

Background

DMF Medical has developed a new CO2 filtration device that uses membrane technology to remove CO2 from anesthesia circuits and is safer and more cost effective than the current chemical processes.

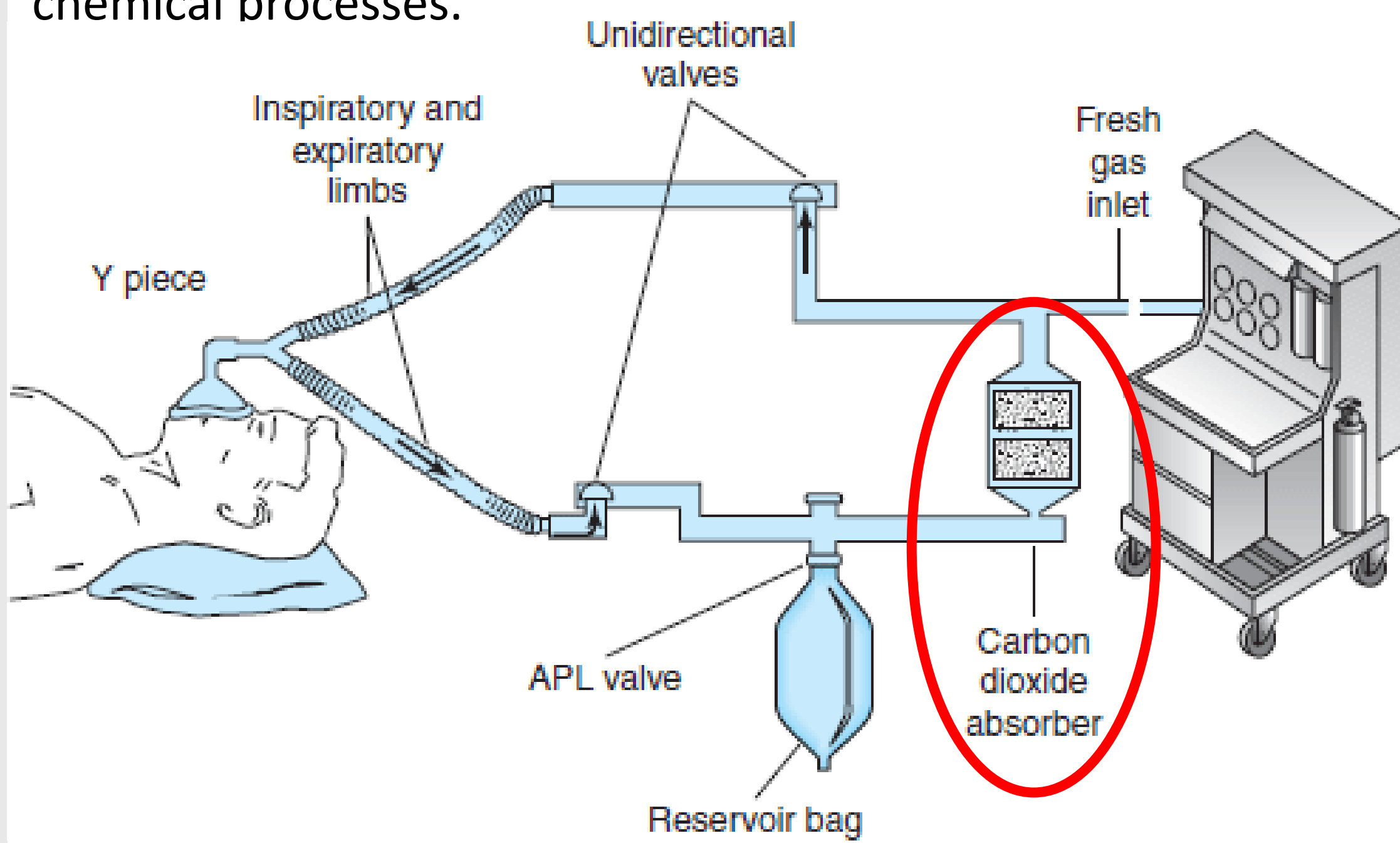


Figure 1 - Anesthesia Circuit with a CO2 Absorber

The current manufacturing process of the device is manually done by hand and is time consuming and inconsistent.

A solution is required for an efficient and easy method of checking the dimensional tolerances and applying reliable glue lines to the parts.

This project consists of two main components:

- **Dimensional inspection station** for each individual component.
- **Semi-automated glue dispensing machine** to assist in the assembly of the device.

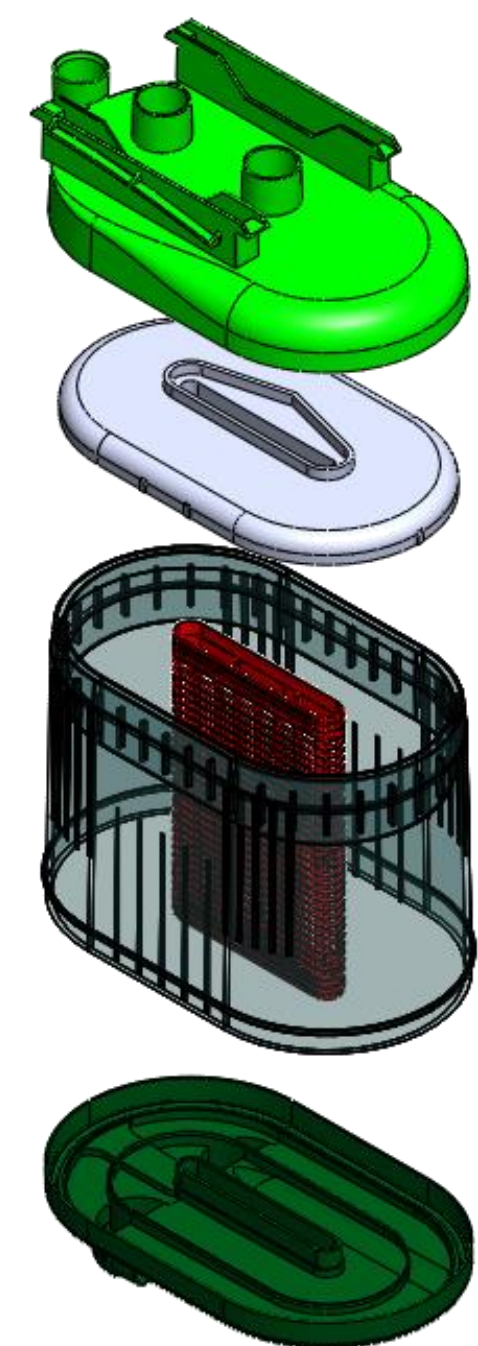


Figure 2 - Exploded View of CO2 Filtration Device

Requirements

Dimensional inspection station:

1. The inspection station shall verify 6 parts with 40 critical dimensions.
2. The inspection time per part shall not exceed 2 minutes.
3. The inspection station shall not exceed an area of 5' by 5'.

Semi-automated glue dispensing machine:

1. The machine shall follow 7 glue path lines.
2. The machine shall dispense glue lines less than 2 mm thick.
3. The machine shall not deviate in accuracy or resolution by more than 0.5 mm.

Semi-Automatic Glue Dispensing Design

Design Components:

1. CNC controller controls the X, Y, Z coordinates, Z-axis rotation angle and dispensing pressure of the glue syringe.
2. Z-axis rotation stepper motor rotates the syringe allowing it to stay perpendicular to curved vertical surfaces.
3. Actuator dispenses glue at a constant flowrate
4. Arduino uses the signal from the controller to control the actuator.
5. Syringe with bent nozzle allows application of glue on vertical surfaces.
6. Part to be glued.
7. Mounting fixture ensures components have the same reference point for each glue line.

Design Features:

- Capable of automatically gluing 7 different glue path lines on 5 different parts.
- Easy removal and replacement of each part and syringe.
- Each path line has the same start and stop point for all path lines allowing for easy transitions between parts.

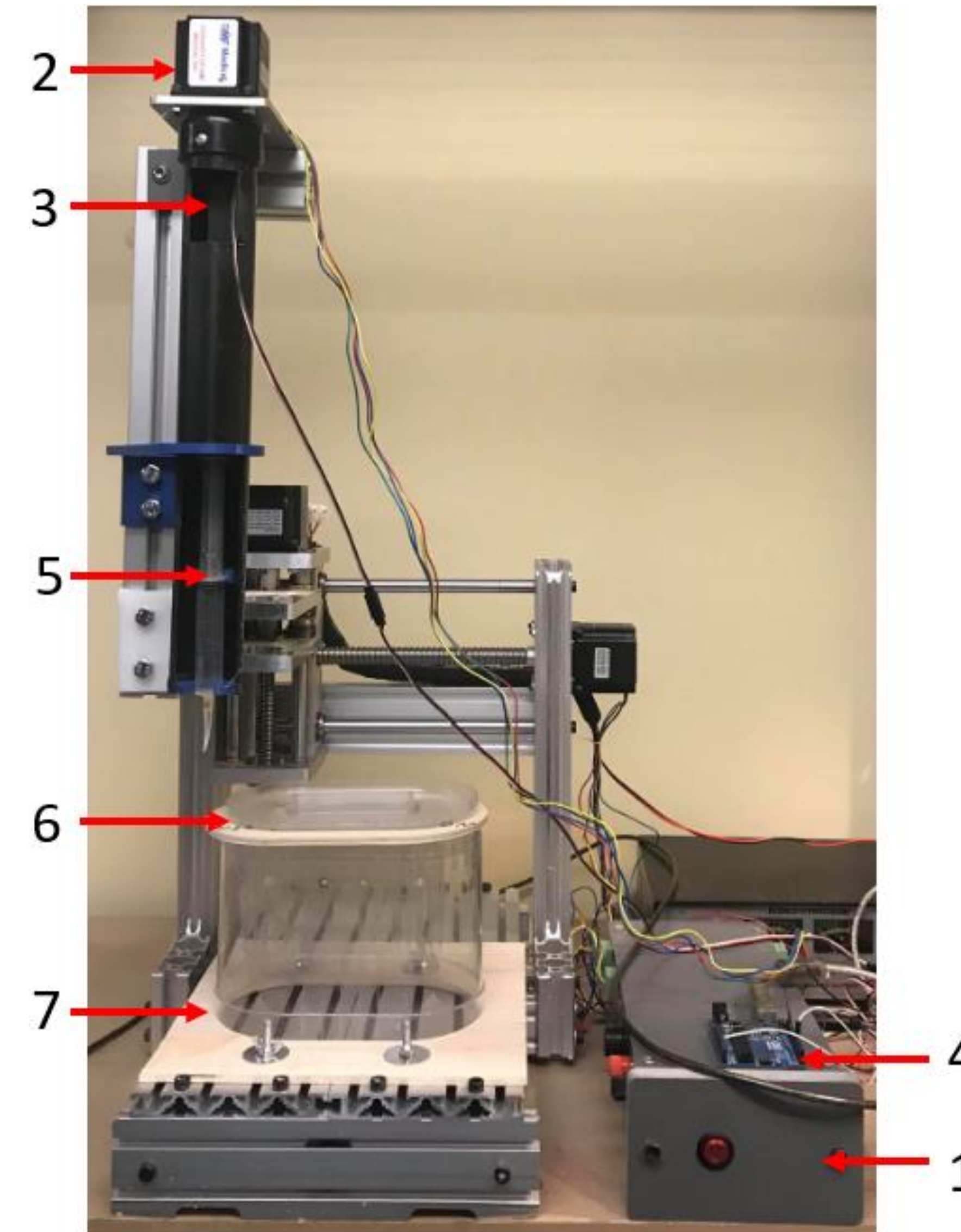


Figure 3 - Glue Dispensing Machine

Dimensional Inspection Station Design

- Dimensional checks were arranged on a fixed plate for compatibility and ease of use.
- 6 inserts were designed for the internal checks that were not feasible to be located on the plate.
- The design of the plate and inserts was based on the go / no-go jig concept.

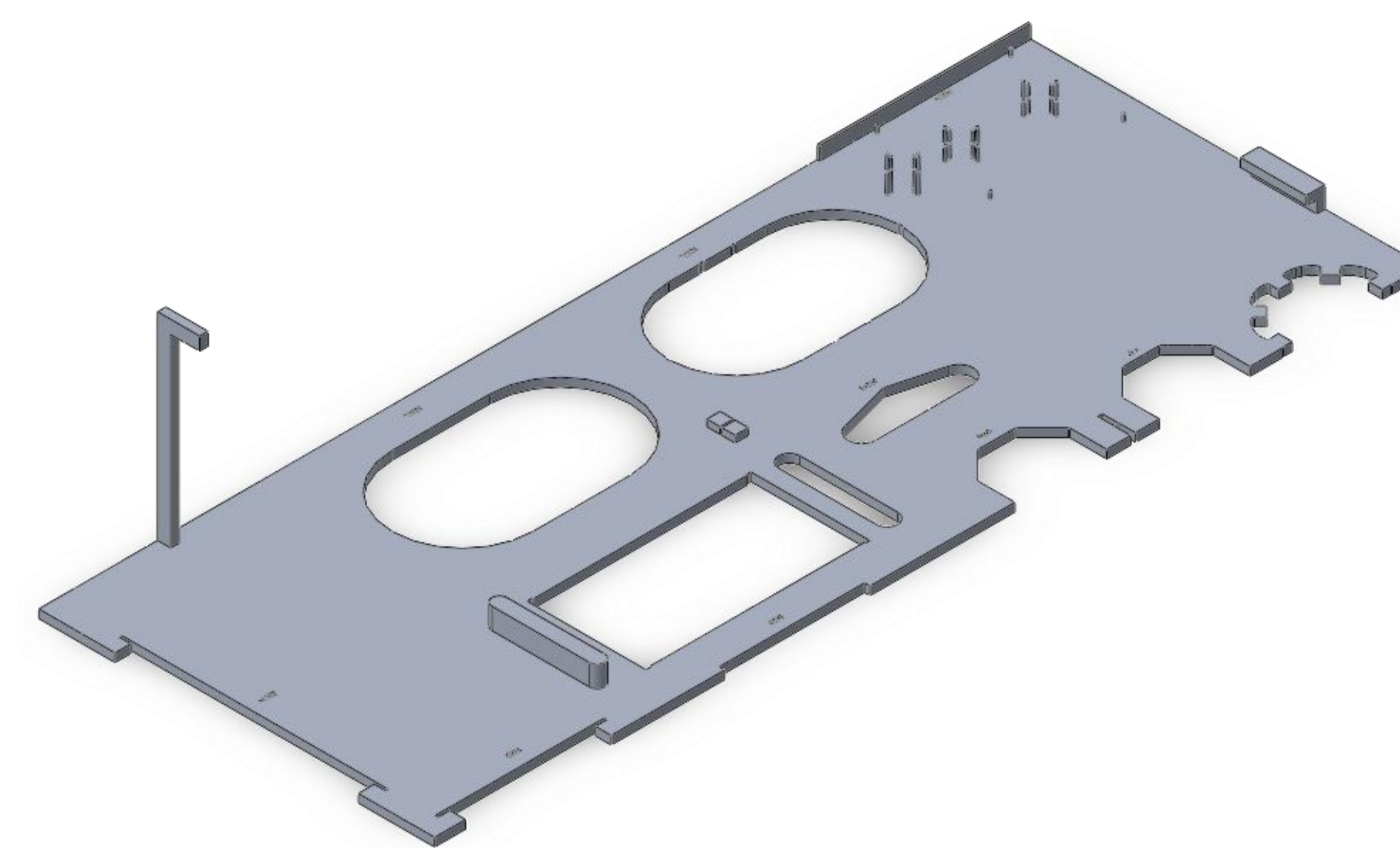


Figure 4 - Plate Layout (2.5' x 1')

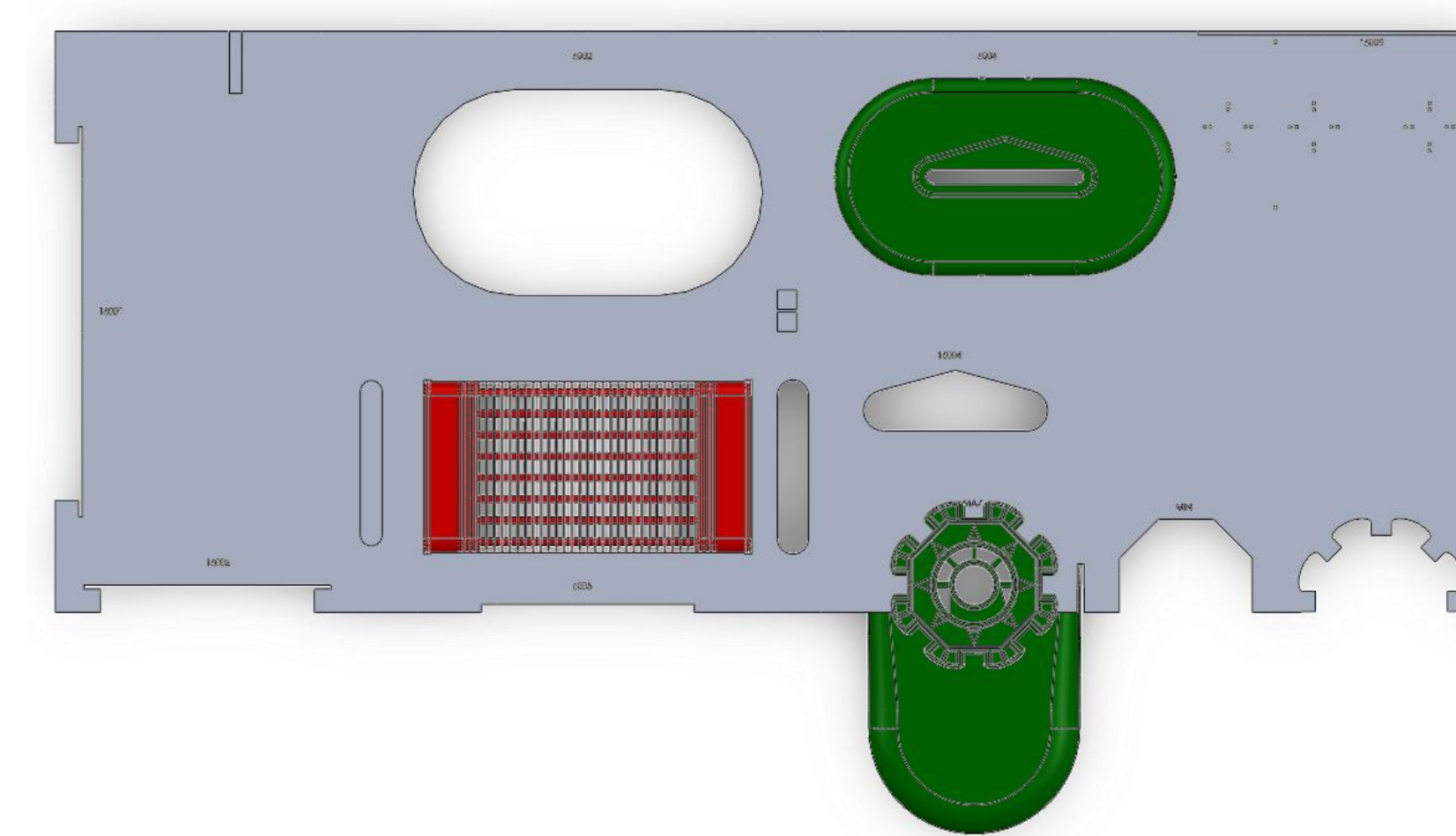


Figure 5 - Part Check Examples

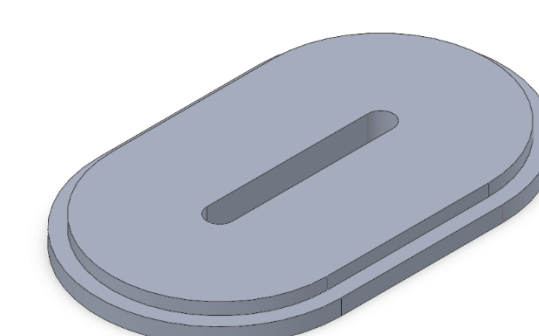


Figure 6 - Inside Contour Height and Cut-out Check

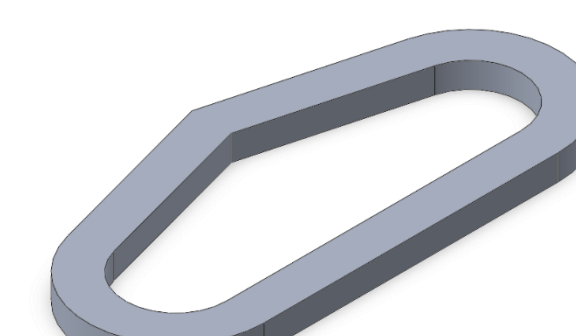


Figure 7 - Inner Geometry Check



Figure 8 - Port Diameter Check

- The plate and inserts together allow for the verification of 40 critical dimensions on 6 individual parts.

Validation & Recommendations

Validation of Glue Path Lines

The ability for the CNC machine to accurately and repeatably follow the glue lines was validated by having it trace two paths with a marker three times.



Figure 9 - CNC Drawn Path Lines with Part for Comparison

Validation of Glue Dispensing System

The system ability to dispense glue lines less than 2 mm thick was validated by testing with corn syrup.



Figure 10 - Corn Syrup Applied to Section of Part

Validation of go/ no go jigs

The dimensional inspection station was validated by milling each jig out of wood and physically checking all parts.



Figure 11 - Validation of Selected Jigs

Recommendations:

- To improve the durability and reliability of the semi-automatic glue dispensing system it is recommended that aluminum be used to replace all plastic and wood parts.
- To improve the dimensional stability and life time of the inspection jigs it is recommended that they be waterjet cut from an aluminum or plastic sheet.

References

- Morgan GE, Mikhail MS, Murray MJ. "Clinical Anesthesiology." <https://accessanesthesiology.mhmedical.com>
- Florentin Wilfart & Brian Macadam. DMF Medical.