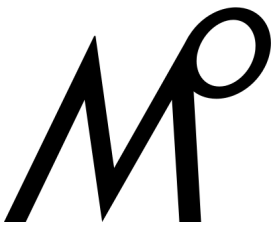
Manawa Ora

Technical Note after Agorize submission

Manawa Ora Team



2020-04-03

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Summary

This note is a collection of documents that were part of the submission in the Agorize Competition: "Code Life Ventilator Challenge". The team name for that competition was *Manawa Ora*, and that name is also used herein for the team and the design.

Our design goals were to make and design a simple ventilator that:

- could be made anywhere in the world
- used parts with supply chains outside the medical industry

Our main constraint was that we started the design only a couple of days before New Zealand went into lock-down, and therefore only had the parts we'd bought the day before stores closed.

The current version has the following "features":

- 1" (25mm) BSP irrigation fittings provide gas conveyance, structural integrity, and sensor housing. These can be purchased from local suppliers in (plastic or stainless steel) or 3D-printed.
- Air and oxygen flow are sensed using automotive Mass Air Flow Sensors. The ratio of these flows provides measurement of FiO2.
- An expiration valve closes during inspiration and when expiration pressure falls below PEEP. High PEEP pressures can be provided by introducing small amounts of air via the inspriation valves.
- The valving logic removes the need for a flap valve at the Y-piece.
- Wireless communication of measured data and control commands. This allows for multiple viewers (e.g. tablet, PC, centralised PC, decentralised).
- Filters and humidifier are separate units.

The design relies on the supply of clean compressed air and oxygen. This choice has been made to a) keep the machine simple, and b) because we think large gas banks and/or compressors are a more efficient way to supply several or many ventilators.

Status

The prototype is built and satisfies most of the Agorize competition goals. It is, however, not ready for production. The big picture of outstanding work follows:

Missing/incomplete feature	Difficulty
Add alarms to code and GUI	Simple
Sort required security for wireless communication and control	Depends on reuirements
Add correct fittings for hospital air/O2 supply	Simple
Improve flutter in valve control	Medium
Improve/test PEEP control when there is vacuum connected to expiration exhaust	Medium
Add a 230 v plug and main switch	Simple

Many of these aspects could be improved by having technical support from appropriately trained and experienced medical personnel.

Design

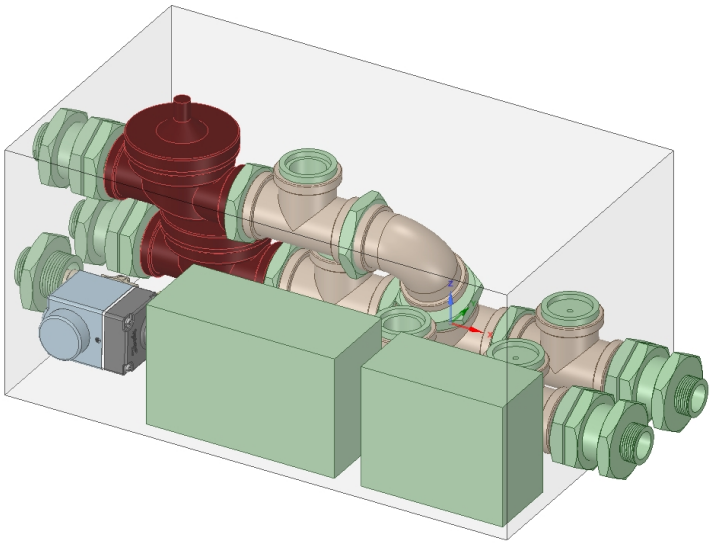

Figure 1: Isometric depiction of ventilator. The cabinet is semi-transparent, and the two ports on the front of the machine are the patient-side inspiration (right) and expiration (left) ports

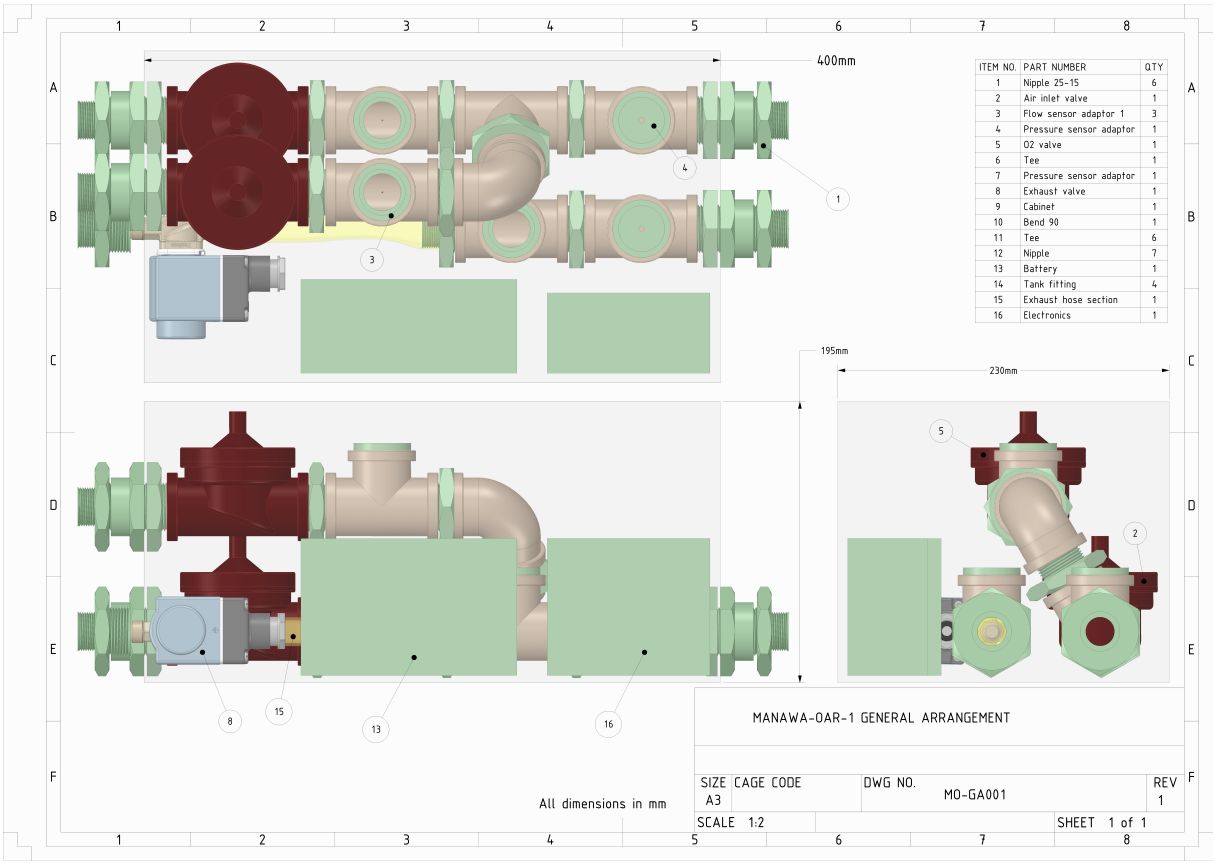

Figure 2: Layout of the proposed ventilator

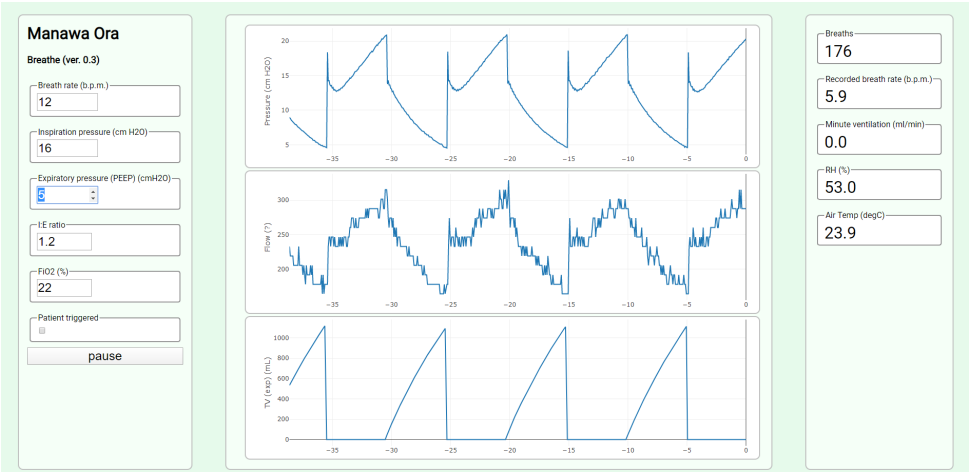

Figure 3: Operator user interface. The unit does not have any screen of it's own: it relies on wireless communication to other computers and devices.

Prototype

The following two photos show the prototype that was made.

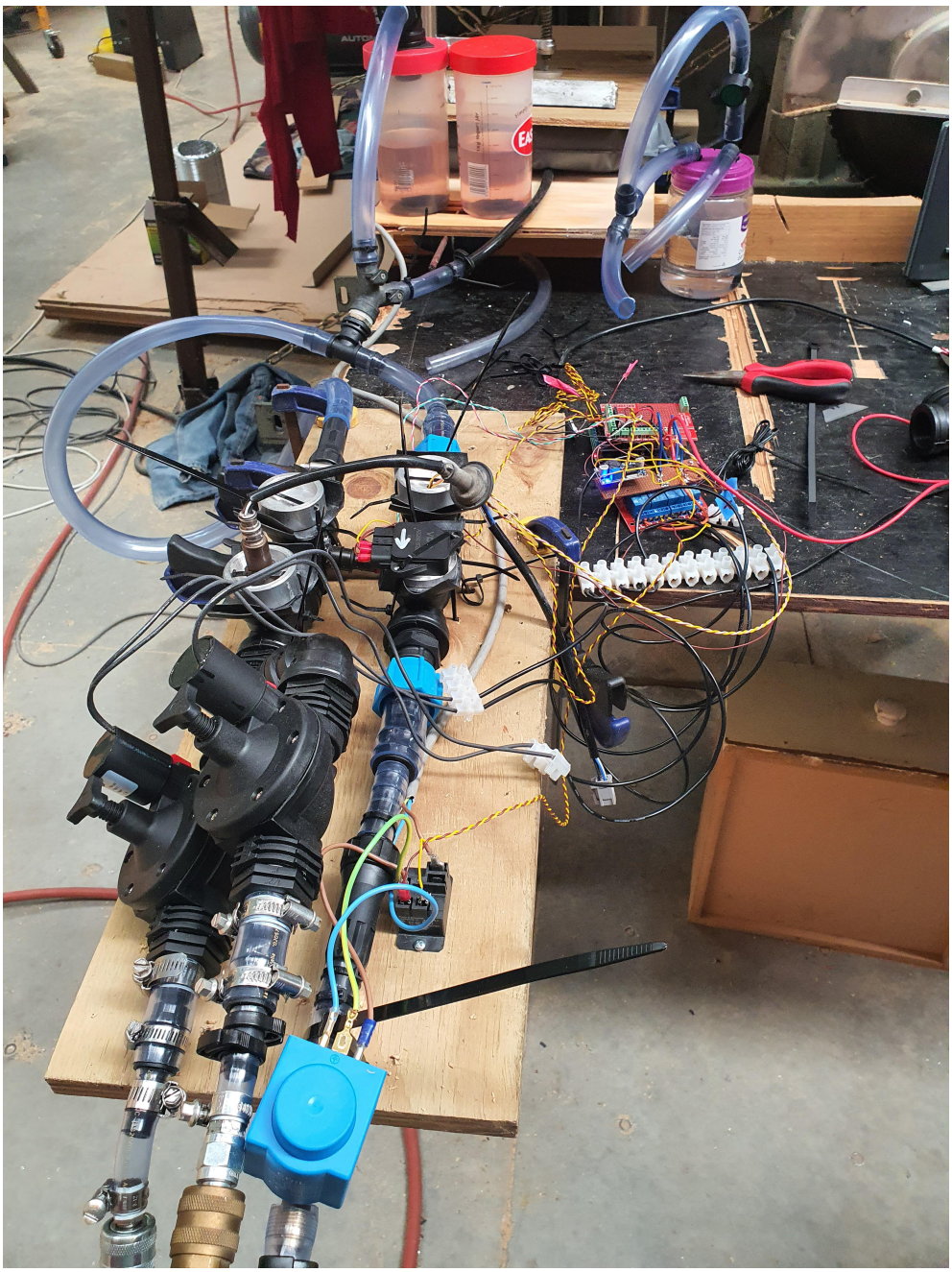

Figure 4: Ventilator prototype. The rear of the machine is in the foreground: air inlet, oxygen inlet, expriation exhaust. The middle ground shows the inspiration and expiration conveyances, sensors, and electronics. In the background is the tidal volume calibration (EasyYo) containers, the patient, and the bubble humidifier. The patient is simulated by a dry bag restrained by a weighted and sprung plywood hinge. Patient compliance is reduced by increasing the spring stiffness.

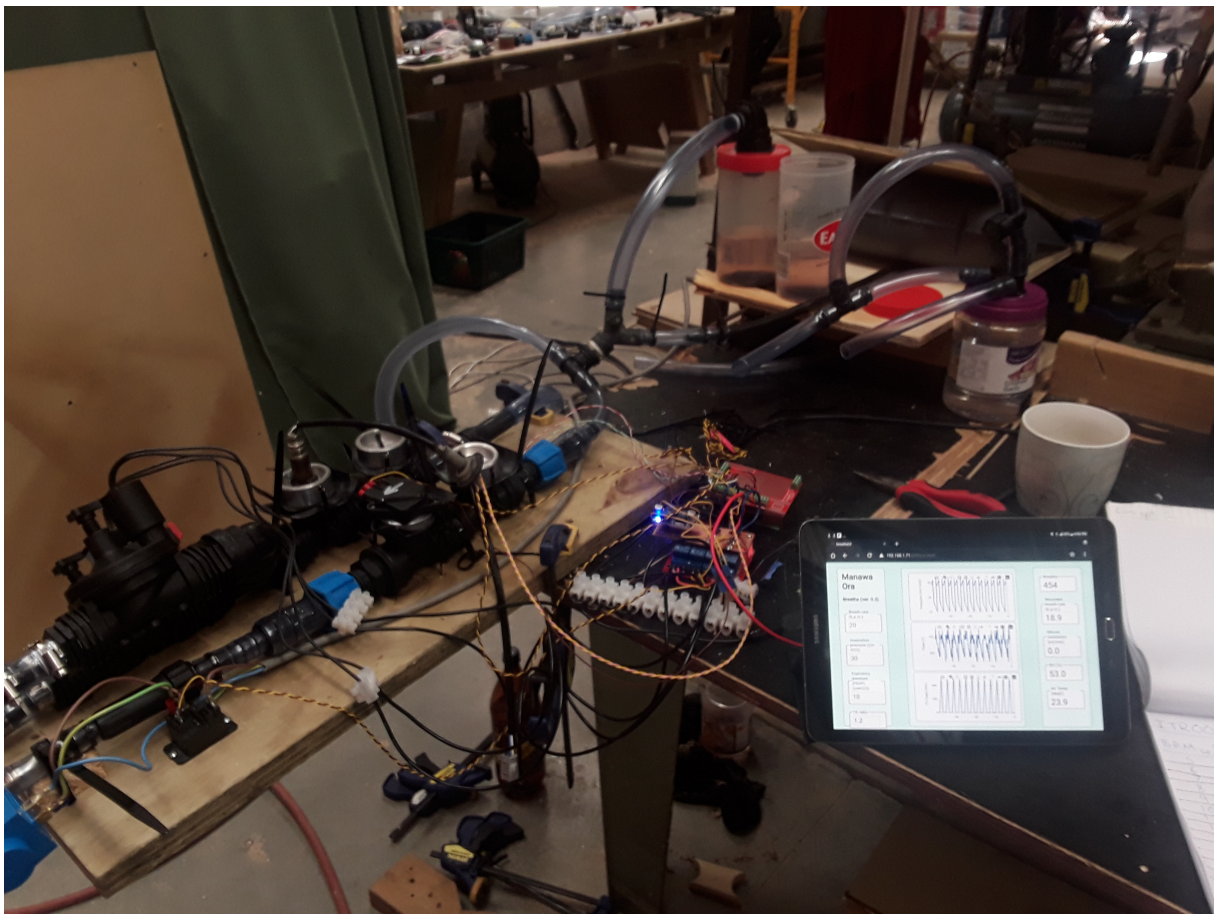

Figure 5: Operator interface on a tablet

Appendices