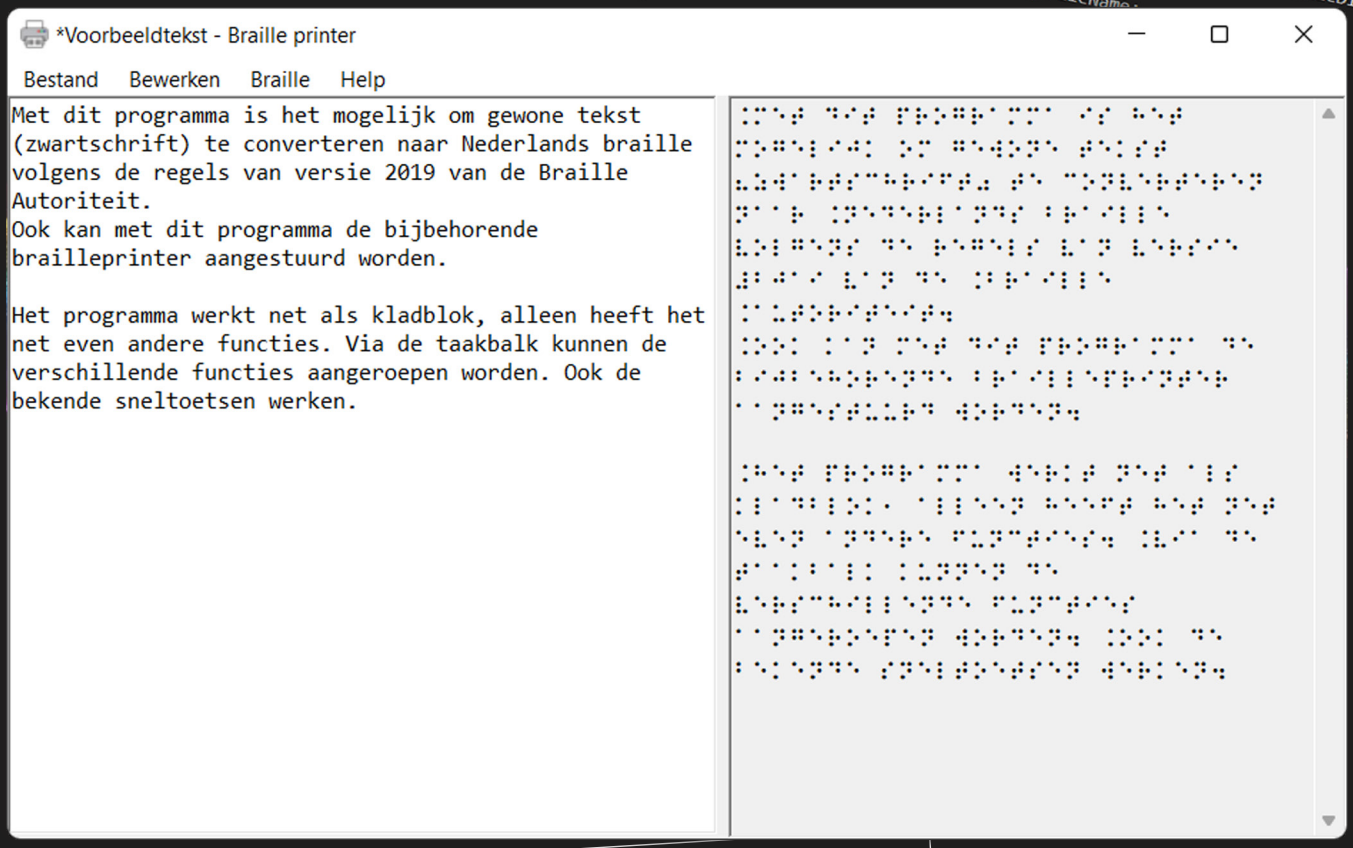


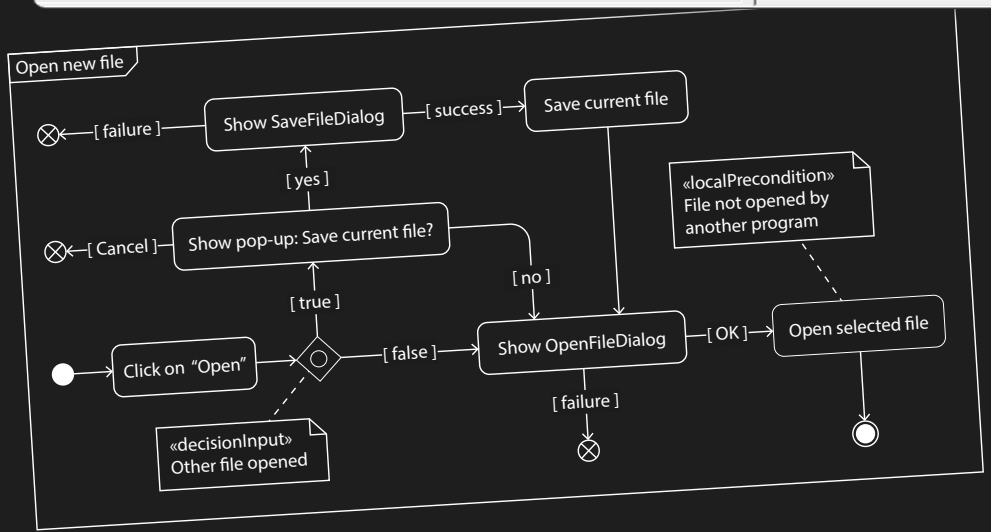


While assembling, I learned the relevance of “design for assembly” the hard way. Though the result is mesmerising, you cannot imagine how much patience, perseverance and motivation this project required.

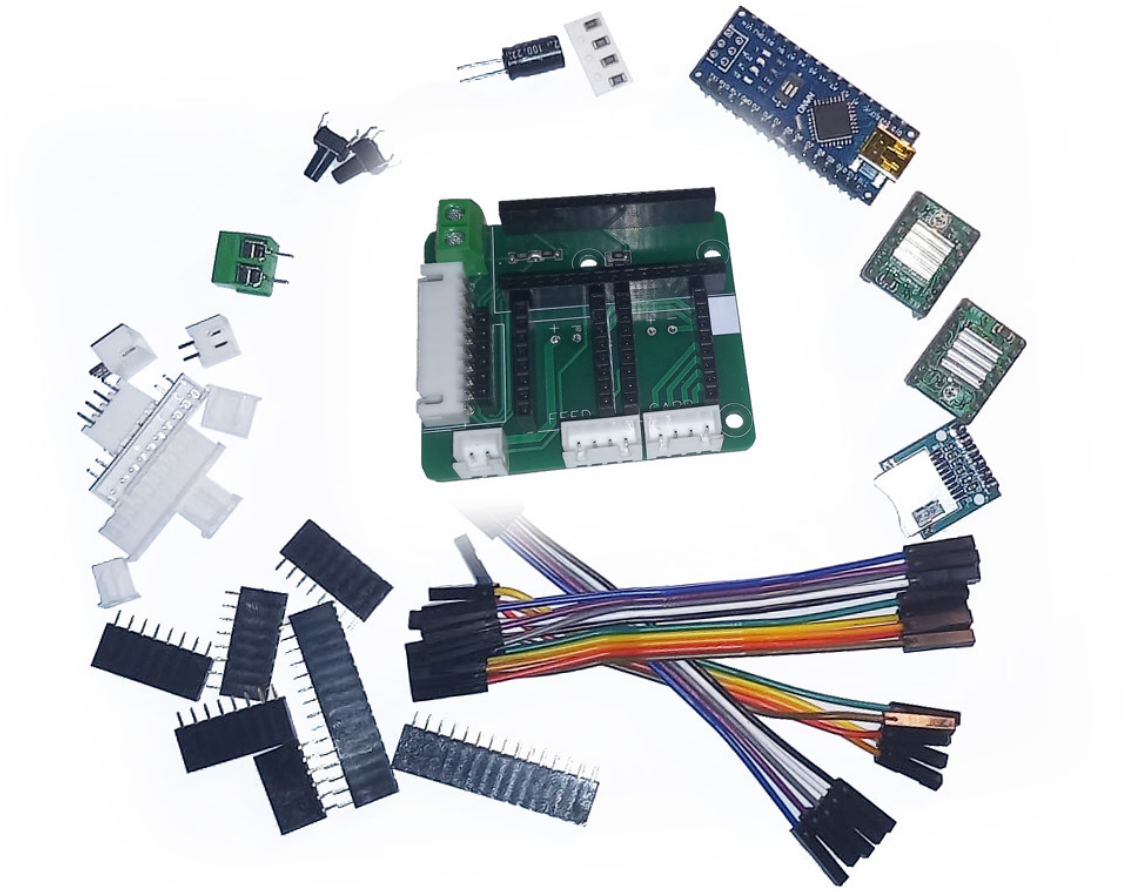
```
Split in lines, convert line by line and return as list
ivate List<String> ConvertToBraille(String input)

List<String> output = new List<String>();

String[] myOutput = ConvertLineToBraille(input).Split('\n');
for (int i = 0; i < myOutput.Length; i++)
{
    output.Add(myOutput[i]);
}

return output;
}
```

```
ivate void MI_save_Click(object sender, EventArgs e)
{
    if (filePath != "")
    { // save without save-dialog
        File.WriteAllText(filePath, this.TB_input.Text);
        fileChanged = false;
    }
    UpdateTitle();
}
else
{
    saveFileDialog = new SaveFileDialog { Filter = fileTypes };
    if (saveFileDialog.ShowDialog() == DialogResult.OK)
    {
        File.WriteAllText(saveFileDialog.FileName, this.TB_input.Text);
        fileChanged = false;
        this.Name = Path.GetFileNameWithoutExtension(saveFileDialog.FileNa
        UpdateTitle();
        filePath = saveFileDialog.FileName;
    }
}
```



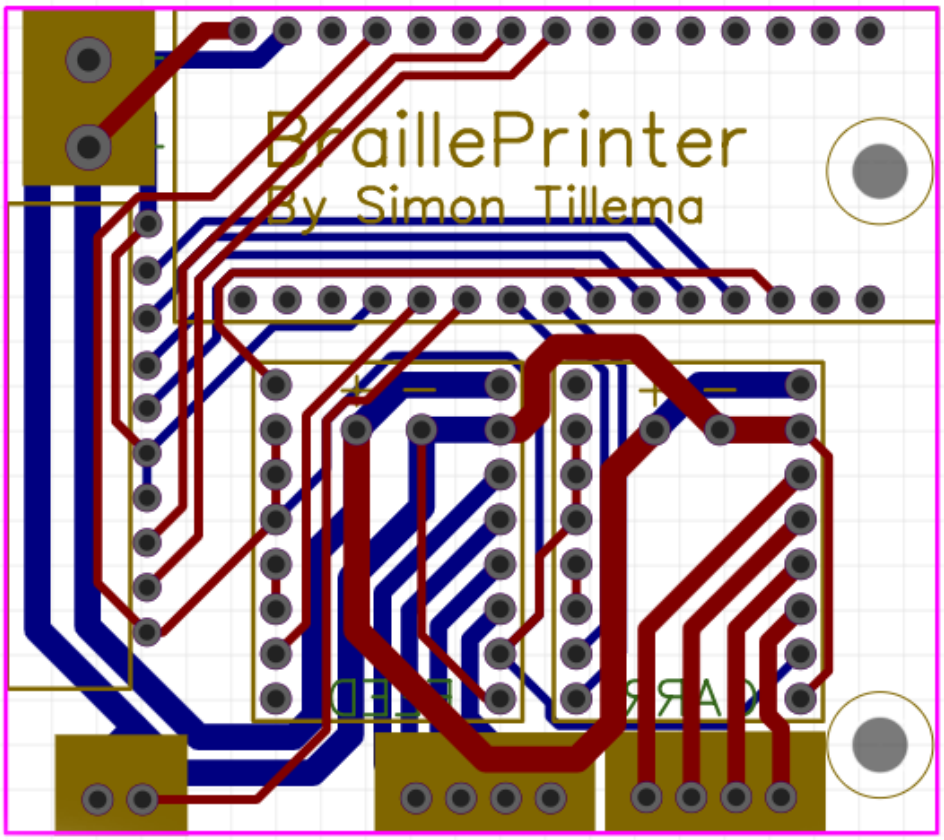


The Program



PCB

Plan - Compose - Build



Never Give Up!

I had to solve 1001 problems. Below a list of the most interesting ones:

Servos became glowing hot!
Due to the incorrect power supply, way too much current was provided to the servos, causing them to overheat. The temperature was far beyond the safe operation temperature. Within two minutes, the servos rose to an untouchable temperature. The solution to this problem was to use a DC/DC-module with lower specification.

Arduino was backwards oriented on PCB
A stupid mistake I will never make again: the pin orientation of the Arduino was reversed on the custom PCB, causing the connector to face inward instead of to the back. The only solution was to redesign the PCB.

Installation of open loop belt hard to install
Though the idea was good (no restriction on belt length), in practice is caused me twice a headache - during assembly, and when a servo had to be replaced. The solution I came up with uses a closed loop belt. This makes installation much easier. The only required modification was a different frame plate design.

Beam with holes not properly aligned
Because a few constructive parts were 3D printed, the alignment of the beam relative to the printhead was misaligned about 0,3 mm, which is way too much. Allowable tolerance is around 0,05 mm, since the pins do not have a lot of play. This issue was fixed by heating the 3D printed part and cheating them in the right position.

Servos not powerful enough
To emboss a dot in paper, quite some force is required. The maximum torque the used SG90 servos can provide, proved to be insufficient in this case. The solution will be to decrease the length of the arm attached to the rotor.

Servos 'shock' at boot
When the servos are powered at a boot, they tend to move clockwise, no matter in which position they are. This resulted in 3 pins penetrating the beam, and 3 pins falling out of the printer. This is an issued that cannot be solved without the use of better servos. The solution I came up with is to reduce the time from initial boot until first signal. Pins are still falling out sometimes.

Arduino not suitable for braille conversion
The used Arduino with ATmega168p chip is very limited on possibilities. Converting regular text to braille is impossible for the Arduino. This requires too much memory. The only solution was to let the computer do the calculations. As a result, I had to to rewrite the entire program code, communication protocol, and interface of the program. After that, the Arduino uses about 70% of its memory. The second optimization reduced the file by more than 50%! Due to a lot of fiddling in the code, it became very inefficient.

Motor for paper feed not powerful enough
When all features are on high-power mode, the available power need to be divided over 6 servos and 2 steppers. This caused the paper feed stepper to be not strong enough to feed the paper. The solution was quite simple; turn off the power for the other motors when paper is fed.

Arduino unable to play sound
Without external module, an Arduino cannot play voice messages (like *"Welcome! Please load a new paper into the printer..."*) on a speaker. The solution was to use some standard signals instead of voice messages. Beep, beep, beep, and the user knows the printer requires attention. The program now contains 4 different tunes and the used frequences according to ISO 16.

#OpenToWork

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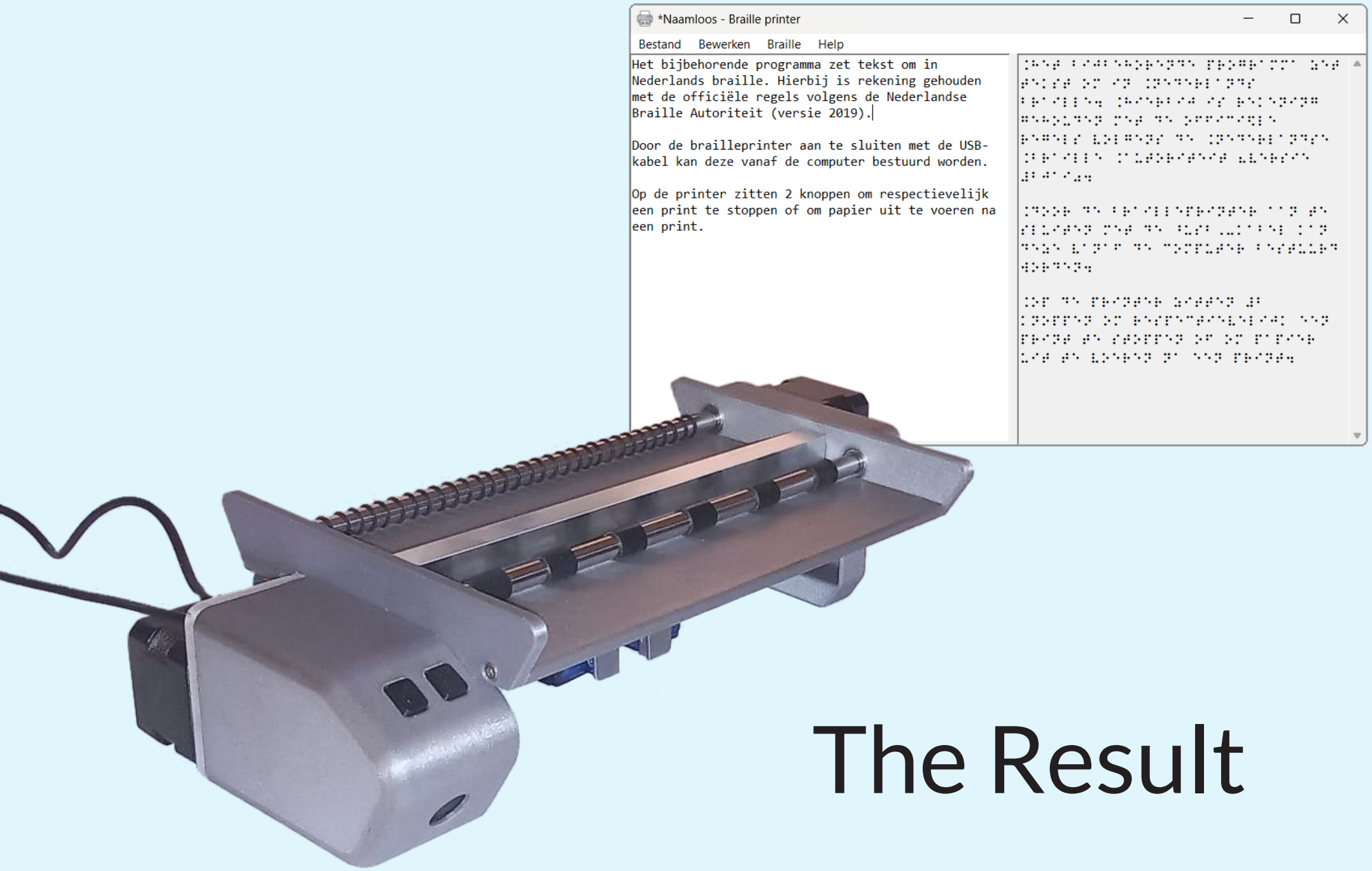
*Naamloos - Braille printer
Bestand Bewerken Braille Help
Het bijbehorende programma zet tekst om in Nederlands braille. Hierbij is rekening gehouden met de officiële regels volgens de Nederlandse Braille Autoriteit (versie 2019).
Door de brailleprinter aan te sluiten met de USB-kabel kan deze vanaf de computer bestuurd worden.
Op de printer zitten 2 knoppen om respectievelijk een print te stoppen of om papier uit te voeren na een print.

The Result