

Public Invention Q4 Report, 2023

-- Robert L. Read (Rob), January 6th, 2023

Executive Summary

This year we began a \$300,000 contract with NASA to build a digital control system for a cutting-edge ceramic oxygen generator. This will someday be needed in space, but will be a boon to global health, if we continue making progress. Public Invention was a part of an experiment showing this can produce absolutely pure O₂ and 3000 psi with no moving parts. This project has consumed a major part of Rob's time—our internal joke is “We're not going to quiet quit NASA.” In order to finance paying the engineers, Rob had to make significant personal contributions. This contract will extend into June. As of Feb. 4th, we have invoiced for \$108K of this, but the remainder is being canceled/changed by NASA.

The PolyVent educational ventilator platform project is on the verge of failing. Nobody has expressed interest in it. We hope soon to learn if we have been awarded a \$300,000 grant from the National Science Foundation (NSF). If not, this project will be mothballed.

The GOSQAS project, which was co-initiated by Public Invention with Open Source Medical Supplies (OSMS), is going very well. We have an active team, and people who hear of the project are enthusiastic. We are acting as a fiscal sponsor to this project but it will soon be its own California corporation and will apply for its own 501c3 status.

Our fiscal support of the Glia Tourniquet project is drawing to a successful (though somewhat behind schedule) close. The tourniquets are now being made in Poland with a complete open-source desktop injection molding system.

We received \$1000 from Recognize Good in Austin, TX.

The Moonrat project raised \$2000 as a crowd-funded project. The project is going well, and has attracted three graduate students from Cinvestav University in Guadalajara.

Attempts to raise money from the Moody foundation have not yet succeeded.

Many small projects are progressing, but too slowly to be successful: Unscrew Propeller, Ferrofluid Pump, Ferrofluid Check Valve.

The General Purpose Alarm Device (GPAD) was completed and a paper submitted to HardwareX.

We created a [shop](#), where the GPAD, VentMon, and PolyVent devices can be purchased. Despite nobody specifically expressing any interest in purchasing these devices, we have made them available for public accessibility and purchase.

Every month in 2023 we held a third-Thursday event known as our Inventors' Gathering. These had between 7-15 people attend on average. They had a very positive vibe and were often very interesting. We plan to continue these in 2024.

NASA Ceramic Oxygen Generator Project

In August, Public Invention was awarded a \$300,000 contract to build a digital control system for a ceramic oxygen generator (COG). This was awarded after the successful completion of a previous \$50,000 design contract.

On September 25th, Lawrence Kincheloe and Rob made a long road trip from Austin through Oklahoma City to Salt Lake City. We delivered two Public Invention devices to American Oxygen, the contractor with chemical expertise building the ion transport membrane equipment.

This technology has no moving parts, except for a fan to keep air moving, and extracts absolute pure O₂ from the air. NASA needs this sort of thing to fill spacesuits in space without costly and unreliable electromechanical equipment such as Pressure Swing Adsorption processes followed by oxygen compressors. It could also have enormous benefits for global health, as it can be scaled down to the size of small rural clinics in low- and middle-income countries.

The first equipment we delivered controls the extraction of O₂ from normal air. This is the Oxygen Engine Digital Control System (OEDCS). This is made more complicated by the fact that it needs to occur at 750°C, and there is a danger of thermal runaway.

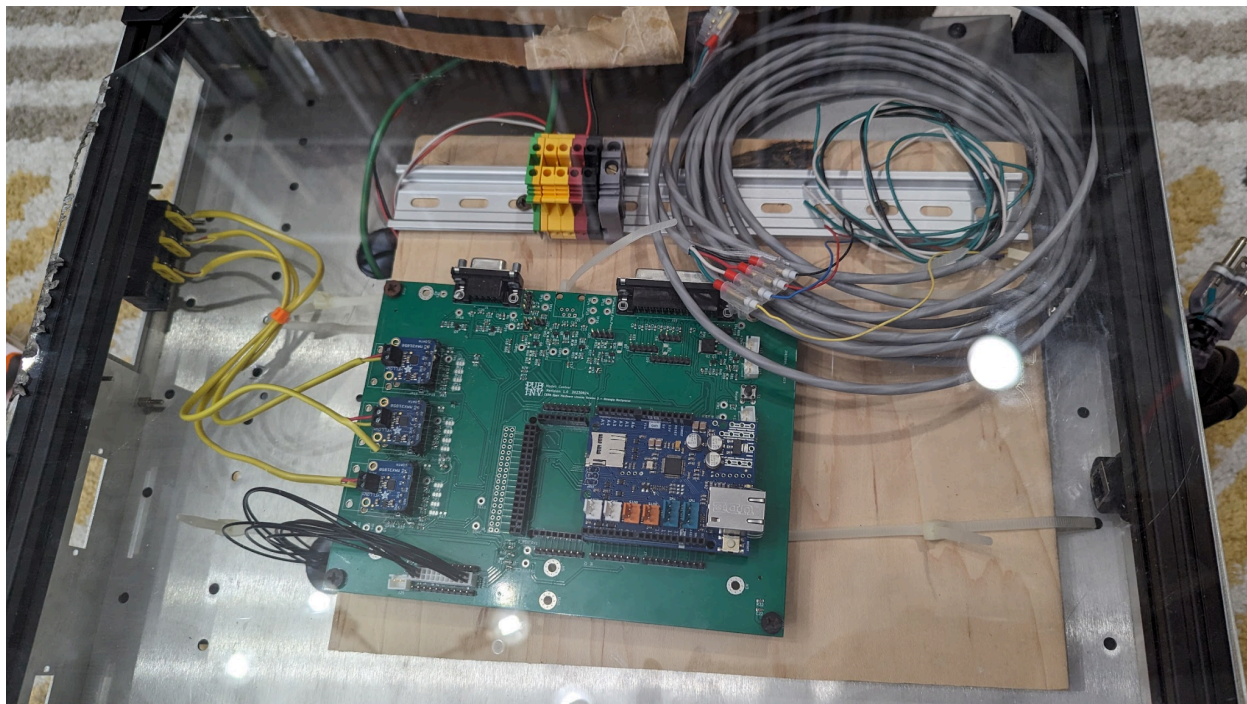


Figure 1a. The OEDCS SN#2, delivered to NASA in September.

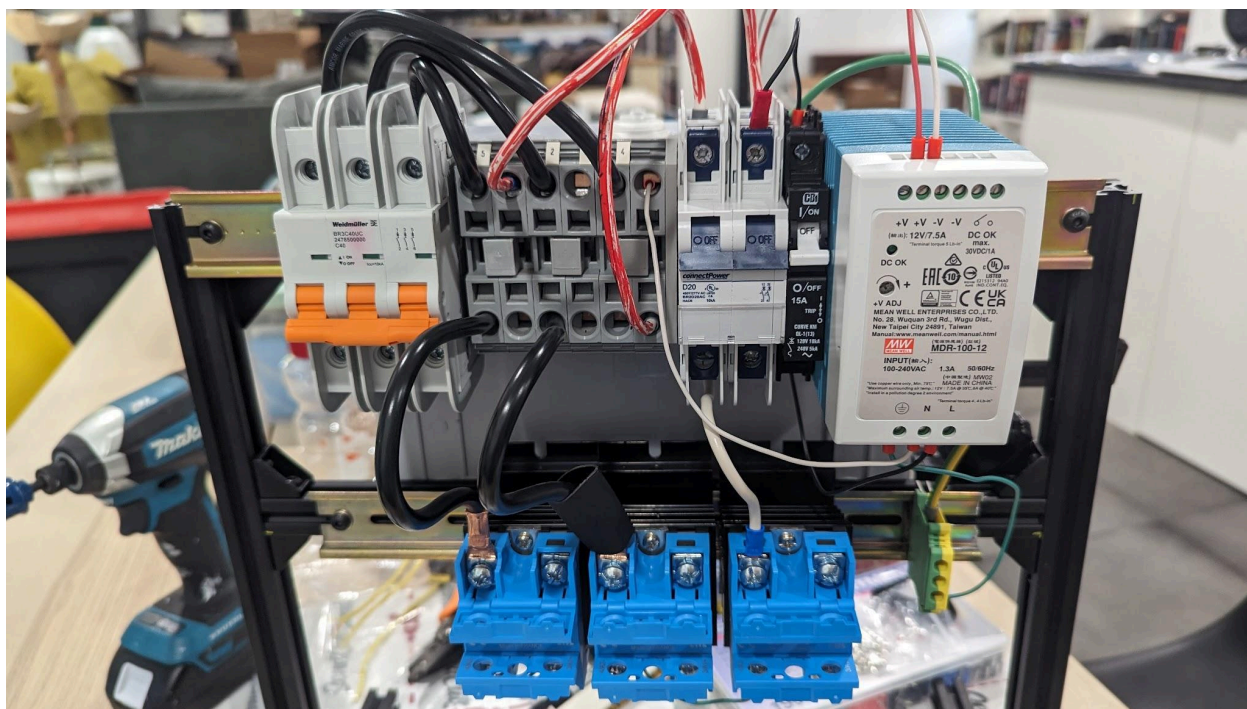


Figure 1b.

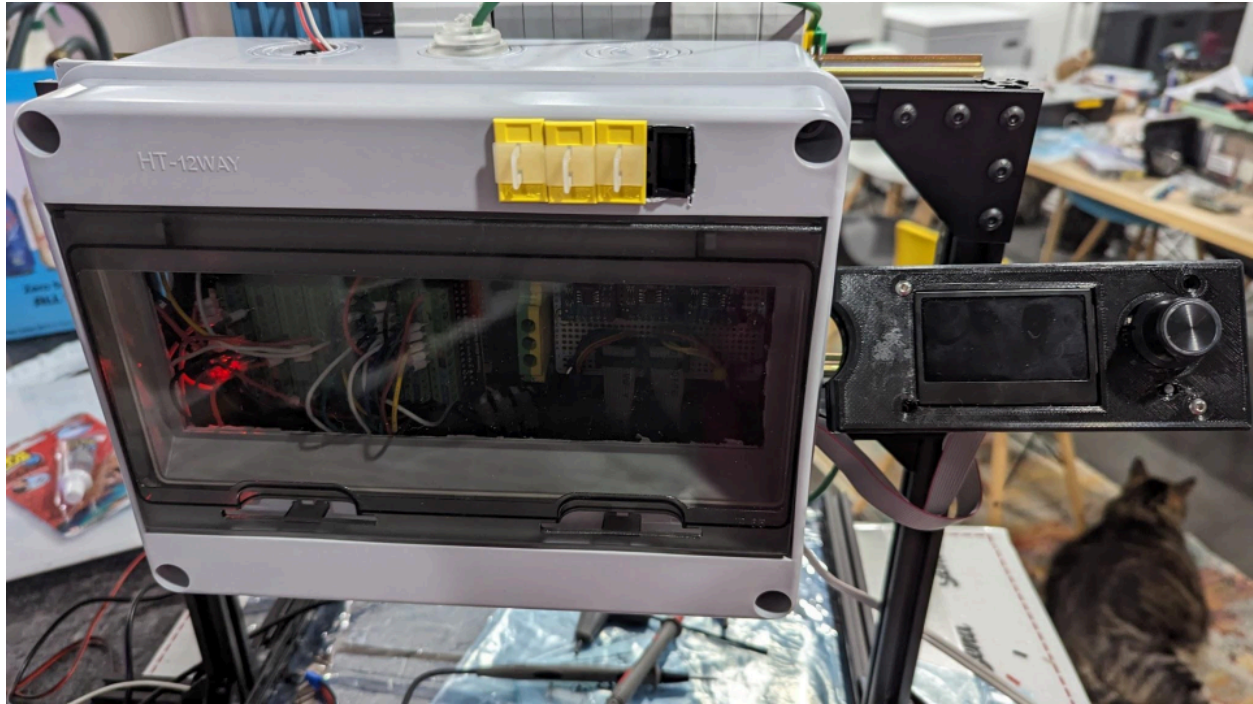


Figure 1c.

The second device was a control for a second stage that is a first-in-the-world experiment to produce oxygen at high-pressures. If successful, this will be a game-changing inflection point.

The development effort and the trip to Utah were very strenuous. Although we have submitted an invoice for the first of five contractual “tasks,” and therefore have receivables of \$50,000, we went badly over budget and in fact have spent more than that to Lawrence, Lee Erickson, and Geoff Mulligan. Rob made a large donation to be able to pay them in a (more) timely manner.

Public Invention now has the expertise to undertake building machines that use kilowatts of power, instead of only the small instruments which we have built in the past. The project may be in the black for Public Invention, but has been a failure if we imagine Public Invention getting the benefit of the compensation for Rob’s time; most of the money has gone to our paid engineers.

On Feb. 1st, we completed the second task and invoiced Jacobs Engineering (the prime contractor) for \$58K. NASA has “cancelled” the remainder of the project due to congressional budget uncertainty (no reflection on our performance). The current “change order” under discussion will place polite projects with PATH and the Pan American Health Organization (PAHO).

Freespireco Grant

The flagship project of Public Invention is the [PolyVent Educational Platform](#). Along with the GPAD, the VentMon, and related software, these devices form the “Free Respiration Ecosystem” or Freespireco.

Last year, we applied for the NSF POSE grant for \$300,000 for Freespireco. Despite good reviews, we did not win an award. These are usually given to Universities. I consider our chances low at about 40%, but our application is better this year. We have a letter of support from NASA, and we have secured an intention from John Sullivan, previous executive director of the Free Software Foundation, to lead the project if the money is awarded.

We paid several thousand dollars to Jessica Feather, the grant writer who helped us last year, to help work through the application process, which is quite extensive. We have been asked to provide reviewers by the overseer of the NSF engineering section, which we have done.

As of Feb. 4th, there is still no word on this.

PolyVent

The PolyVent project is now the second largest Public Invention project after the OEDCS. We are awaiting to see if we receive a grant, win a contest, or receive an order for it. If none of these things happen, the project may have to be mothballed.

General Purpose Alarm Device (GPAD)

Lawrence mentored two teams at Oklahoma University who made great strides in adding voice and Wifi to the GPAD, though neither completed the work. Rob, Lawrence, and Lee have nearly completed a paper on the GPAD they intend to submit to the journal HardwareX. Additionally, a new volunteer, Naghran Kheir of Lebanon, will begin working on adding WiFi.

VentMon T0.5

Mr. Ben Coombs designed VentMon T0.5, and has sent me a box of 12 of them. The T0.5 is very small and a significantly improved design. Ben is going to make 13 more and send them to me. Our plan is to make a product offering of this as an IoT spirometer on our website. The photographs below show the T0.5 (on the left) compared to the T0.4 (on the right), showing how much smaller Ben has made it.

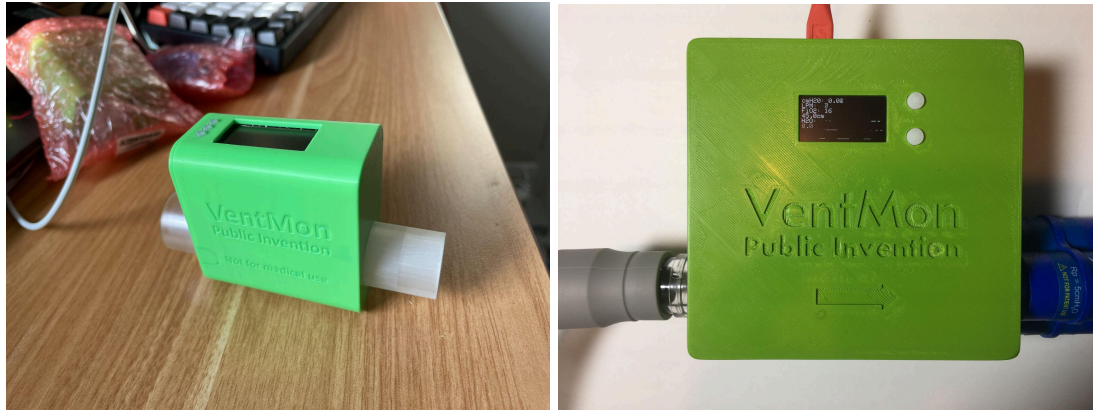


Figure 2. The left-most image represents the smaller version (i.e., T0.5) and the right-most image depicts the original version (i.e., T0.4).

The VentMon, the GPAD, and the PolyVent are all essential parts of the Freespireco idea—the idea of creating a Free-libre respiration ecosystem of cooperating components.

Global Open Source Quality Assurance System (GOSQAS) alliance formed

In October, Pubic Invention and Open Source Medical Supplies (OSMS) led a symposium attended by about 15 thought leaders around the problem of assuring quality in rapidly manufactured emergency and medical devices based on free-libre open designs. There was broad agreement that this is a serious problem and most of the attendees agreed to create a [Global Open Source Quality Assurance System \(GOSQAS\)](#) alliance. Robert L. Read of Public Invention and Victoria Jaqua (board member of Public Invention and OSMS) and Christina Cole of OSMS are leading this effort.

Our initial approach is to develop a completely open provenance tracking system.

Participants in the GOSQAS alliance include:

- Public Invention
- Open Source Medical Supplies (OSMS)
- University Health Network Advanced Perioperative Imaging Lab (APIL)
- Every Breath Counts Coalition (EBCC)
- Helpful (Helpful Engineering)
- IoPA (Internet of Production Alliance)
- UBORA
- OSHWA (Open Source Hardware Alliance)

We worked with a firm to develop the software, but backed out of it due to non-performance in the initial stages. We then got very lucky in finding Mr. Harry Pierson, who did an initial prototype

based on a design by Rob for \$1000. We then raised \$10,000 from a private donor and obliged it to Harry for the completion of the design.

We now have a [Minimum Viable Product](#), and Harry has been paid. Geoff Mulligan has expressed interest in continuing the work. Please try it!

GOSQAS is now a separate corporation, of which Rob, Christina Cole, and Victoria Jaqua are on the board. Public Invention will continue to be a fiscal sponsor for GOSQAS until it achieves its 50c3 status independently.

The MVP is going to be shown at Maker Faire Bay Area on October 22nd by Christina Cole and Rob Read. Rob is flying to San Francisco for this. We have a short speaking opportunity on stage, and will have half a booth, where we will give out stickers with QR codes for Makers to use to track the objects.

As part of the GOSQAS project, Public Invention paid \$1000 for a report by Alex Barton (a regulatory expert who is making an FDA-ready maker space) to create [a report](#) on how GOSQAS satisfies the FDA market surveillance requirements.

The Global Distributed Tracking offered by GOSQAS is probably the Public Invention project with the most potential to change the world in the next two years. However, Public Invention will need GOSQAS to raise its own money in the future.

Glia Tourniquet Project

Sadly, the armed conflict in Ukraine continues. The Russian Federation seems to target civilian targets, leading to great loss of life, including of children.

Public Invention has been acting as a fiscal sponsor for GLIA, a Canadian firm that makes an [open source tourniquet](#), which is particularly in demand in Ukraine. We have raised over \$37,000 in partnership with them (included in our donations), which have already been transferred to their team. They have also given us quarterly reports in writing as we have requested.



Figure 3. Depicts injection molded versions of the tourniquets made by the Glia Project.

They are now injection molding and manufacturing the tourniquets. These are high-quality tourniquets, which are tested with a device designed by graduate students of Joshua Pearce of Western University in Canada.

They function well on people with small limbs, such as women and children. The US Military is moving to having not one, but multiple tourniquets available in first aid kits, as having multiple on hand is a life-saving factor for multi-limb injuries and mass-casualties, which are all-too-common in today's conflicts.

This is completely free-and-open technology. Anyone who has a desk-top injection mold machine can start manufacturing these. However, we intend to deliver 1000 to Ukraine as originally planned. The cost and price of these is approximately \$20USD.

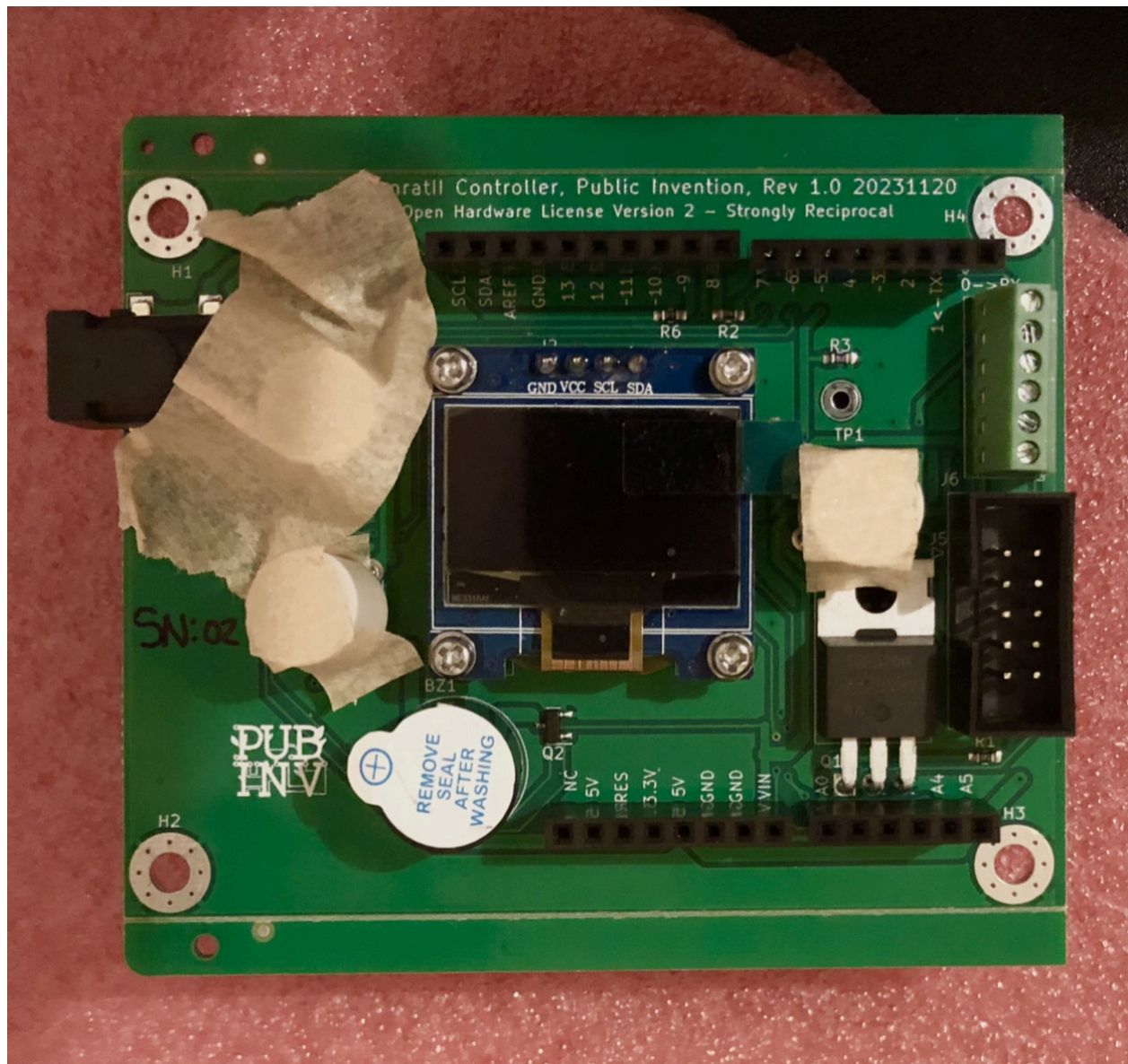
This project is now complete.

Moonrat

This year, we ran a \$2000 crowdfunding campaign, but Rob had to add \$800 at the last minute to make it success.

The Moonrat project to build a portable, battery powered incubator for water quality is going well under the project management of Melanie Laporte and the mentorship of Forrest Lee Erickson. They have made a new printed circuit board (for the first time on this project), which was mostly designed by Lee.

We are lucky to have three PhD students from Cinvestav (Silvia, Enrique and Horacio), who are skillfully advancing the Moonrat software, and will soon integrate it with the hardware.



Passive Ferrofluid Check Valve

A new volunteer, Lisa Kotowski, is now working on the passive ferrofluid check valve, attempting to perform a theoretical analysis and possibly program a simulation. She has made some progress. We would like to return to this project as time allows.

The passover ferrofluid check valve allows the creation of an air pump with no moving parts except ferrofluid. We have worked on this but have not had time to complete it.

We have a separate design for a pump for ferrofluid itself that I have high hopes for, but have not found a volunteer able to work on it, although Sid Chou is doing some manual 3D designs which may let us test the project.

Considerable theoretical work has gone into this to reinforce the experimental work done by Veronica Stuckey. It seems uncertain now if the basic approach will work.

Joe Hershberger has joined this time. Lisa Kotowski has dropped out, after spurring us to significant theoretical efforts.

The Unscrew Propeller

A new volunteer, Matthew McCartney, has been doing a computational fluid dynamics simulation of the [unscrew propeller](#) invention. Matthew is no longer in Austin, and lost the license to use his AutoCAD computational fluid dynamics program. He is now attempting to use a free alternative, OpenFOAM, which has a high-start up curve.

His works allowed us to greatly improve on my initial ideas (which were in fact erroneous.) How most recent simulations suggest it works, but are inconclusive as to effectiveness and efficiency.

A Lung Simulation of Disease Conditions

With volunteer Judith Weng, we have reconstituted a project to make lung simulations based on various disease conditions. This is written in Python and works pretty well now. We have discussed this with Dr. Erich Shultz and it is unclear if there is a demand for this. It may become a valuable part of the Freespireco project. This project is now mothballed.

Financial Position

Our financial position is difficult at the moment.

We have about \$10,000 in cash, about \$20,000 in payables, and about \$58,000 in receivables.

We went seriously overbudget on the first task.

It is entirely possible that we are paying our volunteers who are supported by NASA too much—we pay \$120/hour as our top rate. However, as a non-profit I feel that we should be generous.

Switch to Fund Accounting and Other Accounting Improvements

With the help of Christina Cole, an accountant who does the accounting for other nonprofits (REAP center, OSMS), we have moved to “fund-based accounting”. This will make it a little easier for us to show how we spend money on projects.

Although I have always kept receipts, we are now storing them directly in Quickbooks. This should create less drama if we need to open our books to a potential funder who wants to examine them.

Outreach

Miriam Castillo continues to recruit volunteers. We have improved the presentation of projects at our website, although we are still updating our active projects accordingly. Miriam has learned to use Google Ads effectively for us (Google gives non-profits \$500/month in free advertising)

Monthly Inventor Gatherings on the Third Thursday

We have now held about 10 monthly [Inventor Gatherings](#) in a row, on the third Thursday of every month. These have been attended by between 2 and 20 people. We invite all readers of this report to register at [EventBrite](#) for it and join us for future events! This has been recognized by some as a major thought-leadership event. I believe this is slowly building momentum.

Grant Writing

We worked hard (and paid a grantwriter) to apply to the POSE grant for \$300,000. We are waiting to hear from them. They are late, possibly because of the dysfunction in Congress.

We applied for a Q3 grant from the Moody foundation in Texas for both PolyVent and GOSQAS. We did not hear back from them. We will reapply.

[PolyVent](#) has been submitted to the Hackaday “Save the World” contest with over \$135K in prizes and a \$50K first prize. This has thousands of applicants, but we had high hopes of winning some recognition at least. We did not.

We applied to the (Presidential Awards for Excellence in Science, Mathematics and Engineering Mentoring) PAESMEM award for \$10,000.

Peer-reviewed Publication Submissions

Rob and Megan Cadena submitted their work “[The Plane Tangent to Three Spheres Touching](#)” to [Journal of Geometry and Graphics](#), but it was badly rejected.

Rob, Lawrence Kincheloe, and Lee Erickson submitted “*A General Purpose Alarm Device (GPAD)*” to HardwareX.

Rob, along with authors from Helpful Engineering’s Project Data, submitted “Maximizing Supply Chain Resilience: viability of a distributed manufacturing network Platform using the Open Knowledge Resilience Framework” to [Operations Research Forum](#).

Peer-reviewed Talks

Rob spoke on a panel virtually at [XIX Biennial IASC](#) (International Association for the Study of the Commons) Conference in June about GOSQAS.

Rob presented a paper on the PolyVent classroom experience entitled “[A democratized open-source platform for medical device troubleshooting](#)” to the American Society for Engineering Education in Baltimore In June. This was attended by Nathiel Bechard and Sabia Abidi, who were co-authors, along with Victor Suturin, who did not attend.

Dr. Erich Shultz, Judith Weng, and Robert L. Read have had a poster session accepted to the [IEEE-EMBS 2023 International Conference](#) on Biomedical Health and Informatics (BHI). Judith Weng will present this work. Public Invention is paying her travel costs and lodging.

RecognizeGood

Public Invention has been named a “Lighthouse” by RecognizeGood, and will be presented a check for \$1000 at the next Inventors’ Gathering, on October 18th.

Partnerships and Cooperation

As well, our work with SPEC has been particularly fruitful. The [GOSQAS](#) alliance is actively trying to improve QA across the open source world.

Rob acted as a judge at the Rice360 global design project science fair for senior capstone teams worldwide. Rob is also an active board member at [Helpful Engineering](#), a similar 501c3.

Volunteers

Nothing lasts forever. We have had some great volunteers who have finished their work or moved on. It is a major goal of Public Invention to leave every volunteer with a positive experience so that they refer new volunteers to us.

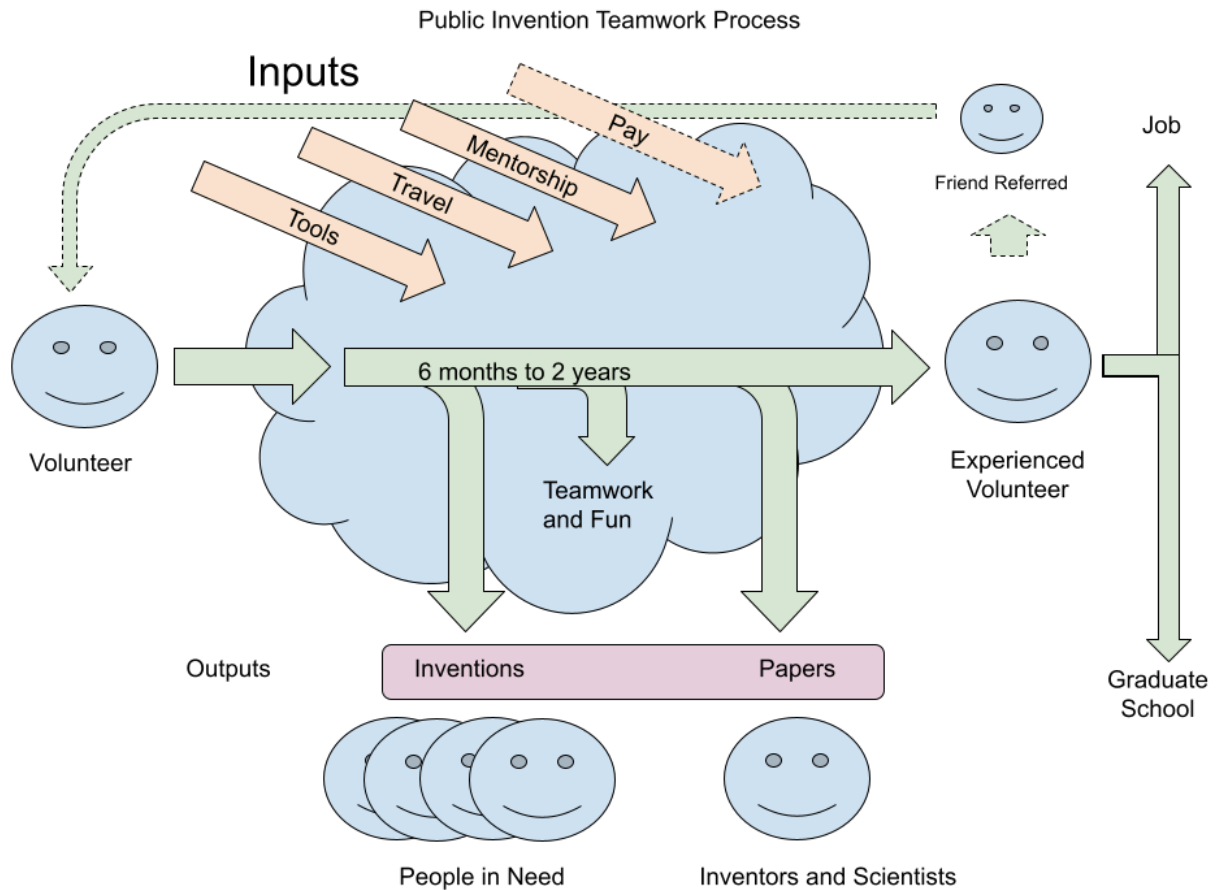
Taken as a whole our current volunteers are a strong team as of Feb. 4th. They are:

1. Lawrence Kincheloe (NASA)
2. Lee Erickson (NASA)
3. From Cinvestav University, Guadalajara (Moonrat):
 - a. Silvia Casillas
 - b. Luis Enrique Ruiz Fernandez
 - c. Horacio Garcia
4. Benedetto Skirde - new, Embedded Botanical Sensors
5. Melanie Laporte - Moonrat
6. Joe Hershberger - Ferrofluid check Valve and Ferrofluid pump
7. Nagham Kheir - GPAD
8. Sid Chou - partial
9. Geoff Mulligan (NASA)

Public Invention is a major part of the GOSQAS effort, which meets weekly, and includes:

1. Victoria Jaqua
2. Christina Cole
3. Harry Pierson
4. Anusha Shringi (high school)
5. Nora Moor (high school)
6. Katie Pryal
7. Judith Weng

In fact, we represent the overall process of Public Invention, in the diagram below. The three outputs of Public Invention are Inventions, Papers, and Experienced Volunteers.



Productization

Public Invention is a non-profit. Nonetheless, we believe we can have a bigger impact by doing “short-run” productions of small numbers (less than 20) units of our inventions and offering them for sale to make it easier for people to evaluate our inventions, even though all of them are completely open source.

We now intend to productize and place on sale:

- The VentMon T0.5
- The General Purpose Alarm Device (GPAD) 0.2
- The PolyVent

Megan has created a storefront for these products, but nobody has bought anything yet.

Strategy for the Coming Year

Much will depend on if we get the Freespireco (POSE) grant or other grants in November.

A long-term goal is to raise enough money to hire an executive director so that Rob can focus on being head invention coach.

Here were our previous priorities for 2023:

1. Making the new NASA contract successful, which is one building block of a revolutionizing therapeutic oxygen delivery in low- and middle-income countries. - SUCCESS SO FAR
2. Selling five of the PolyVent Educational Platforms around the world and building a community of practice. - FAILURE
3. "Productizing" the GPAD 0.2. - PARTIAL
4. "Productizing" the VentMon T0.5 - PARTIAL
5. Completing my book (currently 72 pages):
<https://github.com/PubInv/intro-public-invention/blob/main/intro-pubinv.pdf> and finding a publisher for it. FAILURE
6. Writing a technical paper for VentOS (with Dr. Schulz and Ben Coombs) - NOT DONE
7. Writing a technical paper for the PolyVent system (with Dr. Suturin, Nathaniel, and Antal.) - NOT DONE
8. Creating a second version of the General Purpose Alarm Device (GPAD) and productizing it. - UNDERWAY
9. Make serious research progress on the ferrofluid inventions (valve and pump). - PARTIAL

Strategies for 2024

Public Invention is making a difference. It is in that sense a success. Compared to other nonprofits in this space, we get a lot done. We are publishing good open source software, hardware, and inventions. We are providing many people a valuable learning experience they may not be able to find at Universities.

However, we have not accomplished the mission of creating a world-wide movement toward Public Invention. We have not created a sustainable funding base. We have (probably) not saved any lives yet.

In 2024, we plan to:

1. Apply for grants from more second-tier (regional) foundations.
2. Recruit more Invention coaches, possibly by absorbing and supporting other projects.
3. Finish the publication of our existing projects.
4. Hold some in person events.

Awards for 2023

Forrest Lee Erickson
Best Invention Coach, 2023
For the Moonrat Portable Incubator

Harry Pierson
Best Public Inventor 2023
For GOSQAS Implementation

Lawrence Kincheloe
Best Public Inventor, 2nd Place 2023
For the NASA-MCOG

Melanie Laporte
Best New Public Inventor, 2023
For the Moonrat Portable Incubator

Geoff Mulligan
Best Public Inventor, 3rd Place 2023
For NASA MCOG Extensions

Miriam Castillo
Best Paid Staff Contribution, 2023
For Google Ads and Recruitment

Megan Cadena
Best Paid Staff Contribution, 2nd Place, 2023
For Outreach Coordination

Sabia Abidi
Most Active Board Member, 2nd Place, 2023
For PolyVent Educational Platform

Victoria Jaqua
Most Active Board Member 2022
For GOSQAS and Glia Tourniquet

Nathaniel Bechard
Best Technical Paper, 2023
PolyVent Educational Platform

Erich Schulz
Best Technical Paper, 2nd Place 2023
For Tracheal Tube Pitch, Roll and Yaw

Judith Weng
Best Technical Paper, 3rd Place 2023
For Tracheal Tube Pitch, Roll and Yaw

Christina Cole
Best Presentation, 2023
For Maker Faire Bay Area

Ben Coombs
Best Design Evolution, 2023
For VentMon T0.5