MAKERS FOR DEVELOPMENT

SHOWCASING THE POTENTIAL OF MAKERS

INTRODUCTION

We have been makers since the dawn of time. From Beduin tents to yurts, saris to suits, and foods to philosophies, we have changed, broken, mended, explored, connected, minified and magnified the world around us. New machines have been engineered and new techniques invented, including 3D printers, programmable microchips, tiny sensors and the internet synergizing them - tools that amplify, accelerate and empower.

Public spaces - fab labs, maker spaces and hacker spaces - have developed around the world to democratize access to these otherwise capital intensive tools and foster a community around them. These are spaces for the young and old, educated and uneducated, alike. Spaces for creativity, thinking, problem solving, learning, making, inventing, doing and changing.

Colloquially called the "maker movement", this emerging global ecosystem is about solving local challenges through collaboration, innovation, and entrepreneurship.

Projects everywhere benefit from this - ideas can be cheaply transformed into prototypes; products become customized for culture, climate and people; manufacturing becomes local and just-in-time; and goods become easy and affordable to repair and recycle.

To highlight the potential of these spaces, we showcase twelve of these projects in this catalog, projects that are low in cost but rich in potential. Because ultimately, these spaces empower the maker within each of us and catalyze our collective development.

LEGEND

- Health
- Environment
- Urban
- Approximate Price per Unit
- Location of Innovation

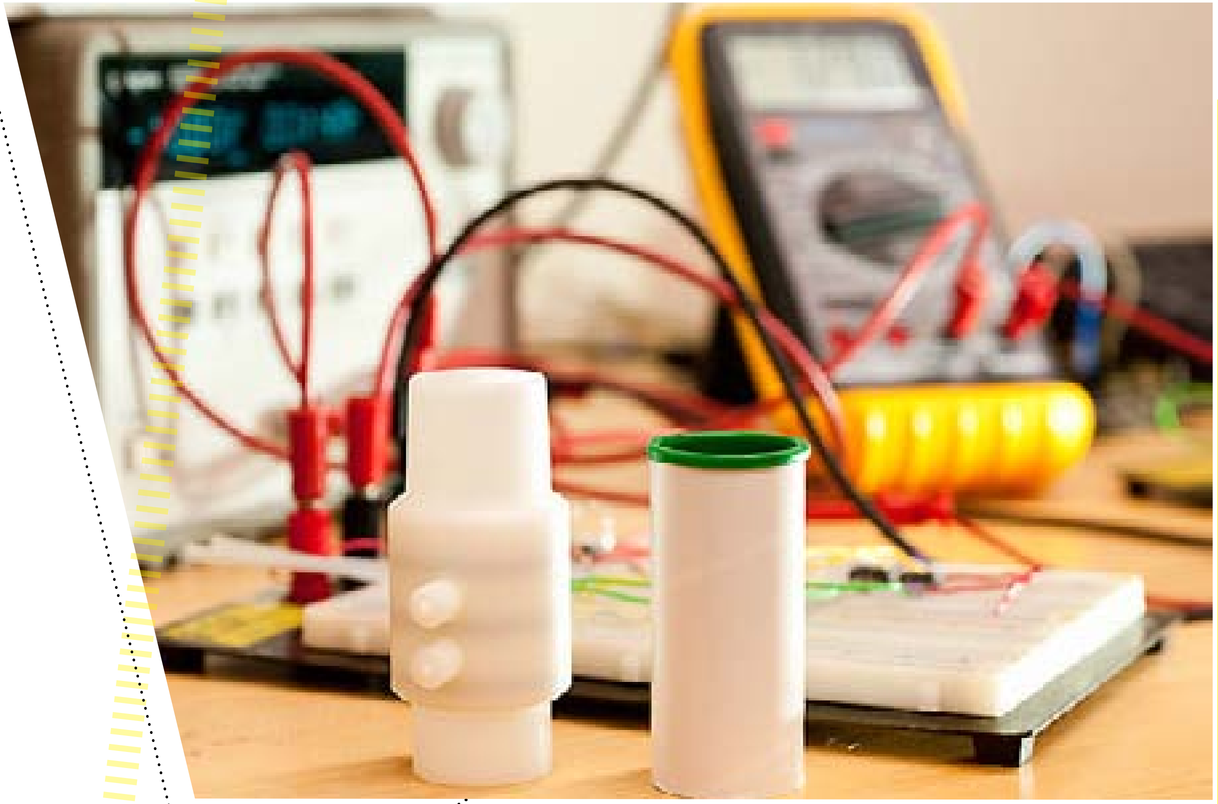
Ajuntament de Barcelona

WORLD BANK GROUP

USAID FROM THE AMERICAN PEOPLE

FABFOUNDATION

FAB LAB BCN

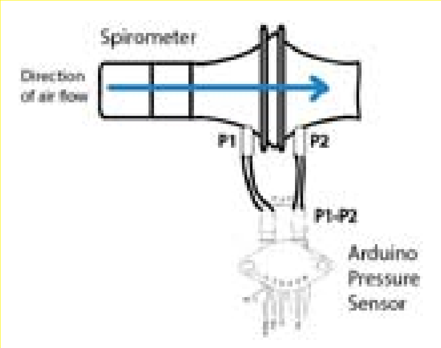


DIAGNOSE & MANAGE **RESPIRATORY DISEASE**

CHEAP, REUSABLE & RAPID TESTING

LOW COST **SPIROMETER**

A spirometer built by fifteen year old high school student, Maya Varma, for the early diagnosis of Chronic Obstructive Pulmonary Disease (COPD), a disease caused by air pollution:



SO WHAT?

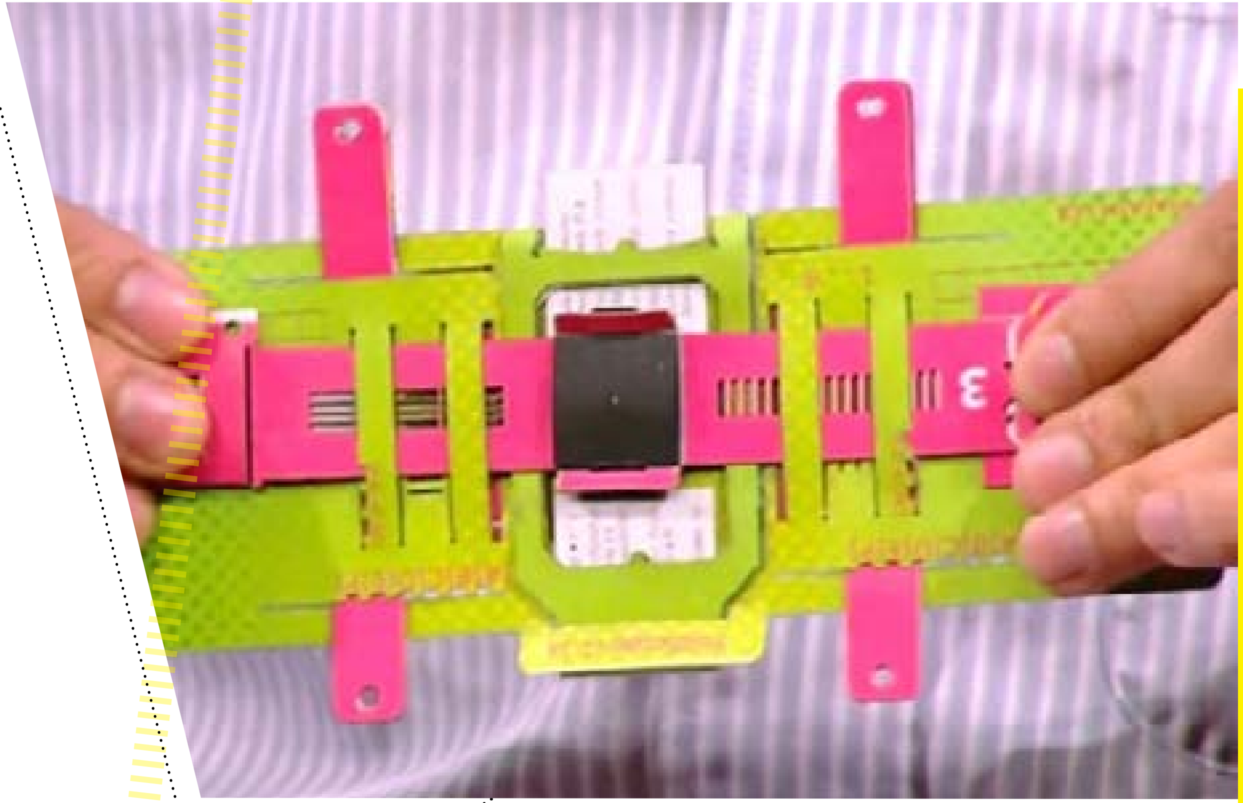
COPD is the third largest killer in the world - greater than HIV/AIDS and diarrhoeal diseases combined.

While irreversible and incurable, early detection of COPD can slow its progression.

COPD, however, remains under diagnosed around the world, limiting treatment.

$35

USA



FIELD BASED **CITIZEN SCIENCE**
TROPICAL DISEASE **DIAGNOSIS**
SCIENCE **EDUCATION**

PRINT & FOLD PAPER **MICROSCOPE**

An origami-inspired optical microscope that can be assembled with a sheet of paper and a pair of scissors:

SO WHAT?

Powerful enough to see E. coli bacteria.

Disposable diagnostics for diseases such as Malaria and Visceral Leishmaniasis.

Hundreds of times cheaper than ordinary light microscopes.

$0.97

USA

MEDICAL **DIAGNOSTICS**
PUBLIC **HEALTH**

MANUAL BLOOD **CENTRIFUGE**

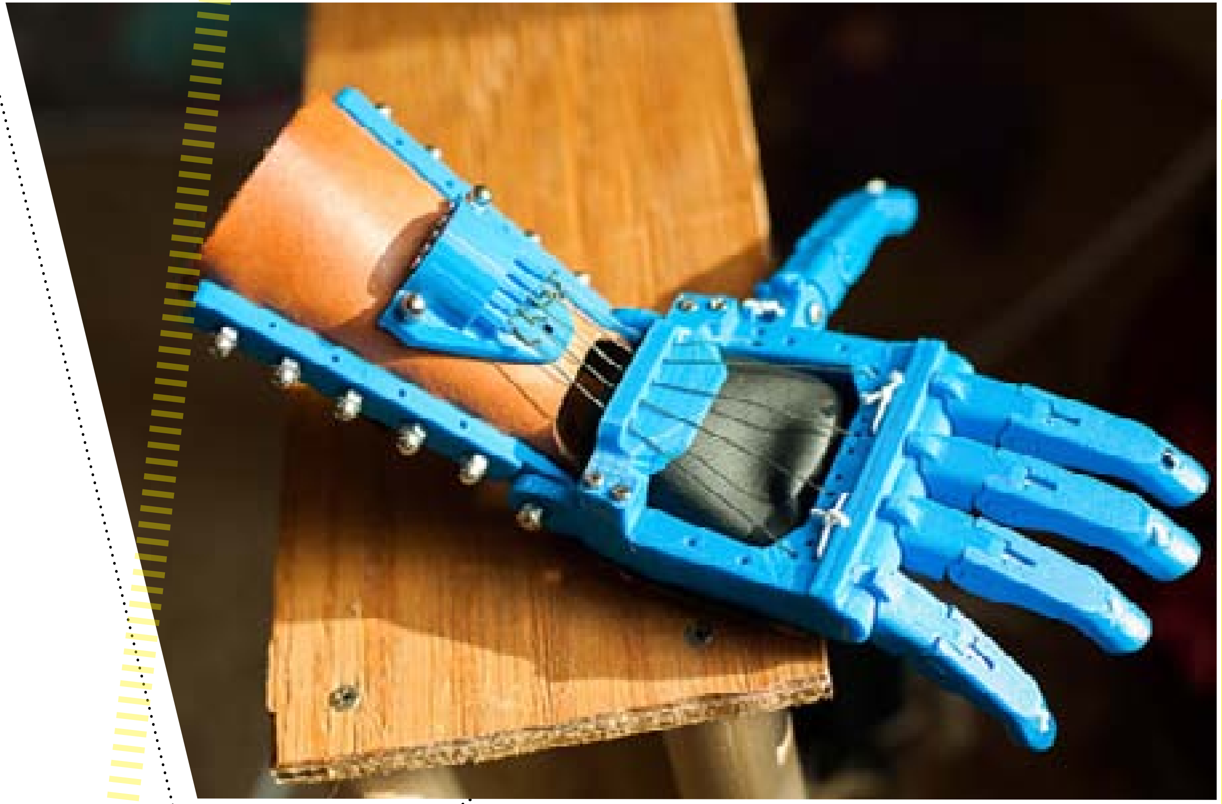
A blood centrifuge, which separates blood for disease diagnostics - anemia, etc. - made out of bicycle parts and hand drills.

SO WHAT?

Unlike most hospital equipment, this centrifuge does not require a reliable electricity supply, only five minutes of pedaling.

This saves on generator costs and involves the family of the patient in their care.

NIGERIA



ASSISSTANCE FOR **DISASTER & WAR VICTIMS**

MEDICAL AMPUTATIONS

FRAGILE/ **POST CONFLICT** STATES

3D PRINTED **PROSTHETICS**

Prosthetics made out of stainless steel, moldable plastics and 3D printed parts, customized to each individual:

SO WHAT?

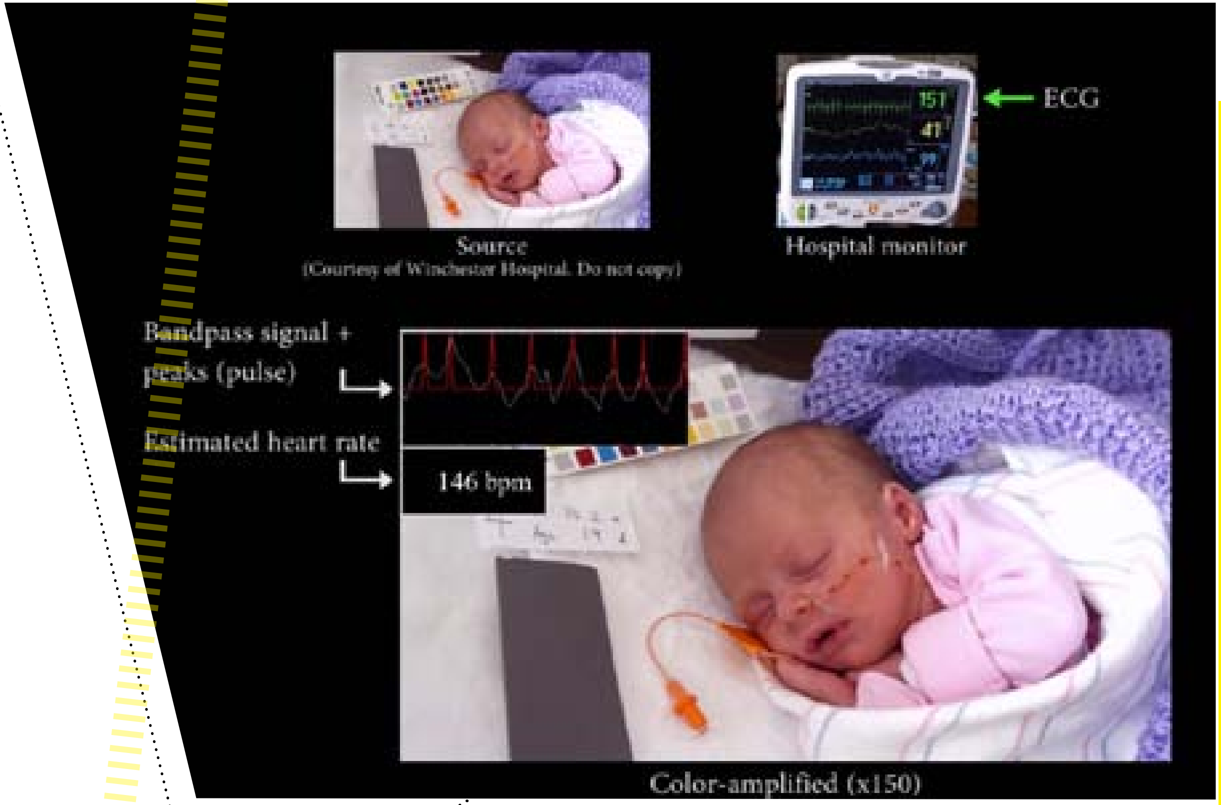
Millions worldwide require prosthetics; 80% of whom live in developing countries.

Typical prosthetics cost in excess of $1,000; cheap ones are not typically customized.

Replacements are needed every 6-12 months for children, 3-5 years for adults.

$150

USA & NETHERLANDS



NONINVASIVE **NEONATAL MONITORING**

MECHANICAL STRESS **ANALYSIS**

VIDEO MAGNIFICATION **FOR ANALYSIS**

An algorithm that amplifies color changes and motion from a video feed to detect otherwise unseen events - heart rate, respiratory rate, and the swaying of buildings, among others:

SO WHAT?

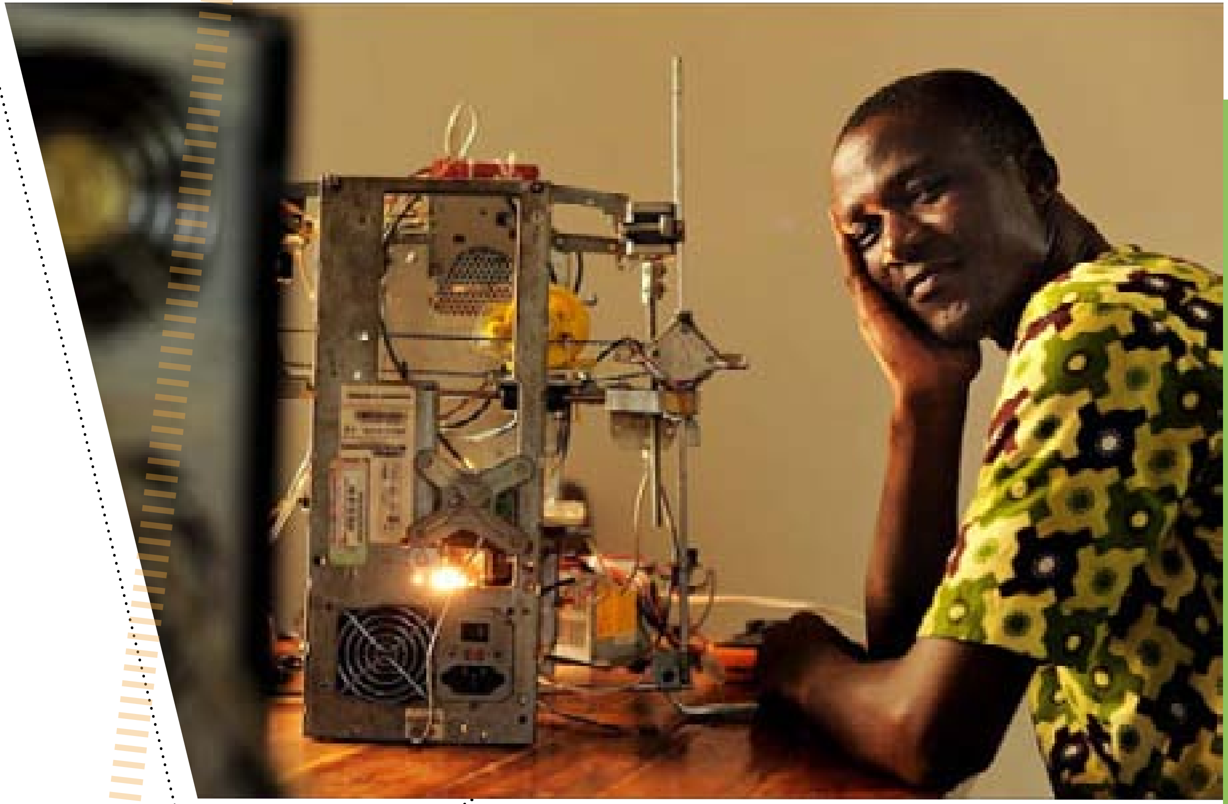
Cheaper than traditional pulsemeters - it only requires a webcam.

Can track multiple events - patients or buildings - at once.

The code runs on any computer.

$5

USA



INEXPENSIVE RAPID PROTOTYPING
E-WASTE MANAGEMENT

E-WASTE
3D PRINTER

Afate Gnikou from Togo, built a 3D printer from parts he scrounged from broken computers, other e-waste electronics and $100 worth of specialized electronics:

SO WHAT?

Costs a fraction of those currently on the market.

Recycles otherwise environmentally damaging waste.

Made with local parts means that it can be fixed with local parts.

$100

TOGO

REDUCES PLASTIC ON THE LANDFILL
INCREASES **SELF-SUFFICIENCY**
STREAMLINES SUPPLY CHAINS

PLASTIC RECYCLING **FOR 3D PRINTERS**

Waste plastic can be recycled into both 3D printer filament (the only consumable in 3D printing) and injection molding pellets, ready to be converted into new projects:

SO WHAT?

Cost of 3D printing filament decreases by a factor of 10.

While lower quality than virgin filament, it enables even cheaper prototyping.

Recover the energy in the plastics to save oil, plastic and energy.

$299

USA

WATER QUALITY AND FLOW RATE **MONITORING**
ENVIRONMENTAL CONSERVATION
POLICY PLANNING

WATER **SENSORS**

A network of sensors that collect water quality and quantity data in realtime, analyze its patterns and predict future trends:

SO WHAT?

Sensors can easily be swapped to any low-cost, low power sensor: flow rate, chemical indicators, etc.

Track water quality to work out the cleanest time to collect water.

Send contamination warning and repair status alerts

$140

USA

COMMUNITY DRIVEN & CROWDSOURCED
RAPID DATA COLLECTION
POST- DISASTER ASSESSMENT

AIR QUALITY SENSOR NETWORK

A self-contained sensing unit attached to cars and other vehicles that reports localized air quality data in real time:

SO WHAT?

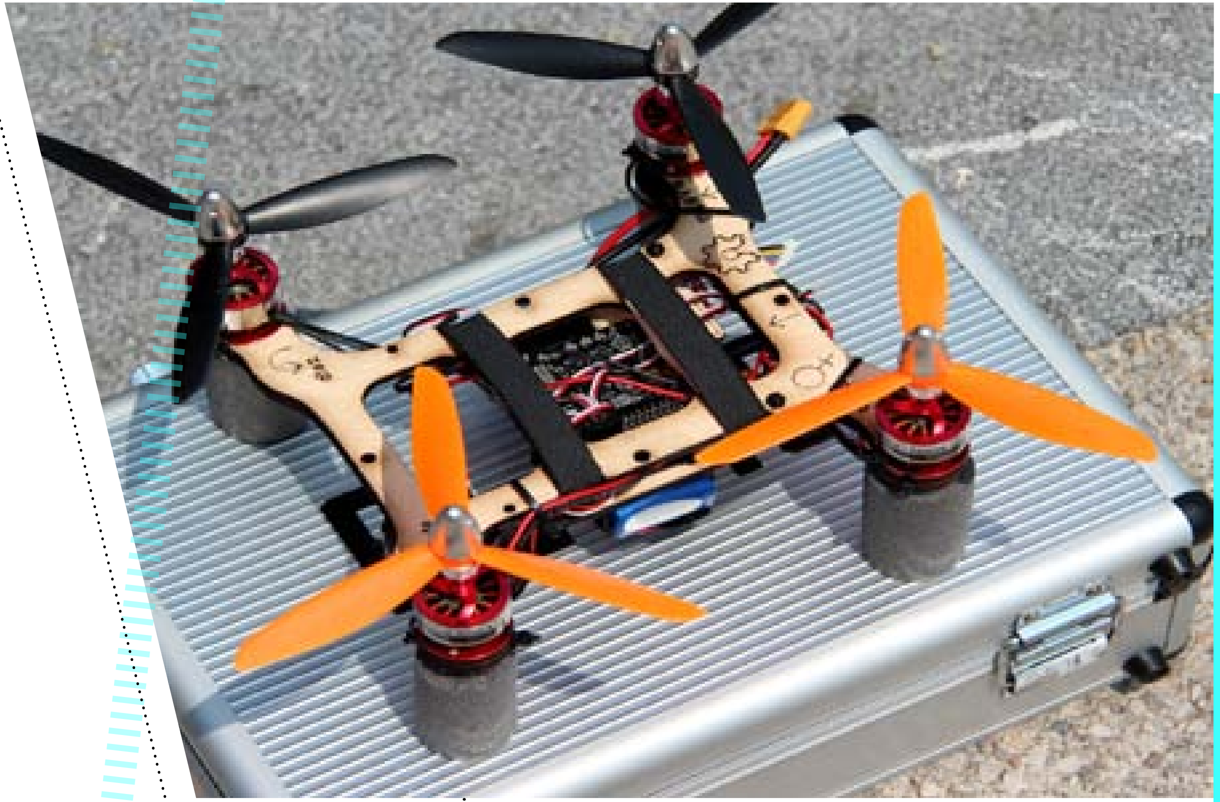
Crowdsources data logging for up- to-date information with limited investment.

Supports different sensors - radiation levels, carbon monoxide, dust and others.

Automated collection and anonymized upload makes it easy to use.

$200

BENIN & JAPAN



POLLUTION MONITORING AND ENFORCEMENT
DISASTER **MAPPING**
AERIAL **SURVEYS**

UNMANNED AERIAL VEHICLES

A mobile sensing platform that can be customized, built and flown locally, using 3D printed and laser cut parts:

SO WHAT?

Data and images are immediate - necessary for search and rescue, disasters and agriculture.

Higher resolution data than satellites could provide and faster than ground-based devices.

Supports different sensors - radiation levels, carbon monoxide, dust and others.

$90

SPAIN, SWITZERLAND & USA

TRANSPORT AND **TRAFFIC MANAGEMENT**
URBAN DEVELOPMENT AND CITY PLANNING

TRAFFIC **COUNTER**

A low-cost device that accurately measures and visualize street traffic - pedestrians, bicyles and cars:

SO WHAT?

Quarter the cost of commercial products.

Opens traffic data to the public.

Helps to study environmental impact.

$50

USA

COMMUNITY DRIVEN URBAN IMPROVEMENT
REVITALISING PUBLIC SPACES
SOCIAL EMPOWERMENT

PUBLIC SPACE **FURNITURE**

Building community furniture together with the community: skateparks, plant pots, soccer goals and park benches:

SO WHAT?

Provides opportunities for social interaction, social mixing and social inclusion.

Facilitates the development of community ties.

Entrepreneurs can make their own furniture in the fab lab and sell it at the local market.

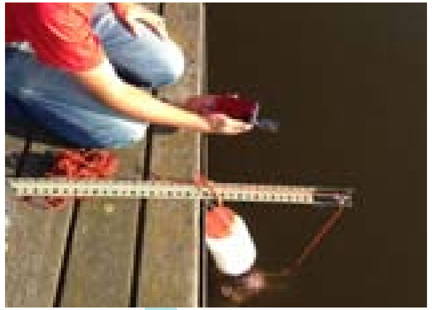
COLOMBIA

SPONSORED BY

SENSORS FOR GLOBAL DEVELOPMENT
AWARDS FINALISTS

Durable, low-cost sensors have the power to provide critical information needed to help improve the lives of the world's most vulnerable people. Maker-created sensor technologies are poised to democratize the collection of local data by providing reliable, usable data with a low per-unit cost.

This is the first digital fabrication innovation contest - organized in partnership between USAID, Intel Corporation, Fab Foundation and the World Bank - challenging the maker community to envision and build sensors for global development. These are the six finalists.



KDUINO

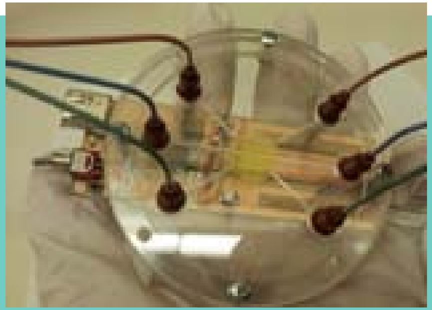
A research project that measures water transparency and sends it to your phone.

Citclops Europe Project

NANO PLASMONICS BIOSENSOR

A prototype of the emerging portable, molecular-level sensor technology.

Reza Abbaspour, Parker H. Petit Institute for Bioengineering & Bioscience at Georgia Tech, USA



FRESH AIR IN BENIN

An ongoing project in Benin to track air quality by mounting self-contained sensors on cars.

Marco Zennaro et al., Benin

MOMO

A remote sensing platform that measures water flow rate from hand-pump wells.

WellDone, USA

GROWERBOT

A home gardening device that automatically irrigates based on soil conditions.

Luke Iseman, USA

SAFECAST

A Geiger counter that is attached to your car and transmits radiation levels in real time.

Sean Bonner et al., Crash Space, Fabcafe Tokyo, MIT Media Lab, Tokyo Hackerspace

APPENDIX

Projects like these - and ones we have not even dreamt of yet - are being invented, prototyped, built and sold all around the world right now. When one opens their work to the world, everybody benefits - barriers crumble and opportunities emerge. This list attempts to locate some of the many different projects, each with their own brilliant nuances, behind the ideas showcased. It is by no means an exhaustive list, but hopefully gives an indication to the breadth of different projects happening in the world right now.

Low Cost Spirometer

Citations:
World Health Organization, *"The top 10 causes of death"*, data from 2010 / updated 2014
Primary Care Respiratory Journal, Frederick van Gemert et al., The impact of asthma and COPD in sub-Saharan Africa, 2010
Maya Varma, San Jose USA, 2014 - funded by the CTY Cogito Research Award.

Images:
(Left) UW-Madison, University Communications (Bryce Richter), "Designing a Low Cost Spirometer", 2009
(Right) Maya Varma, *"A Novel Wireless Microcontroller-Based Pulmonary Function Analyzer "*, 2014

Other Projects:
Knox Medical Diagnostics (Charvi Shetty, Huyson Lam, Noel Jee, Inderjit Jutla), California USA, 2014
University of Wisconsin-Madison (Andrew Dias, Andrew Bremer, Jeremy Schaefer, Jeremy Glynn), Wisconsin USA, 2009

Materials: Pressure sensor, Arduino, flexible tubing, 3D printed mouthpiece, Bluetooth and a phone.
Equipment: Electronics workbench, 3D printer.

Print & Fold Paper Microscope

Citations:
Manu Prakash et al., Department of Bioengineering at Stanford University USA, 2014

Images:
(Left) Manu Prakash, *"A 50-cent microscope that folds like origami"*, TEDGlobal 2012
(Right) Alex Johnson, 2014

Equipment: Paper, Ball lens,
Materials: A paper printer.

Manual Blood Centrifuge

Citations:
Dr. Oluyombo Awojobi, the Manual Haematocrit Centrifuge, Awojobi Clinic Eruwa Nigeria, 2010
Massachusetts Institute of Technology (K. Kung, T.Moallem, D. A, K. Williams, M. Salinas), the Coriolis Haematocrit Centrifuge, Boston USA, 2013

Images:
(Left, Right): PRI, "This Nigerian doctor runs his hospital on corn cobs and used bike parts", Rowan Moore Gerety, Eruwa Nigeria, 2014

Materials: Scrap bicycle parts, table.
Equipment: Metal working area (with welding.)

3D Printed Prosthetics

Citations:
Stanford University, Maurice LeBlanc, *"Give Hope - Give a Hand - The LN-4 Prosthetic Hand"*, data from 2008 / presentation 2011
World Health Organization, *"World Report on Disability 2011"*, 2011
The American Academy of Orthotists & Prosthetists, Erin Strait, *"Prosthetics in Developing Countries"*, 2006
Haitian Amputee Coalition, Ivan R. Sable, 2010
University of Buffalo, New York (Kurichi JE, Bates BE, Stineman MG), *"Amputation - International Encyclopedia of Rehabilitation"*, 2010
E-nable, South Africa & USA, 2014
Robohand, Australia & USA, 2014
Talon Hand 2.0, USA, 2014
Oxy Hand RP 1.0, USA, 2014

Images:
(Left) Jen Owen, RIT, 2014
(Right) 3ders.com, 2014

Equipment: Stainless steel, moldable plastics and 3D printed parts.
Materials: A 3D printer, camera, metal working area, trained prosthetist.

Video Magnification for Analysis

Citations:
Eulerian Video Magnification at the Massachusetts Institute of Technology (Hao-Yu Wu, Michael Rubinstein, Eugene Shih, John Guttag, Frédo Durand and William T. Freeman), Cambridge USA, 2012

Images:
(Left): Euliarn Video Magnification, MIT, Cambridge USA, 2012
(Left): Peri, Administration Building Central Bank of Nigeria, Lagos Nigeria, 2012

Equipment: Webcam, computer.
Materials: ---

E-waste 3D Printer

Citations:
Kodjo Afate Gnikou at Woelab in Loma, Togo, 2013
Images:
(Left) FranceSoir, Victor Lefebvre, *"Woelab, des décharges togolaises à la planète Mars"*, 2013
(Right) http://greenbuildingelements.com/, 2013

Equipment: Scrap metal parts, $100 worth in electronics (an Arduino + others.)
Materials: Electronics working area, screwdriver.

Plastic recycling for 3D printers

Citations:
Filastruder by Tim Elmore, Florida USA, 2013
The Cambridge-MIT Institute at the University of Cambridge, *"The Improving Engineering Education (ImpEE) Project: Recycling of Plastics"*, 2005
Container Recycling Institute, Pat Franklin, *"Down the drain"*, 2006
Petco, PET plastic recycling South Africa, 2014
Images:
(Left): Filabot by Tyler McNaney, Vermont USA, 2010
(Right): Malte Ahrens, *"Plastic collectors in Soweto on Sea, South Africa"*, 2014

Equipment: Scrap plastic (cleaned and shredded) and for good quality prints: virgin ABS beads
Materials: -

Water Sensors

Citations:
Massachusetts Institute of Technology (Malte Ahrens, Jonathan Garcia, Alberto Mulero, Shinjini Saha), Cambridge USA, 2014
Momo by WellDone, California USA, 2014 - currently deploying prototypes in Tanzania
World Health Organization, *"Guidelines for Safe Drinking Water - Fourth Edition"*, 2011
World Health Organization, *"Indicators of microbial water quality"*, 2001
Epidemiology, John M. Colford, Jr. et al., *"Water Quality Indicators and the Risk of Illness at Beaches with Nonpoint Sources of Fecal Contamination"*, Volume 18, Number 1, January 2007
Images:
(Left): Elisabet Diaz Sanmartin, 2014
(Right): WellDone, 2014

Equipment: PVC (or other waterproof enclosure), Arduino, water sensors, GSM radio.
Materials: Electronics working area, laser cutter.

Air Quality Sensor

Citations:
Safecast, Sean Bonner et al., Crash Space, Fabcafe Tokyo, MIT Media Lab, Tokyo Hackerspace, 2014
Fresh Air in Benin, Benin, 2014
CLAIRITY: An Air Quality Network for MIT's Campus by MIT, Cambridge USA, 2014
Images:
(Left): Safecast (Pieter Franken, Sean Bonner and Dan Sythe), Washington DC USA, 2014
(Right): Marco Zennaro, Benin, 2014

Materials: Some plastic weatherproof enclosure, Arduino, air quality sensors, GSM radio.
Equipment: Electronics working area.

Unmanned Aerial Vehicles

Citations:
SenseFly by Parrot, Cheseaux-Lausanne Switzerland, 2009

Images:
(Left): Flone by Aeracoop, 2013
(Right):United Nations - UNITAR/UNOSAT, *"UAV Survey of Gran Ravine, Port Au Prince, Haiti"*, 2012

Other Projects:
Flone by AeraCoop, Barcelona Spain, 2013
Sulsa by the University of Southampton, UK, 2011
VAST AUAV (Variable AirSpeed Telescoping Additive Unmanned Air Vehicle) by the MIT Lincoln Laboratory, Cambridge USA, 2013

Materials: Motors, propellers, flight electronics (radios, Arduino, etc.)
Equipment: Laser cutter, general workshop.

Traffic Counter

Citations:
WayCount by Tomorrow Lab LLC, New York USA, 2012
Traffic Tally 2 by Diamond Traffic, Oregon USA, 2010
Images:
(Left and Right): Tomorrow Lab LLC, 2012

Equipment: Pressure sensor, plastic tubing, plastic box, Arduino
Materials: Electronics working area.

Public Space Furniture

Citations:
Insitu by Blokcad Lab and uAbureau, Medellin, Colombia, 2011
Images:
(Left and Right): Fabio Lopez, Medellin Columbia, 2011

Equipment: Concrete, Plywood.
Materials: Wood working area.

Front Cover Image - Safecast (Pieter Franken, Sean Bonner and Dan Sythe), Washington DC USA, 2014

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Ajuntament de Barcelona

MAKING SENSE

MAKERS POLICY FOR POLICY MAKERS