Self Aligning Connector

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1 Motivation

I read an article stating a sentence like "the future of the connector is round". That made me think of common connectors, what I think is wrong with them and what a perfect connector should be.

1.1 Requirements

- Aligning - Contrary to USB, the connector shall be self alining.
- Mechanical Protection - The Pins have to be protected against mechanical stresses from an uneven insertion.
- Water Resistance - At least when connected the connections shall be protected against water.
- Locking - The Connector has to lock to prevent unwanted disconnection.
- Scaleability - The connector has to be scaleable from as little as one connection to as many as needed. Also the size of each connection must be scaleable.

2 CAD Modell

The modell was desinged using OnShape. OnShape is an online CAD program. It was used because they offer a free plan and the program is quite simple to get into.

2.1 Connections

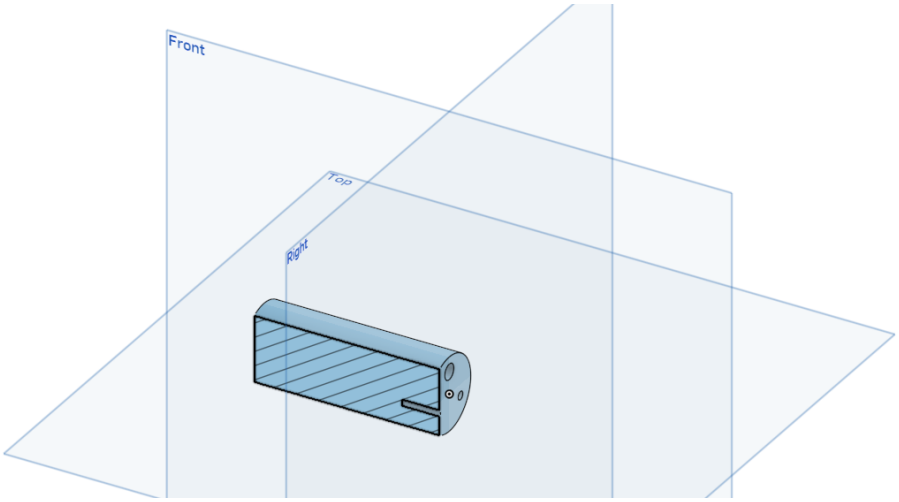

Figure 1: Female Connector

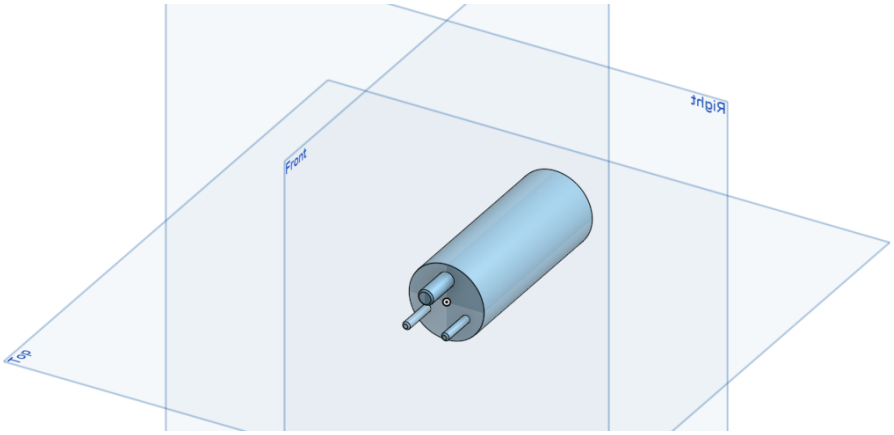

Figure 2: Male Connector

Both the female and male parts of the connector are simple round shapes with a number of pins in the male part, and a corresponing number of holes in the female part. Note that for this example there are three pins, one with a different diameter, that will only go together in one direction. This is no requirement, but will prove that the connector is indeed self aligning.

2.2 Alignment

USB-C for example uses a connector that can be plugged in in reverse. This is not the case here. There is only one correct way, but due to the alignment mechanism the connector will automatically find it.

The alignment mechanism is purely mechanical. The female connector was surrounded by a diagonal contour. It is designed in a way that will guide the male connector to a predefined slot.

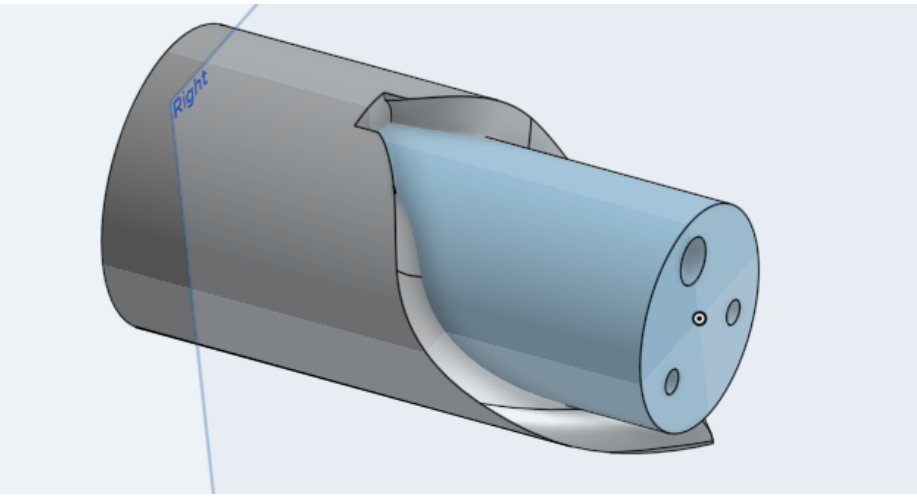

Figure 3: Female Alignment Mechanism

The male part of the connector as an extension that will follow the added contour around the female cocnnector part. The extension extends so far, that the pins will be aligned before they engage. That way the pins are protected against uneven insertion.

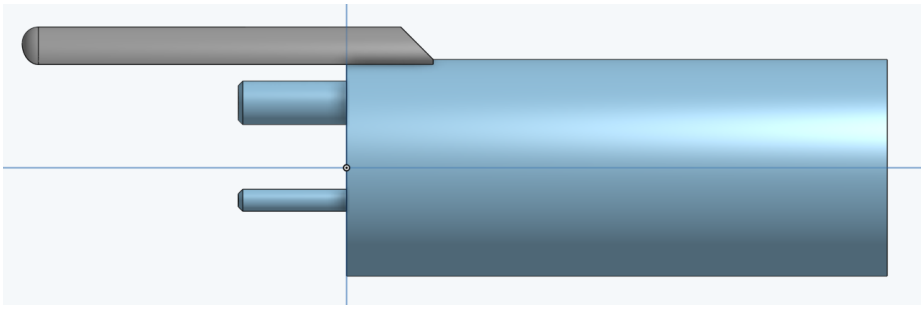

Figure 4: Male Alignment Mechanism

2.3 Lock

To lock the connector into place, a mechanism similar to a BNC connection was added. The female part of the connector has two pins. The pins will lock into the hull added to the male connector. By turning the hull, the pins will lock. A spring can add tension to the locking mechanism.

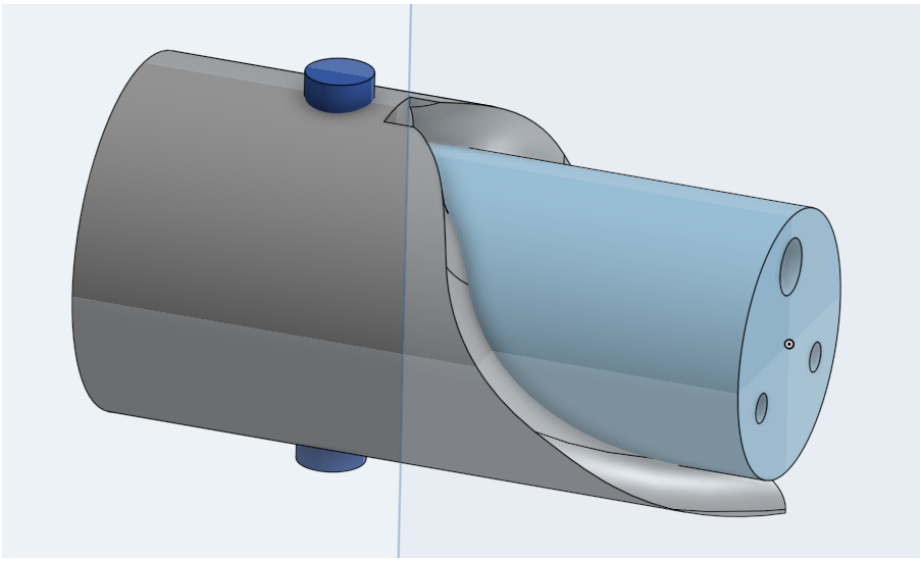

Figure 5: Female Connector with Locking Pins

The hull on the male connector also protects the pins inside.

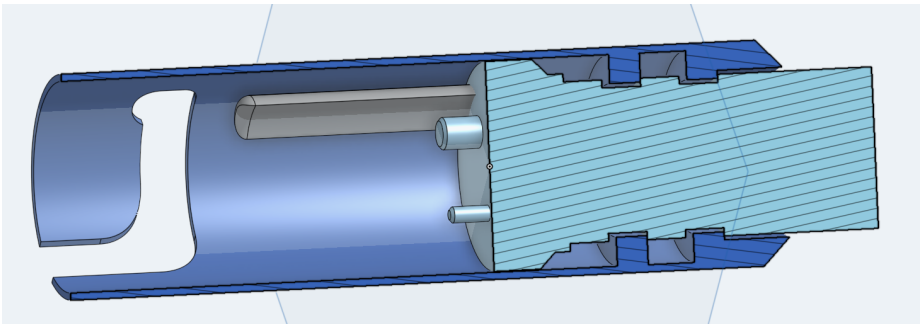

Figure 6: Cut through the Male Connector

Additionally the hull is only held in place by some slots in the male connector, allowing it to turn freely. This is required to turn the locking part of the connector when the pins have already engaged. Also the inner part can turn freely, allowing the alignment mechanism to do its job.

2.4 Seal

To protect against water, a small groove can be added to the connecting surfaces. A rubber seal can be placed there. The locking mechanism will add the appropriate preassure.

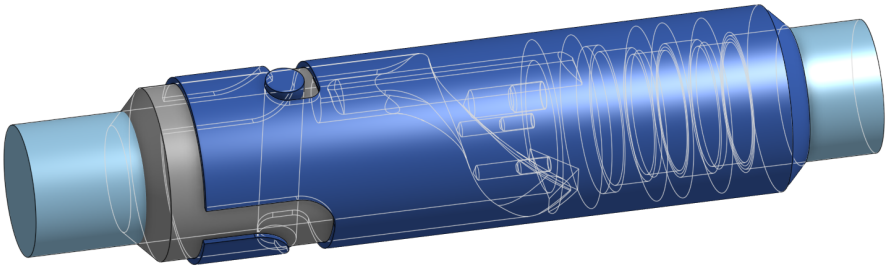

Figure 7: The Assembly with Inner Edges exposed

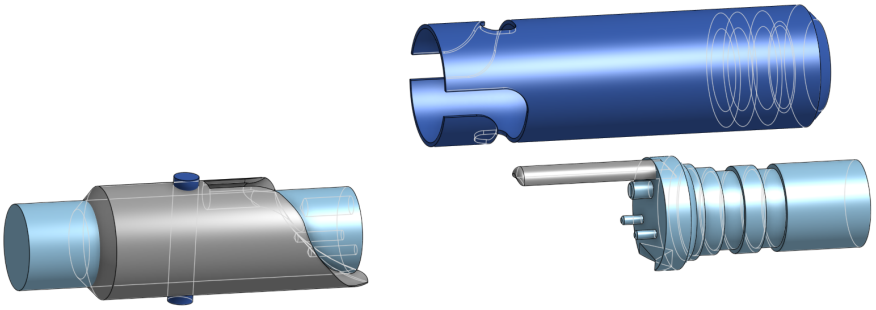

Figure 8: Parts prepared for 3D Printing

3 3D Printing

The parts were 3D printed on an Anycubic i3 Mega in black filament.

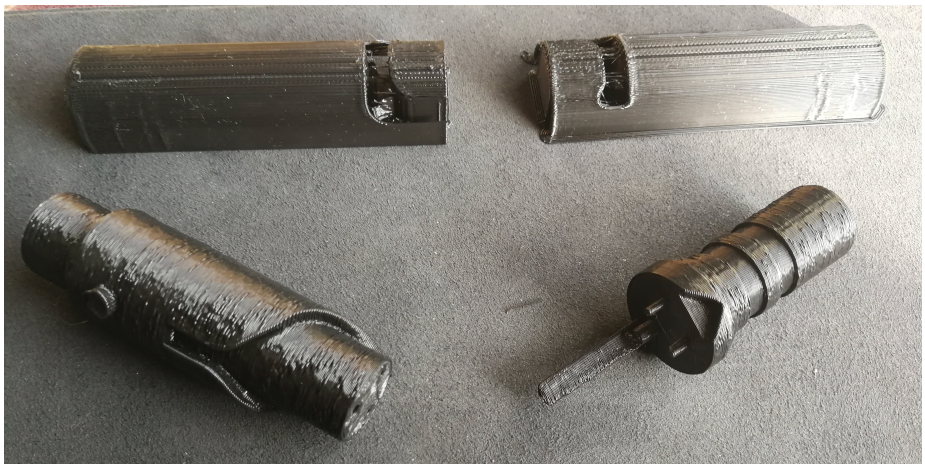

Figure 9: 3D Printed Parts

3.1 Mistakes

A lot of learning opportunities happened during printing.

- Lock is too thin
- Lock is missing a ring at the front, holding the locking hull together
- There is too much support
- The support is too stiff, allowing no breaking away without damaging the part
- The slot in the locking hull is too small
- The holes for the pins in the female part are too small
- The outer shell is printed unevenly
- The pins for locking on the female part are not round due to overhang
- The alignment extension on the male part is too short
- The alignment mechanism does not reach as it does in the CAD modell
- The pins on the male connector are printed very brittle and not straight

4 Final Thoughts

At first, I was not going to write this documentation at all. But then I reminded myself, that I just threw away the 3D prints. That made me feel bad, because it was like a waste of time and filament at first. But then again, this is a learning opportunity. So I decided to write a little, just to document what went wrong and what can be improved. Because learning happens when you make mistakes and reflect on what happened and why.