



Open-source respiratory health commons

**15 projects communities can adapt, repair, reproduce
for low cost medical care (libre and open-source tech)**

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A core goal of **public policy should** be to facilitate the development of institutions that **bring out the best in humans**.

Elinor Ostrom. 2009

Harnessing **open-source methodology** will ensure that funding used to develop scientific equipment is spent only once. Scaled replication **saves 90–99% on conventional costs**.

Joshua Pearce. 2014

An example: **open-sourcing MRI scanners in Germany could spare up to 3.3 billion dollars within 20 years**. This does not fundamentally change the medical system, or business, but promotes real innovation.

Lukas Winter et al. 2019

Today, 6 humans in 10 have no access to medical care or do not adhere to it.

Health as a business (IP)



Health as commons (open-source)

limited number of employees
black box design
excluding propriety
centralized validation
centralized mass production
price barrier excludes users

competition, dependency

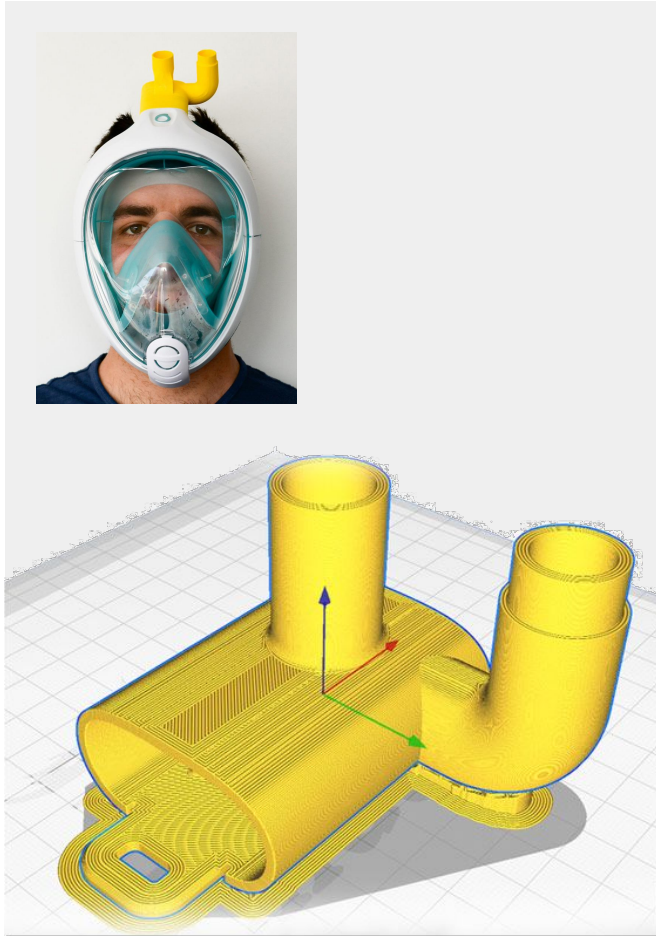
open network of interdisciplinary contributors
iterative co-creation and documentation
shared rights to use, repair, study, reproduce, adapt
shared responsibility
distributed crowd/peer production
fair price or gratis, costs cut by 10-100 with mutualization

solidarity, capacity building



**disease
management**

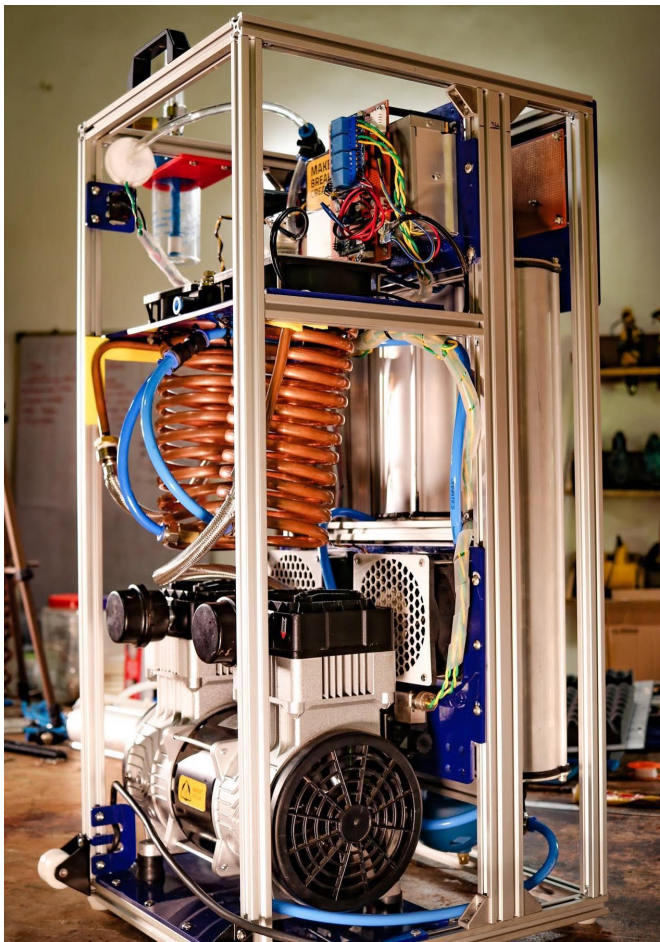
Please refer to the websites regarding the projects aims, and seek professional advice before using or reproducing them.



Source: isinnova.it

Isinnova Charlotte – valve for mask

| | |
|-----------------|---|
| Challenge | Providing a rapid solution to the shortage of C-PAP masks in hospitals, which ensures the right amount of air/oxygen is provided to users with a sealed system. |
| Current version | 3D-printable valve to connect a commercial snorkeling mask to oxygen supply, a PEEP valve, and optionally a reservoir (adding a 3D-printed fork element). |
| Readiness | Ready to manufacture, not a medical device |
| Licences | open-source (not described) - mask is closed source |
| Reprod. cost | filament + time (~ 10 pieces daily per printer) |
| Next steps | - |
| Inspiring story | The start-up created a prototype, tested it and printed a hundred pieces in three days. 1200 manufacturers contacted them to support with the manufacturing. |
| Websites | www.isinnova.it/archivio-progetti/easy-covid-19/ |



Source: makersylum.com

M19 O2 – Oxygen concentrator

| | |
|-----------------|---|
| Challenge | Activating local communities to make an oxygen concentrator in India; building capacity to manufacture and maintain it locally and in a decentralised manner. |
| Current version | Delta version with indigenously sourced parts, 15 liters per minute, 96% oxygen concentration, OSHA certification, 150 organisations contributing |
| Readiness | Final stages of functional testing, ready to manufacture |
| Licences | CERN OHL S 2 (hardware), MIT (software), CC BY 4 (doc) |
| Reprod. cost | 1000 € material + 8 hours |
| Next steps | Capacity building for repair and reuse, research paper on scaling decentralised manufacturing (Cambridge), final certification on functional testing via NABL |
| Inspiring story | 1 million face shields in 49 days, 42 cities → M19 O2 The M19 collective has a centralised open source design philosophy with decentralised manufacturing. |
| Websites | www.makersylum.com/m19o2/ www.github.com/MakersAsylumIndia/M19O2 |

OpenVent – Ventilation machine

Challenge Answering the shortage of ventilation machines thanks to a design that can be rapidly manufactured in various countries and at low-cost.

Current version Respirator combining an approved bag valve mask and a motorized arm, with adjustable PEEP valve, standard air outlet and setting interface. Requires a power outlet.

Readiness TRL 3

Licence MIT (hardware)

Reprod. cost 380 € material

Next steps 3d-printed flow sensors prototyping, laboratory testing (MHRA), application for medical device clearance (FDA, EUA, ISO-13485), life testing.

Inspiring story ?

Websites www.github.com/Open-Vent-Bristol
www.openventbristol.co.uk



Polyvent – Ventilator co-design platform

Challenge Lowering entry hurdles to locally develop and produce intense care unit ventilators. Bridging geographical clusters around one adaptable design for accessibility.

Current version Fourth prototype in development. Includes several interchangeable modules: gas drive, control, gas routing, gas supply, and more.

Readiness 6/10

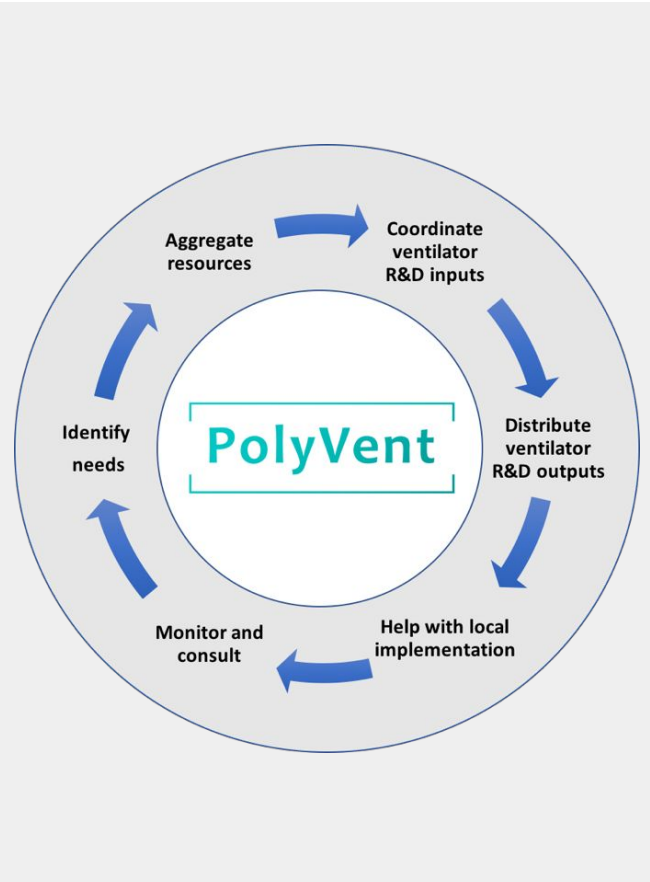
Licence CERN OHL S

Reprod. cost 1500 € material + 50 hours + 300 € post

Next steps Finish the latest version and replicate 6 times to disseminate in the global clusters centering around universities.

Inspiring story We have been operating as volunteers since the very beginning of the pandemic, and are still growing!

Websites www.pubinv.org/project/polyvent/
app.jogl.io/project/577





OpenPCR – Genetic material development

| | |
|-----------------|---|
| Challenge | Improving access to genetic research with a low-cost, do-it yourself polymerase chain reaction thermocycler, especially for low-resource regions, students, hobbyists |
| Current version | Thermocycler with 16 sample well block to control PCR for DNA sequencing and barcoding. Heated lid, 2 °C per second ramp time. Software for Mac and Windows. |
| Readiness | Ready for production |
| Licences | GPL 3 (hardware, software and doc) |
| Reprod. cost | 510 € kit + 5 hours |
| Next steps | Designs are accessible but the kit sold by the organization was replaced by a ten times more expensive model |
| Inspiring story | Two graduate students tested 60 samples of seafood in New York sushi restaurants and grocery stores and found out that most of them were mislabeled. |
| Websites | www.openpcr.org www.github.com/jperfetto/OpenPCR |



Source: ospfound.org

OSPF OpenVax – Repurposing vaccines

| | |
|-----------------|--|
| Challenge | Rapidly and equitably fighting epidemics by repurposing existing widely-available off-patent low-cost vaccines with strong safety records to achieve medicine for all. |
| Current version | Computational discovery and late stage clinical trials. Creating an ecosystem of crowdsourced and computer-driven drug discovery, generics manufacturing. |
| Readiness | Collab. on phase 3 Covid-19 vaccine trials in Brazil |
| Licences | Public domain, dev. open source licenses for pharma |
| Reprod. cost | 1% usual costs |
| Next steps | Develop field, create open model of R&D, create new generation of innate-immunity vaccines, curb epidemics earlier and more equitably with off the shelf vaccines |
| Inspiring story | Completing, with Gov of India, a multicentric phase 2b clinical trial for an off-patent TB adjunct therapy, for less than 1% the usual cost, and a decade faster than usual. |
| Website | www.ospfound.org www.ospfound.org/achievements.html |

ANTICOV

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Resources

Platform trial

- Master Protocol
- Participant Information and Informed Consent Form

Ancillary studies

- Epidemiological substudy Protocol
- Epidemiological substudy Informed Consent Form
- Immunological substudy Protocol
- Immunological substudy Informed Consent Form (Asymptomatic)
- Immunological substudy Informed Consent Form (Symptomatic)

Standard Operating Procedures

- Guidance for measuring the vital signs
- Guidance for temperature measurement
- Guidance for pulse oximetry reading
- Guidance for pulse oximetry reading
- Safety Assessment: Adverse Events and Serious Adverse Events
- Guidance for blood drawing
- Guide pour le prélèvement sanguin
- Guidance for temperature measurement (non-contact infrared)
- Guide pour mesurer la température (sans contact)
- Guidance for temperature measurement (Klixia)
- Guide pour mesurer la température
- Guidance for measuring weight and height
- Guide pour mesurer le poids et la taille
- Guidance for a resting 12-lead Electrocardiogram
- Guide pour un électrocardiogramme à 12 dérivationes au repos

ANTICOV & DNDi – Repurposing treatments

| | |
|-----------------|--|
| Challenge | Identifying treatments for mild and moderate cases of covid-19. Ensuring populations affected who live in impoverished regions can access low-cost treatments. |
| Current version | Clinical research ongoing in 13 African countries. Open access protocols, operating procedures, and results. Public tracking of participation available day + 1. |
| Readiness | Recruitment open (target 3000 participants aimed) |
| Licences | IP agreements for shared use rights |
| Reprod. cost | Affordable (max 1\$ per treatment) |
| Next steps | Release of data safety analysis, launch of additional research arms, identification of new drug candidates for treatment, acceleration of regulatory approvals |
| Inspiring story | Thanks to compulsory licensing, DNDi was able to make one of their treatments accessible at 300 €, when the pharma manufacturer initially set the price at 50,000 €. |
| Websites | DNDi: www.dndi.org ANTICOV Consortium: www.anticov.org |



**disease
prevention**

Please refer to the websites regarding the projects aims, and seek professional advice before using or reproducing them.

Geneva Hand Hygiene Model – Hand rub



| | |
|-----------------|--|
| Challenge | One in ten patients gets infected when receiving care. Minimize the time required by caregivers to wash their hands. Nosocomial disease kill 20-50000 people daily. |
| Current version | WHO hand rub kills 99.9% of bacteria in a few seconds. Composition: ethanol or isopropyl alcohol, hydrogen peroxide, glycerol, sterile distilled or boiled cold water. |
| Readiness | Validated recipe ready for local production |
| Licences | Patent-free |
| Reprod. cost | ~ 3.50 € / liter (vs 21-68 € for commercial product) |
| Next steps | Foster the adoption of efficient hand washing in medical settings and in the broader population. Strengthen infection prevention and control |
| Inspiring story | In Kenya, Dr Pittet discovers that hand rub costs three times the European price. He releases patent-free the recipe created with W. Griffiths so that all can afford it. |
| Websites | www.who.int/publications/i/item/WHO-IER-PSP-2010.5 www.cleanhandssavelives.org |

Pulmonary Toolkit – 3D lung modeling

Challenge Providing a functional and robust software to visualize and analyze (segmentation, detection, etc.) 3D medical lung images for academic research.

Current version Toolkit with: GUI visualization and analysis (CT & MRI), library of algorithms, framework to run and develop algorithms, API to use external code. Requires MatLab.

Readiness Alpha version

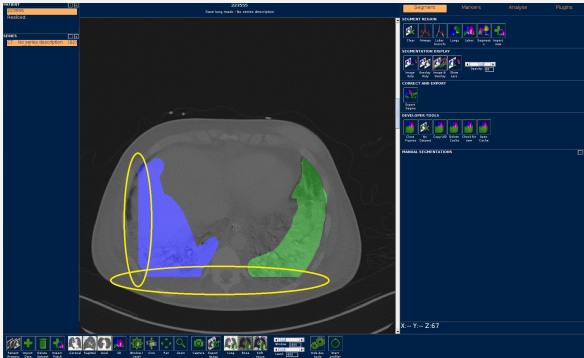
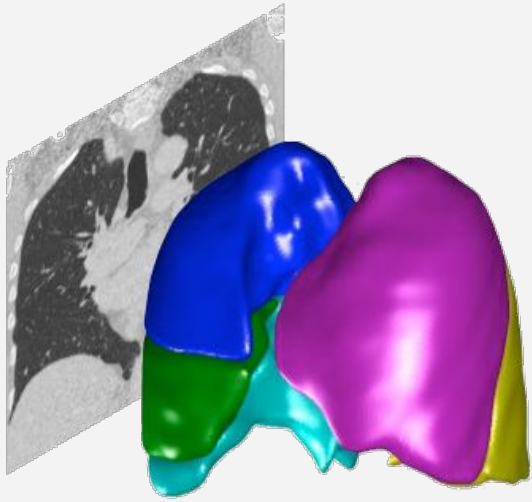
Licences GPL 3 and others

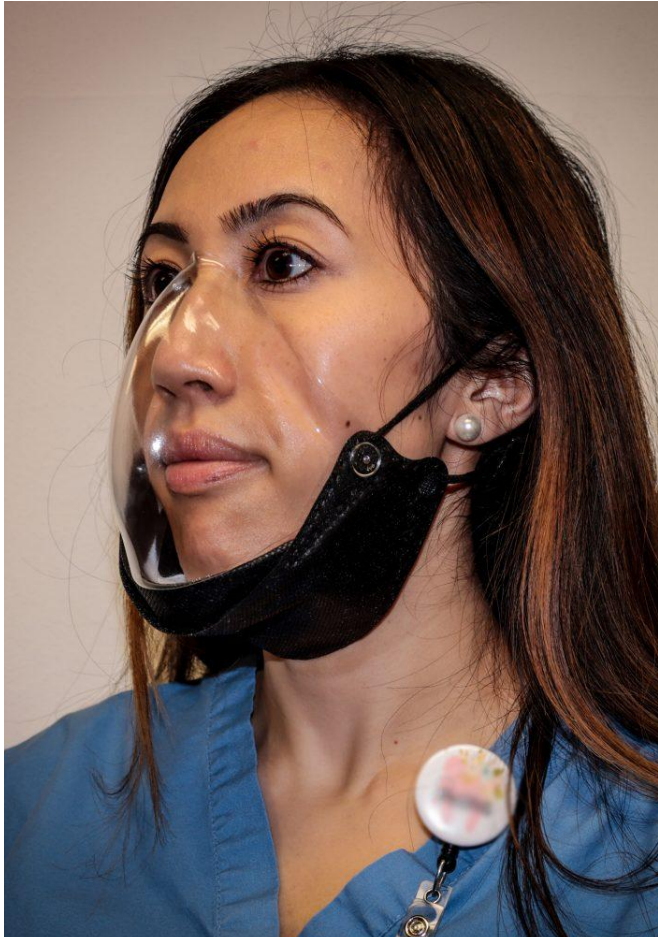
Reprod. cost 0 € + time

Next steps Developing functionalities such as freehand editing, zooming, export of non-mesh data.

Inspiring story ?

Websites www.github.com/tomdoel/pulmonarytoolkit/wiki/Pulmonary-Toolkit





Source: bemask.org

BEclear – Transparent mask

| | |
|-----------------|---|
| Challenge | Building a clear mask that eases emotional relatedness and lip-reading while providing sound filtering. Initially thought for deaf people and for educational settings. |
| Current version | Iterative design and testing, 1500 produced. Combination of conventional medical mask with vacuum-formed plastic adapter. Aim at KF94 standard. |
| Readiness | TRL 3 |
| Licences | CERN OHL P (hardware) |
| Reprod. cost | 7 € material or 17 € product + post |
| Next steps | Lab (filtration, pressure, blood resistance, flame spread, sound) and user testing, design-for-manufacture. Application submitted to Canadian research fund. |
| Inspiring story | Initiated by volunteers from Enable Buffalo, the project mobilized a dozen researchers within 10 days to sketch a plan towards the production of 100K units/months. |
| Websites | www.bemask.org/vacuum-forming www.enablingthefuture.org |

LogAir – Air quality mapping

Challenge Helping everyone map air quality using cheap portable devices. Generating data to avoid polluted streets, and motivating policy changes.

Current version Arduino-compatible hardware measuring particulate matter and position data, one point per second. App and backend to collect and display data.

Readiness Reproducible and functional

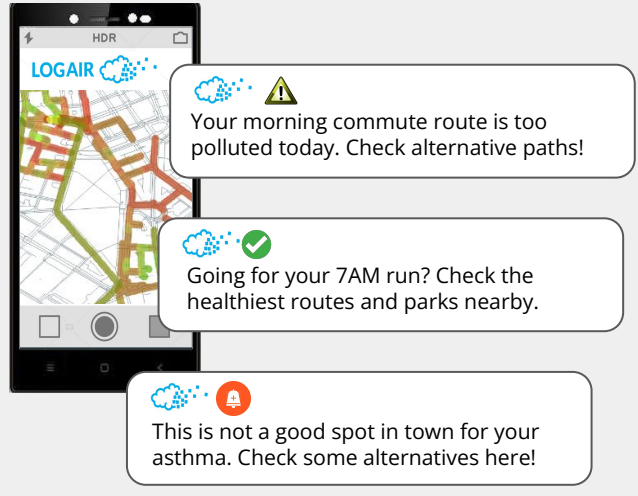
Licences CERN OHL 1.2 (hardware), Apache 2 (software)

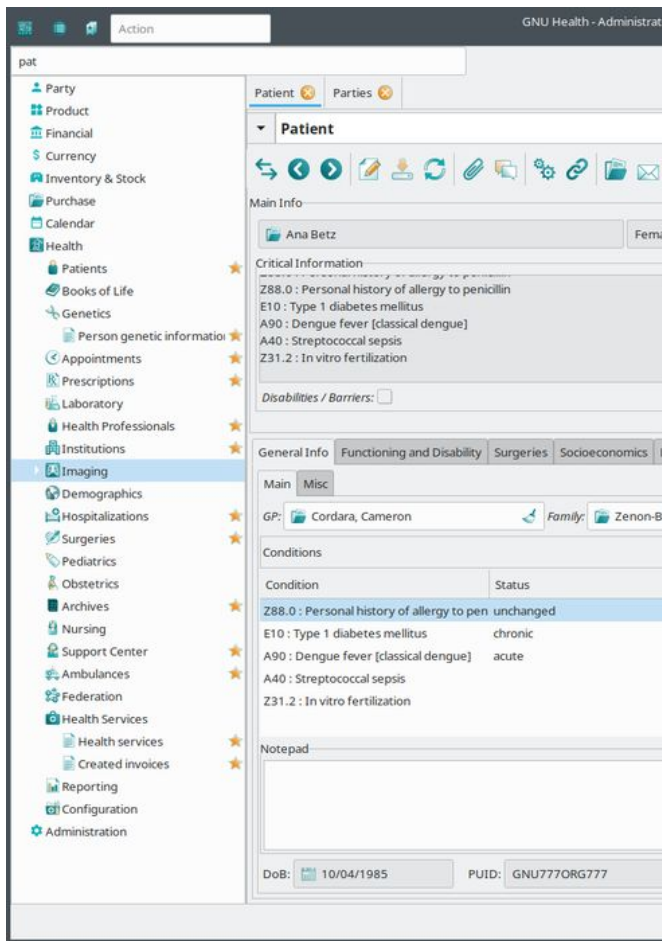
Reprod. cost 50 € material + 1 hour

Next steps Grow the community
Improve and characterize the hardware
Industrialization

Inspiring story From Switzerland to China, LogAir helps citizens take on environmental health by themselves, and build a case for healthier cities and communities in six countries.

Websites www.logair.io
www.github.com/logair/PM-monitor



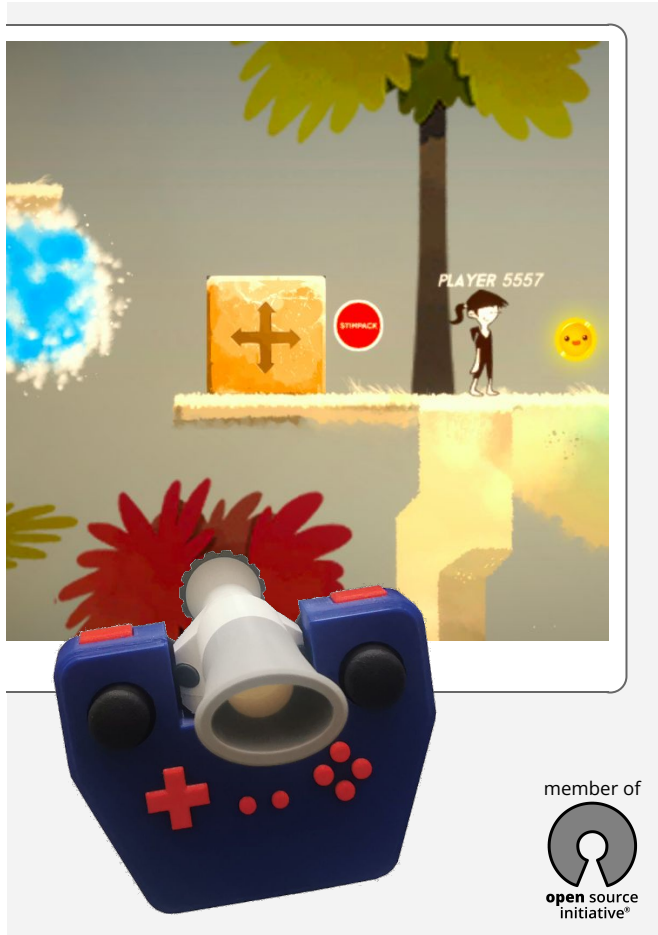


GNU Health – Digital health ecosystem

| | |
|-----------------|---|
| Challenge | Providing medical and patient communities with a libre, freely adaptable and modular software suite for the management of medical services and records. |
| Current version | Hospital / Laboratory Info Management System (3.8), Health Info System, Personal Health Record (1.0). ICD [9,10,11], ICF, HL7 FHIR, JSON-RPC, XML, GPG. |
| Readiness | Adopted by 100s organizations, millions of end-users. |
| Licences | GPL 3 (software), CC BY-SA 4 (doc) |
| Reprod. cost | 0 € + time varies depending on complexity |
| Next steps | Capacity building for repair and reuse, research paper on scaling decentralised manufacturing (Cambridge), final certification on functional testing via NABL |
| Inspiring story | Individuals with respiratory conditions track their vitals, activity, nutrition and emotional status, and share them in real-time with med pro (Argentina covid observatory). |
| Websites | www.gnuhealth.org/download.html www.gnusolidario.org |



Please refer to the websites regarding the projects aims, and seek professional advice before using or reproducing them.

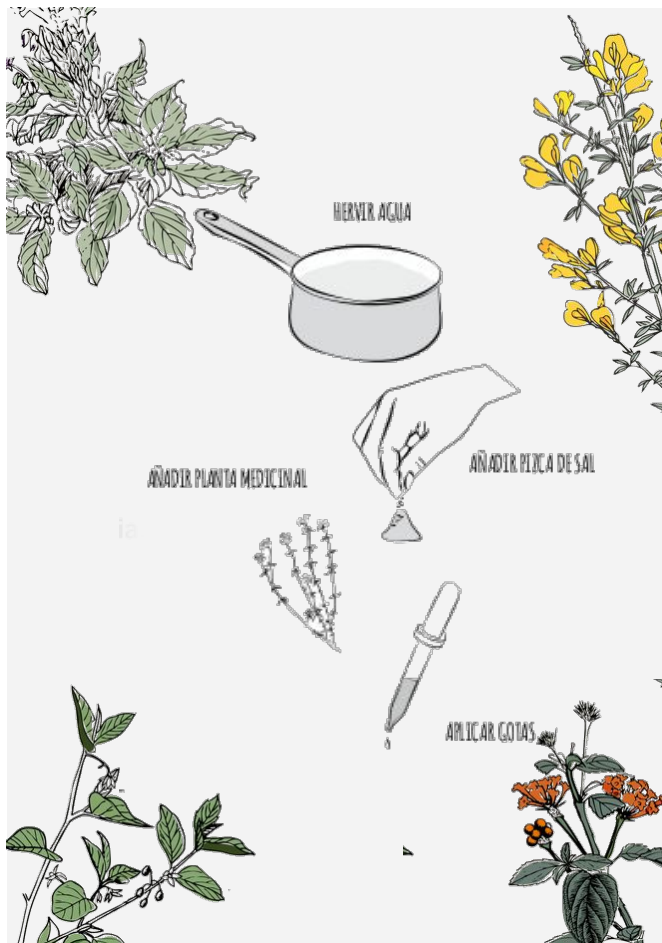


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 open source
 initiative®

Breathing Games – Fun respiratory care

| | |
|-----------------|---|
| Challenge | Tackling low adherence with ludic self- and mutual care. Fostering health and digital literacy through co-creation. Ease breath data collection and use as visual narratives. |
| Current version | Open game environment for up to four players, Games for children with asthma in 10 languages, gamepad with modular nose (flow in/out + resistance). |
| Readiness | Games playable on Win, Mac – Gamepad reproducible |
| Licences | AGPL 3 (soft.), CERN OHL S (hardware), CC BY-SA 4 (doc) |
| Reprod. cost | 50 € material + 6 hours (gamepad), 0 € (games) |
| Next steps | Multiplayer game: have communities build levels Games for asthma: intl. study in various settings Gamepad: iteratively improve enclosure and outcomes |
| Inspiring story | A professor in linguistics mobilized and coordinated around 20 volunteers so that our games for asthma can be played in a dozen languages. |
| Websites | www.breathinggames.net www.youtube.com/c/BreathinggamesNet1 |



Source: cemi.org.co

CEMI – Traditional medicine

| | |
|-----------------|---|
| Challenge | Preserving a living heritage of communal ways to take care of respiratory health. Maintaining natural, local resources such as medicinal plants. |
| Current version | Guide to preserve the air quality, understand health as a whole system, adopt healthy habits in one's daily life, value traditional knowledge and natural remedies. |
| Readiness | Ready to use |
| Licences | – |
| Reprod. cost | Cost to garden medicinal plants |
| Next steps | Promoting intercultural initiatives to recover/strengthen traditional medicine knowledge and resources. Research-action to promote the health of communities. |
| Inspiring story | A local committee of traditional medicine users worked with a local university to co-create a training program to enhance intercultural skills of medical students. |
| Websites | www.cemi.org.co/s/Lo-que-podemos-hacer-para-respirar-bien.pdf |



Source: Victoria Kelly

Art Hives – Social support network

| | |
|-----------------|--|
| Challenge | Providing people with freely accessible, inclusive spaces to build solidarity and respond creatively to community issues, and cultivate the artist in each human. |
| Current version | 224 art hives for dialogue, skill-sharing and art-making between, mostly in North America and Western Europe, including online gatherings. |
| Readiness | Guides to launch an Art Hive (in person or online) |
| Licences | CC BY (guide) |
| Reprod. cost | Material to launch an art hive |
| Next steps | Developing and contributing to public practice art therapy through qualitative and quantitative research, building more accessible ways to art therapy. |
| Inspiring story | A young adult with cystic fibrosis joined an Art Hive as a volunteer to socialize, contribute at his own rhythm, share music he created, and learn to play Tibetan bowl. |
| Websites | www.arthives.org www.arthives.org/resources/art-hives-how-guide |

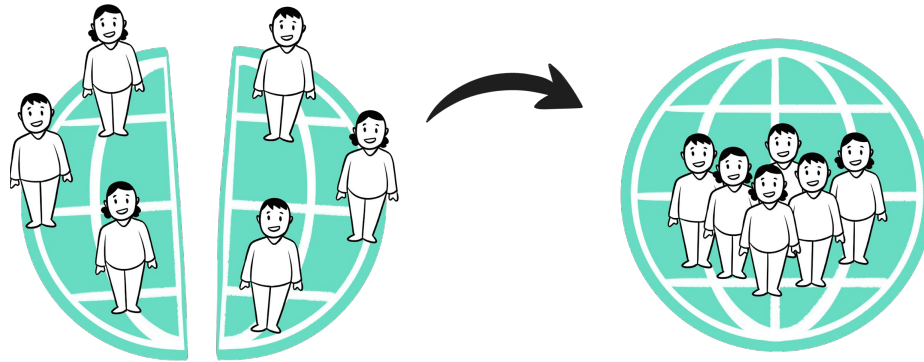
Next steps

Next steps

Research policies:
integrate open-source as an
ethical requirement in
medical research methods

Regulation and monitoring:
fund and build capacity for
community-driven, open
source innovation


Production and distribution:
fund and build capacity for
distributed manufacturing
(crowd/peer production)



Thank you



 www.breathinggames.net/openvillage

 doi.org/10.5281/zenodo.5515632

breathinggames.net/pub/add.htm



Copy this slide and add your open-source, not-for-profit initiative for respi health. Please keep the format as is. We will review and update the publication monthly.

First and last name:
Affiliation:
E-mail:
Co-author: yes/no
ORCID:

Title – Aim

| | |
|-----------|-----------------|
| Challenge | Goal, audience. |
|-----------|-----------------|

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| Current version | ... |
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| Readiness | ... |
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| Licences | ... |
|----------|-----|

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| Reprod. cost | x € + x hours |
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| Next steps | ... |
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|-----------------|-----|
| Inspiring story | ... |
|-----------------|-----|

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| Websites | www... www... |
|----------|------------------|

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Annex: Project assessment

| | 0 – Minimum | 1 | 2 | 3 | 4 – Maximum |
|---|---|---|--|--|--|
| Health (see Greenhalgh) | not acting, not supported (isolated) | coping with illness (disease management) | whole-system approach (prevention, promotion) | critical public health (political action) | holistic, lifelong wellbeing |
| | low compliance ← | | | | → intimate adhesion |
| Contributors | experts alone | users consulted in end product | users give inputs in certain stages | users participate on full life cycle | users adopt initiative for other aims (forking) |
| | top-down ← | | | | → emerging |
| Process, standards, documents, software, ... | closed not shared | closed and shared | partly open and shared | fully open and shared | fully libre, contributing to other libre projects |
| | opaque ← | | | | → trustworthy |
| Licenses including for the core | patent, copyright | patent with free reuse | public domain (ex. CC 0) | non-commercial licence (ex. CC BY-NC) | Reciprocity (ex. Peer Production lic.) |
| | excluding rights ← | | | | → building commons |
| Resource allocation (see Benkler) | for-profit company | social enterprise, cooperative | open access commons | open access commons with value accounting | fewest projects possible,, as much as needed |
| | extractive ← | | | | → generative |
| Physical availability | not produced | centralized | decentralized | distributed, industries (mass production) | distributed, communities (crowd production) |
| | not available ← | | | | → locally reproducible |
| Impact validation (see Guba and Lincoln) | not tested | tested with users | positivist, quantitative studies | naturalistic, mixed methods, one setting | naturalistic, mixed methods, multi settings |
| | not validated ← | | | | → validated |