

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

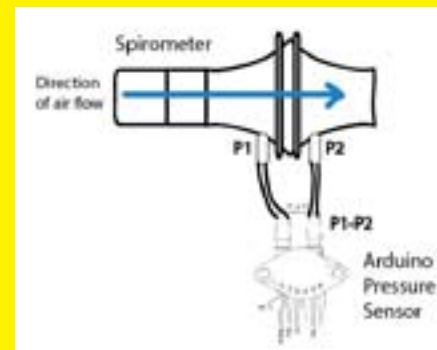




DIAGNOSE & MANAGE RESPIRATORY DISEASE
CHEAP, REUSABLE & RAPID TESTING

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:

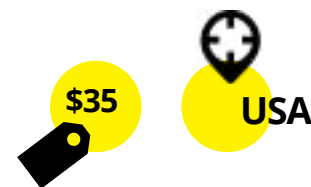


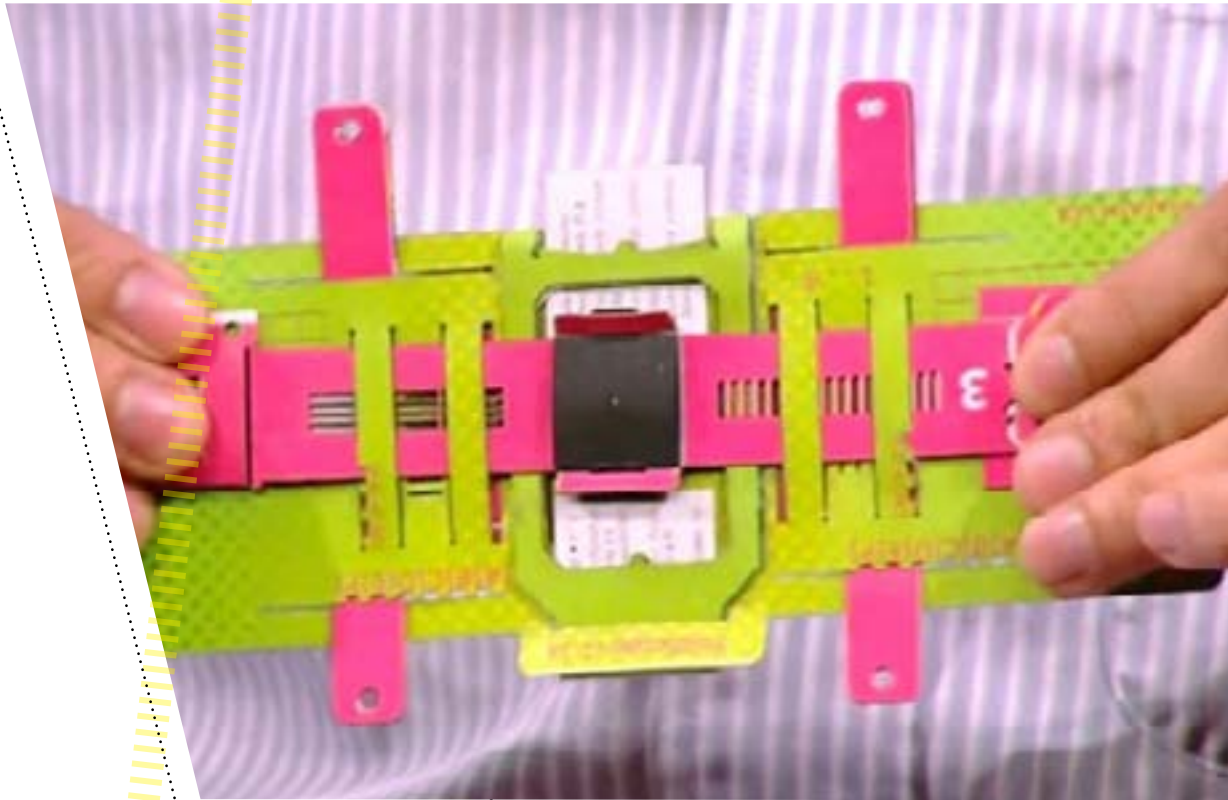
! SO WHAT?

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.





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





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.

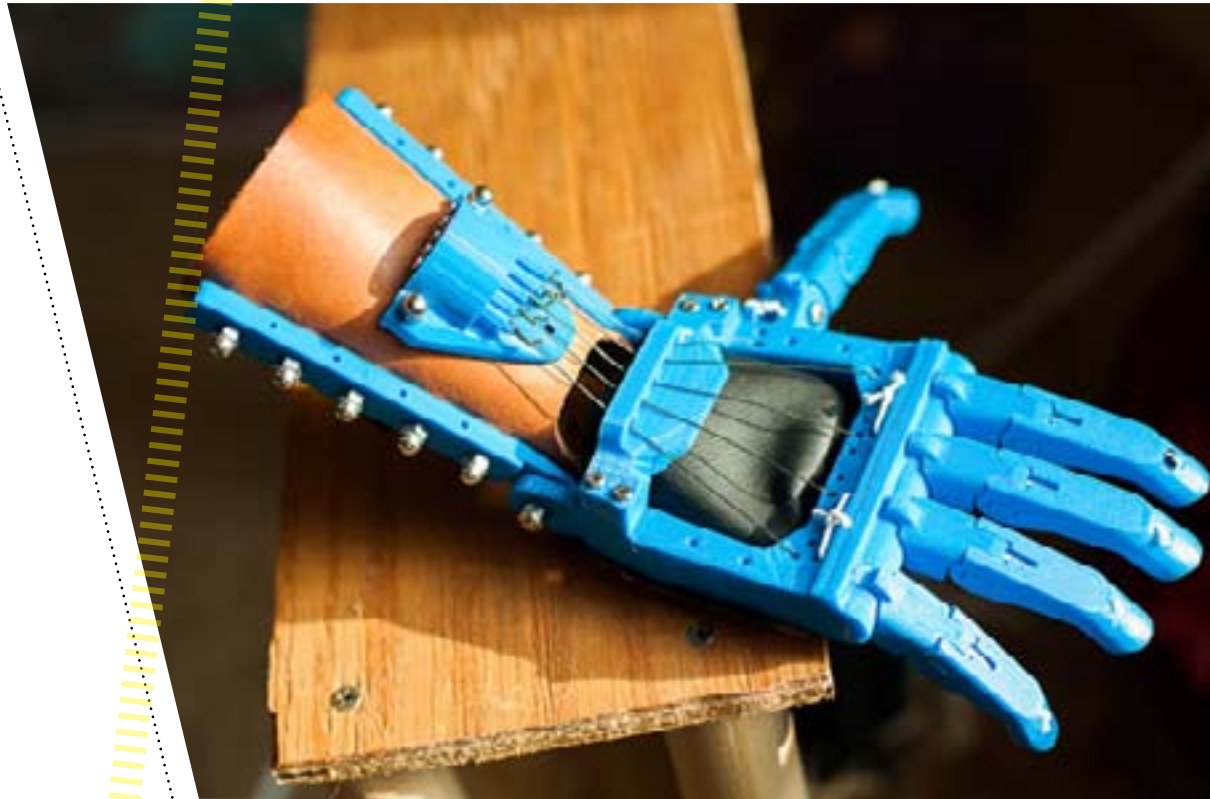


⚠️ SO WHAT?

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.





ASSISTANCE 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.



USA & NETHERLANDS

VIDEO MAGNIFICATION FOR ANALYSIS

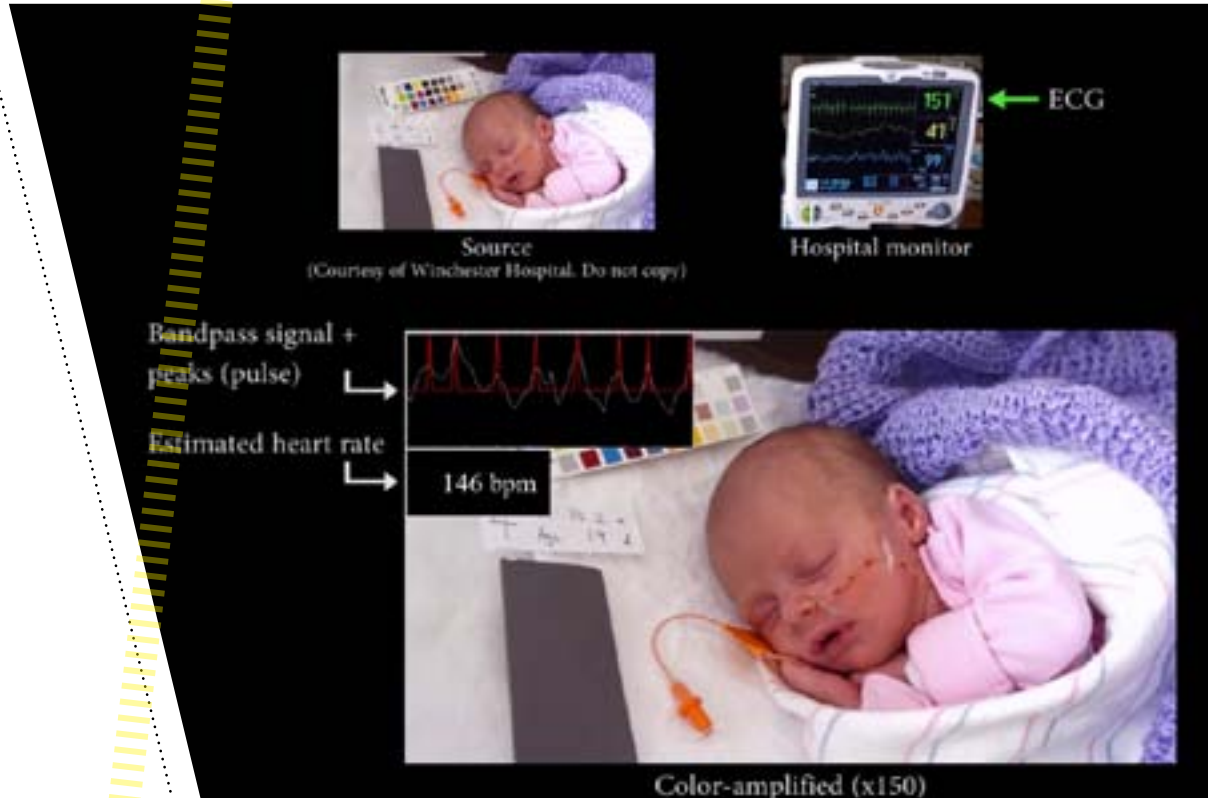
An algorithm that amplifies color changes and motion from a video feed to detect otherwise unseen events - heart rate, respiratory rate, and the swaying of buildings, among others:

! SO WHAT?

Cheaper than traditional pulseimeters - it only requires a webcam.

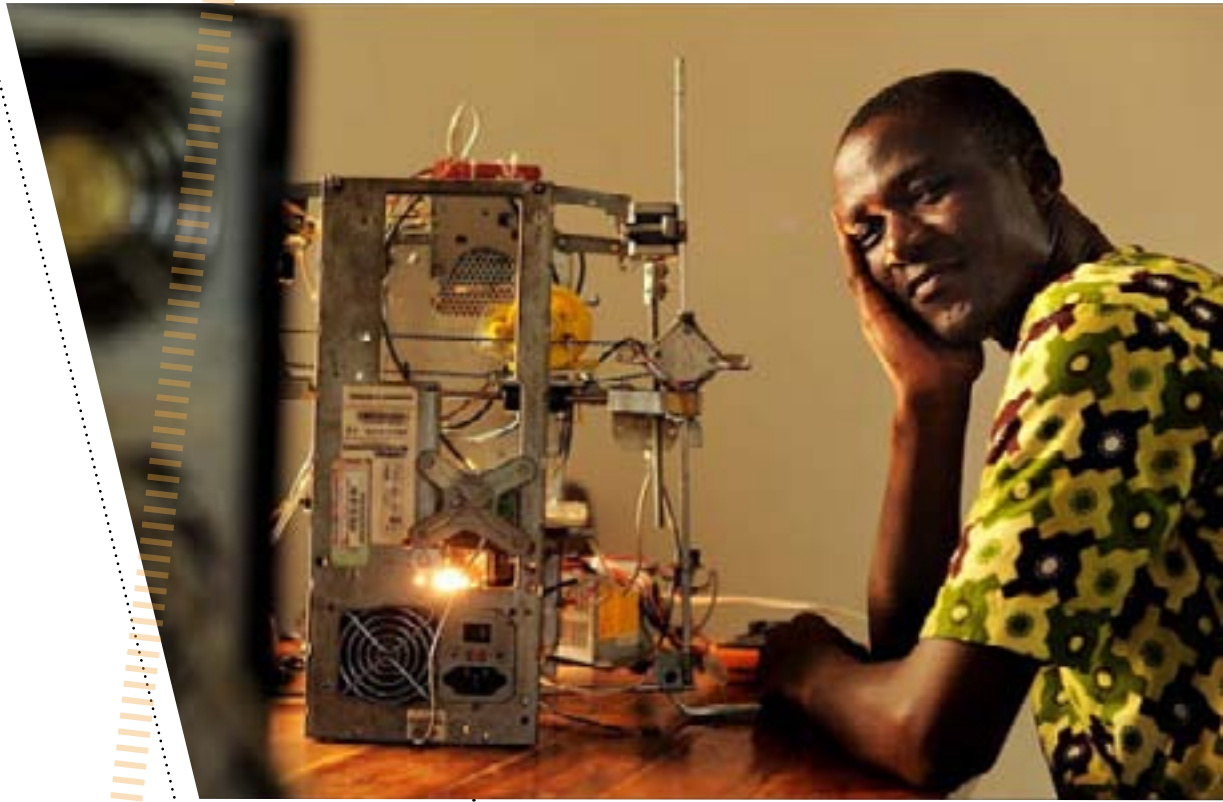
Can track multiple events - patients or buildings - at once.

The code runs on any computer.



NONINVASIVE NEONATAL MONITORING
MECHANICAL STRESS ANALYSIS





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

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:

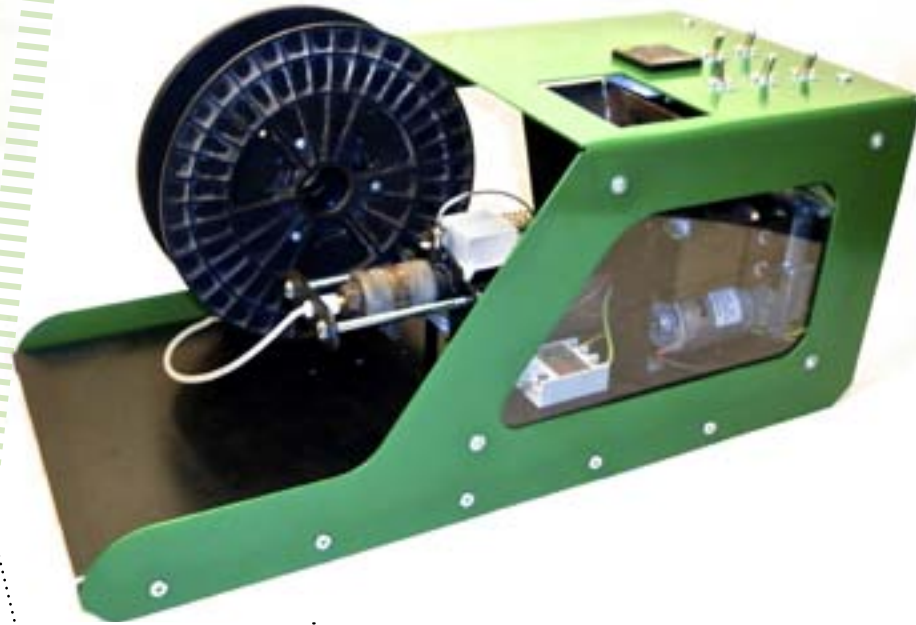


! SO WHAT?

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.



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

\$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:

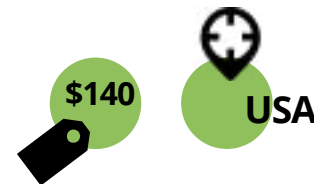


⚠️ SO WHAT?

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





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, bicycles 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



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.

SPONSORED BY





KDUINO

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

Citclops Europe Project



MOMO

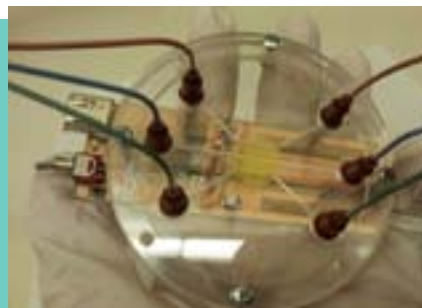
A remote sensing platform that measures water flow rate from hand-pump wells.

WellDone, USA

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



GROWERBOT

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

Luke Iseman, 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



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

Pressure sensor, Arduino, flexible tubing, 3D printed mouthpiece, Bluetooth and a phone.

Materials: Electronics workbench, 3D printer.

Equipment:

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

Paper, Ball lens,

Equipment: A paper printer.

Materials:

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): Eulerian 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
 - Salsa 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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