MIT D-Lab

designing for a more equitable world

Design Portfolio 2020

MISSION

MIT D-Lab works with people around the world to develop and advance collaborative approaches and practical solutions to global poverty challenges.

Cover image: Water filter prototyping session with local women in Bageshwar district, Uttarakhand, India.

Mwana Hamisis and the hand-operated palm oil extractor, developed at a D-Lab Creative Capacity Building training, Tanzania, 2014

HISTORY

In 2002, D-Lab founder Amy Smith offered a course at MIT called "The Haiti Class." She sought to apply engineering and design principles to the complex issues faced by people living in poverty.

That first course embodied the values of technical expertise and a commitment to deep and respectful collaborations with people living in poverty, which D-Lab continues to hold at the center of its work today.

Over the course of 16 years, D-Lab's programs expanded to include more than 20 interdisciplinary courses; six research groups working in collaboration with global partners; technology development for, with, and by people living in poverty; and a suite of international programs, convenings, trainings, and fellowships.

ABOUT

D-Lab approaches international development with a design mindset, as is reflected in our guiding principles:

- Use inclusive practices when designing FOR people living in poverty
- Engage in effective co-creation when designing WITH people living in poverty
- Build confidence and capacity to promote design BY people living in poverty

In following these principles, D-Lab is re-thinking the role of technology and design in development and reshaping the way that development is practiced. D-Lab has become a global leader in participatory design and empowered thousands to address the daily challenges of poverty through design, prototyping, production, and social entrepreneurship.

D-Lab has received support from the Rockefeller Foundation, Community Jameel, United States Agency for International Development, and many others. D-Lab founder Amy Smith has received honors including a MacArthur Fellowship, Time Magazine's 100 Most Influential People (2010), and Business Week's World's Most Influential Designers (2010).

"I believe that it's not just the products of design that have an impact in development, but that the design process itself is empowering. When people create a solution to a challenge they're facing, it transforms the way they think about themselves."

Amy Smith
Founding Director, MIT D-Lab

Ten Design Programs & Projects 2020

Design Programs

- Creative Capacity Building
- International Development Design Summits
- Humanitarian Innovation
- Scale-Ups Fellowship Products & Ventures

Design Projects

- Okoa Project Motorcycle Ambulance
- Fuel from the Fields
- SurgiBox
- Deep Sand Wheelchair
- Corn Sheller & Jig
- Evaporative Cooling

Saathi Pad - 100% biodegradable sanitary napkin made from banana fiber

"Learning the design process itself was an 'aha' moment. When you work in a team to think about something, make a sketch, test it ... you see yourselves get stronger together and have the courage to start something."

Euphrasia Njobvu
Development Facilitator
World Vision, Zambia

Creative Capacity Building

D-Lab Creative Capacity Building workshop: learning design and tool use through corn sheller exercise, Ghana, 2015

Creative Capacity Building

Promoting Local Innovation

Creative Capacity Building (CCB) is a D-Lab design program that invites people to use their creativity and local knowledge to develop solutions to challenges relevant to improving their own lives and communities.

In building the CCB curriculum, D-Lab distilled key elements of the participatory design process into a hands-on training accessible to anyone, regardless of formal education, and is adaptable to a range of themes and settings.

Past CCB projects have focused on improving farming or food processing efficiency; increasing access to energy, water, sanitation, or information; and creating a broad range of income-generating opportunities. CCB workshops often include the creation of technology prototypes. Newer trainings explore business creation and the application of the design process to other forms of problem-solving.

Innovation Centers

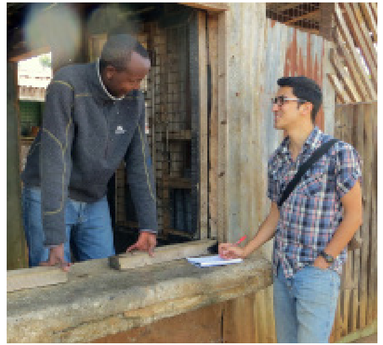
To support further refinement of CCB prototypes and new project development, D-Lab works with local organizations to set up simple innovation centers and community tool libraries. These centers provide ongoing mentorship for CCB participants and engage additional community members.

Impact

A recent research study showed that CCB participants developed prototypes that reduced labor by an average of 85 percent and increased income by 40 percent. In addition, there were significant changes in gender roles, and technology adoption rates were increased by more than ten-fold.

LEARN THE DESIGN PROCESS

UNDERSTAND THE PROBLEM



CREATE SOLUTIONS

BUILD AND TEST

REFINE AND PRESENT

SAMPLE CREATIVE CAPACITY BUILDING PROJECTS

PROJECTS

Left bottom
A low-cost, pedal-powered blender for making juice, El Salvador.

Center top
A brick maker that produces multiple bricks at a time, Uganda.

Center bottom
A floating chicken coop that provides nutrients to a fish pond while using waste beverage bottles as a building material, Philippines.

Above:
A mango picker that prevents damage to the fruit by guiding it through a fabric chute directly into a bag, Uganda.

“The design process was very helpful to me because I thought and thought about the resources available in my village and what I can do with them to help with the community development.”

Wiver Michelo
Farmer & Entrepreneur
Zambia

Menstrual Hygiene Design Team
IDDS, Zambia, 2013

International Development Design Summits

Conceived by D-Lab's Amy Smith in 2007, International Development Design Summits (IDDS) are hands-on design trainings that bring together a diverse group of people to learn about the co-creative design process and to prototype low-cost technological solutions that can improve the livelihoods of people living in poverty.

Summits emphasize the importance of co-creation, the idea that designing with communities is more powerful than designing solutions for them. During a summit, participants work in teams with community members to learn the design cycle, identify problems and solutions, and test prototypes.

Design summits can last two weeks or a month and typically take place in a developing country. Some summits delve into a specific topic such as urban waste systems, while others address broad topics like agriculture, health, and education and result in viable prototypes.

After a summit is over, IDDS participants become a part of the growing International Development Innovation Network. Some continue to work on projects from the summit, while others pursue their own local innovation projects in a wide range of fields.

Impact and outcomes of the summits are closely monitored and evaluated. One study showed that two-thirds of respondents taught design and co-creation to others in the 12 months after IDDS, over half were working on an innovation or venture, and over half applied collaborative design in their work.

A team from IDDS D'kar (Botswana, 2015) working on the development of a fodder chopper prototype.

IDDS Aarogyam (Chennai, India, 2015): designing health-focused interventions and technologies.

A porous cooking briquette developed at IDDS Sustainable Homes (Sololá, Guatemala, 2017).

Participants in IDDS New Coastal Territories (Colombia. 2018) fabricate a prototype for a project related to coastal livelihoods.

An egg-carton design exercise at IDDS Zero Waste (Cali, Colombia, 2015).

Team Spicy Hath addressing the needs of Lady Health Workers, IDDS Lahore (Pakistan, 2017).

11 years

27 Design Summits in 13 countries

120+ innovations in development

Network of 1,000 innovators from 86 countries

7-member international steering committee

“This gave me hope again. I believe I can make things and solve problems.”

17-year-old unaccompanied Afghani refugee, Athens, Greece

Humanitarian Innovation

Refugee-led design

D-Lab design and shop skills workshops for refugee youth at the Faros Horizon Center, Athens, Greece, 2019

Humanitarian Innovation

Changing the paradigm of aid

The world is facing an unprecedented humanitarian crisis with 65 million people displaced by conflict or persecution. Available resources are heavily strained and organizations urgently need creative solutions to providing basic needs to this population.

The vast majority of humanitarian innovation initiatives are top-down, the clients are the humanitarian aid organizations and the "users" are the affected population who have no direct line back to the suppliers. MIT D-Lab is pioneering a new approach to humanitarian innovation, which is training refugees and displaced persons in the design process and the use of tools, so that they can create the kinds of things they need—cookstoves, fans, water coolers, or pumps, for example—to improve their lives and ultimately improve the way humanitarian work is delivered.

Creative Capacity Building with Unaccompanied Refugee Minors - Athens, Greece

Since summer 2017, MIT D-Lab has been working with Faros, a non-profit organization in Athens that provides support to unaccompanied refugee youth - mostly boys from Afghanistan, Pakistan, Syria, Iraq, Iran, and Kurdistan. D-Lab has organized multiple design trainings for the youth and assisted in the development of an innovation center - the Horizon Center.

Disaster Risk Reduction Program — Dry Corridor, El Salvador

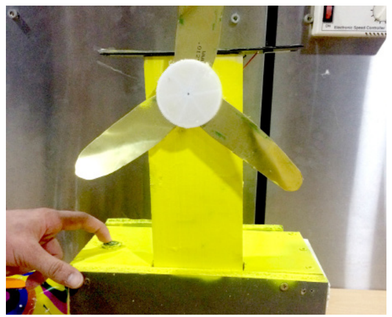
Together with and funded by Oxfam, MIT D-Lab has undertaken a three-year project that aims to build a local ecosystem for innovation. This system includes Creative Capacity Building for people in four communities, the establishment of a local innovation center in a central area, and the development of an advanced CCB training adapted for risk reduction design.

D-Lab has developed a design-build activity called "The Maize Raise," challenging participants to build a structure that supports the maximum number of ears of corn with just two pieces of paper. El Salvador, 2019.

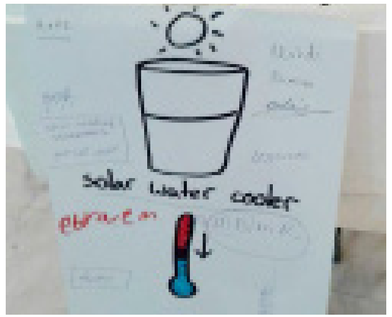
Design for Interactive Learning workshop with UNICEF & Sudan Ministry of Education. Khartoum, Sudan, 2017.

Humanitarian Innovation Jam with UNHCR. Kampala, Uganda, 2016.

An unaccompanied refugee minor prototyping a lockable box of his own design at a D-Lab workshop at The Cube, a maker space in Athens, Greece, 2017.



Fan with rechargeable battery pack and solar panels designed and built by unaccompanied refugee youth.



Design for a solar water cooler by unaccompanied refugee youth. Athens, Greece, 2017.

Co-Creation Toolkit for Humanitarian Innovation

MIT D-Lab is piloting a novel approach to teaching graduate-level design and systems thinking courses that aims to move graduate students in STEM fields — both at MIT and around the globe — toward a more collaborative and inclusive approach to problem-solving that blends participation, systems thinking and design.

Practical Techniques for Water Quality Testing and Purifications - Puerto Rico

Hurricane Maria forced hundreds of thousands of people to collect water from streams or springs leaving them vulnerable to gastrointestinal disease. Oxfam and the Puerto Rico Science, Technology & Research Trust, in collaboration with University of Puerto Rico (UPR), invited MIT D-Lab to lead a hands-on technical training of trainers on water treatment and testing in San Juan.

THE TEAM

D-Lab's Humamitarian Innovation

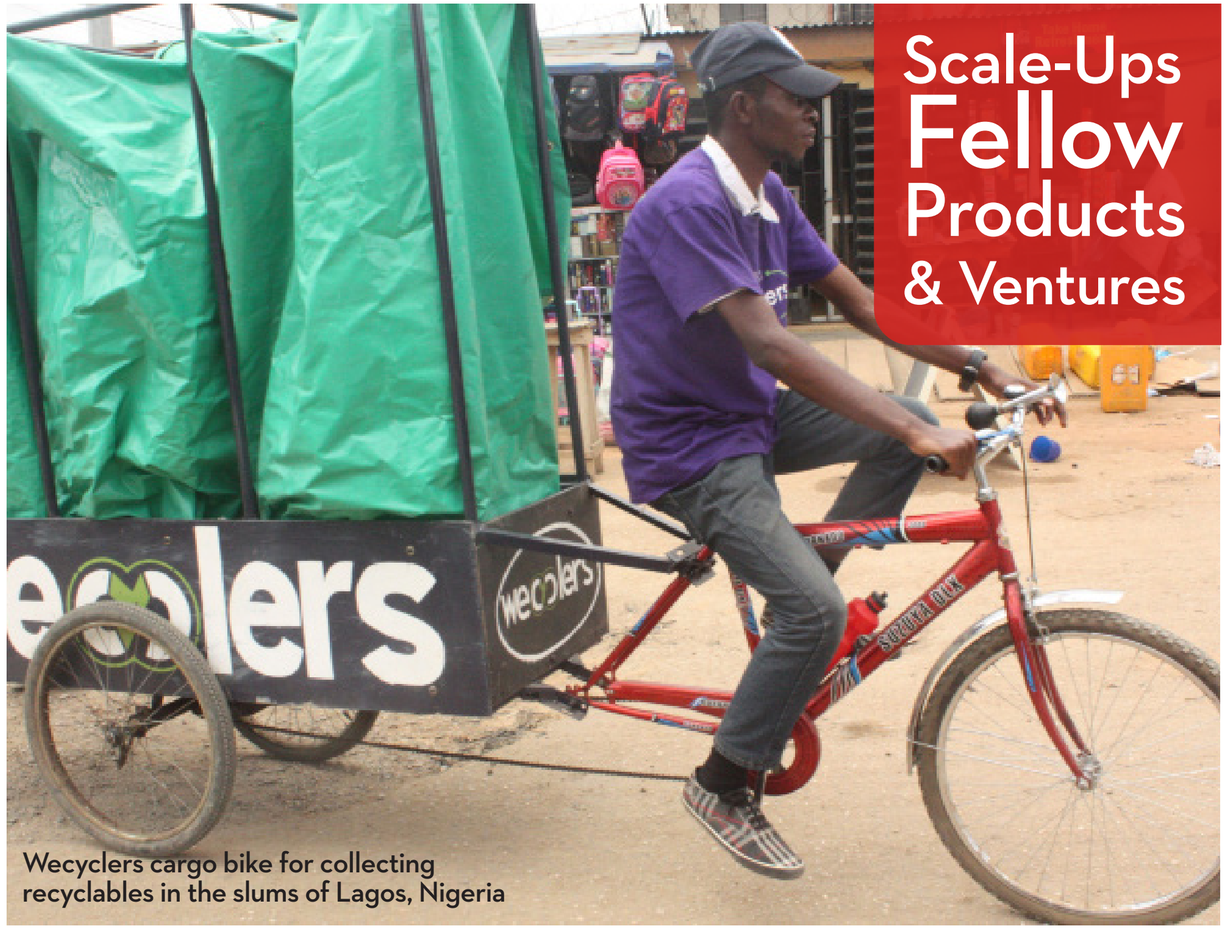
Since 2009, D-Lab Founding Director **Amy Smith** has been bringing design training to refugee and IDP camps. With Martha Thompson, she teaches the MIT course D-Lab: Humanitarian Innovation: Design for Relief, Recovery, and Rebuilding.

Martha Thompson is a humanitarian worker with a focus on gender and exclusion in crisis situations. For more than three decades, she has worked in conflict and emergency situations all over the globe, taught humanitarian practice at Tufts University and Brandeis University, and has published extensively on issues of gender, emergency response, and working in conflict situations.

"D-Lab not only worked with us to design our waste-collection cargo bikes, they helped us design the business."

Bilikiss Adebiyi-Abiola
Founder, Wecyclers
Lagos, Nigeria

Scale-Ups Fellow Products & Ventures



Wecyclers cargo bike for collecting recyclables in the slums of Lagos, Nigeria

D-Lab Scale-Ups Fellow Products & Ventures

Since 2012, D-Lab has supported 33 young social ventures in the design, development, and dissemination of hardware, software, and service-based ventures dedicated to bringing essential low-cost products and services to base-of-the-pyramid markets.

The D-Lab Scale-Ups Fellowship offers one year of support to social innovator-entrepreneurs bringing poverty-alleviating products and services to market.

Fellows enter the program with a compelling proof-of-concept and work to retire risk in technical feasibility and market viability during the 12-month fellowship. Since the fellowship program's launch in 2012, Scale-Ups has sponsored 33 fellows working on four continents.

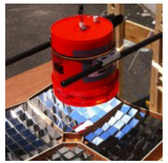
- Sectors: Agriculture, education, energy, financial services, healthcare, livelihoods, mobility, waste, and water
- Markets: Brazil, Ethiopia, Ghana, Haiti, India, Lesotho, Nepal, Nicaragua, Nigeria, Pakistan, Philippines, Tanzania, Uganda, and Zambia
- People served: 1.5 million
- Jobs created: 717direct and 6,708 indirect
- Funds raised by fellows: $11.1 million in equity, debt, and grant investment
- Revenue generated: $10.2 million

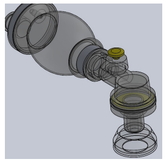
Alumni of the Massachusetts Institute of Technology (MIT) and the International Development Design Summit are eligible to apply.

Scale-Ups Fellows receive a $20,000 grant, tailored mentorship in design, manufacturing, business models, and financing as well as trainings, networking, and access to the D-Lab workshop, students, and instructors.


Leveraged drivetrain wheelchair


Solar water quality indicator, Zambia


Solar medical instrument sterilizer, Nicaragua


Augmented infant resuscitator, Uganda


Moringa seed sheller, Ghana


Treadle multicrop thresher, Tanzania


Autoclave medical instrument sterilizer


Portatherm vaccine cooler, Nepal


Cargo recyclable collection bike, Nigeria


ayzh clean birth kit, multiple markets


Metered solar panels, Philippines

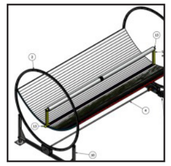

WiCare Wound-Pump


Zimba water chlorinator, India, Nepal


Recycled building insulation, Pakistan


3-D printer filament from waste, India


Portable irrigation pump, India


Microgrid power stations, Lesotho


Small scale farming program, Zambia

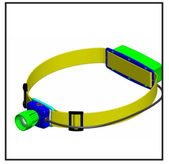

Agricultural waste briquettes, Uganda


Permaculture platform, Ethiopia


Mechanized multicrop thresher, Tanzania


Mobile app for unbanked consumers, Brazil


Banana fiber sanitary pads, India


Headlamp for farmers, India


STEM education in Ghana


Natural cane lower leg prosthetics, India


Smart energy operating system, India


Mobile irrigation systems, Uganda

Industrial waste briquettes, Kenya


Pulmonary disease diagnostic app, India


Digital marketplace for tribal artists


KopaGas, Tanzania

Comprssed files for testing content, Africa

Scale-Ups Venture Sectors Represented

- 7 Agriculture
- 8 Healthcare
- 2 Water
- 3 Financial Services & Livelihoods
- 2 Education
- 7 Energy
- 2 Waste
- 2 Assistive Devices

Jobs Created

717 416 full time, 301 part time jobs

6,708 Indirect jobs created

Users Reached

1.5 m

People reached with goods and services

"Through this incredible collaboration between a Tanzanian NGO and a group of student designers and engineers that D-Lab put together, we were able to take on the critical problem of access to healthcare, and with the community, design and deliver a safe cost-effective solution."

Emily Young,
Co-Founder, The Okoa Project

Okoa Project
Motorcycle ambulance

Okoa Project Motorcycle Ambulance

A lack of adequate transportation is one of the top two reasons people around the world don't receive the medical attention they need. This is particularly true where owning and operating a vehicle of any kind is both expensive and impractical, especially in rural areas with narrow and unpaved roads.

In the spring of 2016, working with a Tanzanian NGO, The Olive Branch for Children, a student team in the D-Lab: Design class set out to address this challenge and the Okoa Project motorcycle ambulance was born.

By engaging hundreds of stakeholders throughout the research, design, and implementation process, they collaborated with the community to create a safe, rugged, comfortable, and sustainable solution - a medical transport trailer with a universal hitch that can be paired with almost any motorcycle. The trailer, build with local materials and locally manufactured, is equipped with essential medical supplies including a birthing kit, a patient in a removable stretcher, and passenger seat for a companion or medical professional.

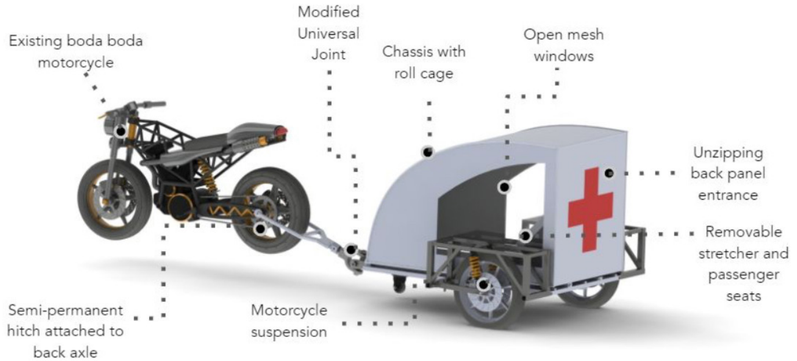
The ambulance has an extensively tested suspension system for a comfortable ride over the narrow, bumpy roads, in order to ensure that patients are not subjected to the kinds of bumps and jolts that might exacerbate their condition. Constructed of locally sourced materials, the ambulance is easy for local technicians to repair and maintain.

With three Okoa ambulances operating in two different regions in Tanzania - Mbeya and Iringa - a Tanzanian team of five is currently building additional trailers to order.

Extensive testing was done to ensure the Okoa Ambulance could endure the challenging - sometimes flooded - road conditions in rural areas of Tanzania.

Junior and Vex are Okoa Apprentices learning vocational skills throughout the process.

The team with local officials, after delivering 2 ambulances to the Tanzanian Rural Health Movement in Iringa.



Design for the Okoa.

In addition to designing and distributing the ambulance, Okoa works to train local drivers.

The Okoa ambulance got its start as a class project in D-Lab: Design. Prototype #1 pictured here.

THE DESIGNERS

Emily Young graduated from MIT in 2018 with an SB in Mechanical Engineering with a concentration in Global Product Design. She is the team's multifaceted creative, functioning as both engineer and cartoonist. She was on the original D-Lab team in 2016 and is continuing this project forward as President of The Okoa Project Inc. - a non-profit that focuses on healthcare challenges in rural areas.

Sade Nabahe graduated from MIT in 2017 with an SB in Mechanical Engineering and an unofficial minor in D-Lab. She has worked on development projects for communities in Peru, Lesotho, and India. She was on the original D-Lab team in Spring 2016 and for three years, led project management and product testing.

Jimmie Harris graduated from MIT in 2017 with an SB in Mechanical Engineering and is a master's student in Stanford's Design Impact program. He has experience in designing electro-mechanical structures for hydroelectric turbines, developing composite manufacturing plans, and race car suspension and composite design.

"Since 2012, D-Lab has supported our team in designing kilns and hand presses for making agro-waste charcoal. This has enabled our team to design even bigger machines to meet the growing needs of our enterprise instead of importing all the machines from China or India."

Betty Ikalany, Founder & CEO
Appropriate Energy Saving Technologies, TEWDI Uganda

Fuel from the Fields

Ag-Waste Charcoal Processes & Tools

Each year, more than four million people die prematurely from the indoor air pollution produced by traditional fuels used in cookstoves. For more than 16 years, D-Lab has been designing tools and processes for producing cleaner burning, more sustainable cooking fuels.

The traditional cooking fuels such as wood and wood charcoal used by three billion people worldwide pose acute health risks, are time consuming for women and children to collect, and contribute to deforestation. D-Lab addresses these issues through designing and disseminating tools, technologies, and processes for alternative fuel production. D-Lab also contributes to the design of remote sensoring systems for use and impact measurement.

Process
In 2002, D-Lab developed a process for transforming ag-waste such as sugarcane bagasse, groundnut shells, and corn cobs into cleaner burning briquettes.

Kiln
The D-Lab kiln is constructed from a single used oil drum and costs about $15 to produce.

Crusher
This device was designed at an IDDS to take the charcoal fines produced in the kiln and grind them down to finer particles for mixing with the binder.

Press
The D-Lab charcoal press was designed to be low-cost and easy to make with minimal instruction.

Sensors
D-Lab studies the use and impact of fuels and stoves through remote sensoring. Working with an MIT/D-Lab sensor startup, Sensen, D-Lab provides context for studies and contributes to the design of sensors.

Making ag-waste charcoal in Zambia - from working with the community to determine what ag-waste is suitable, to teaching design and build skills through making the kilns and charcoal press.

D-LAB KILN: $15. Converts agricultural waste into carbonized material for charcoal in a few hours.

D-LAB PRESS: $2. For forming and compressing 10-12 briquettes per minute.

Betty Ikalany (far left), Founder and CEO of TEWDI Uganda and Appropriate Energy Saving Technologies (AEST) in Soroti, Uganda with part of her team who produces ag-wasted charcoal to supply their community.

D-LAB CRUSHER: $10. For fine grinding of carbonized materials to be mixed with binder.

SENSEN SENSORS: For the accurate remote monitoring of stove use and emissions.

CHARCOAL PROCESS

D-Lab created an illustrated guide using only pictures, so that anyone can learn to carbonize ag-waste, mix it with a natural sticky binder, and form and press the briquettes. A few sample illustrations below.

“The magic of D-Lab was turning the quest to solve an enormous problem — how to protect patients and providers from infection in field surgeries — into simple, non-scary design steps. As a result, I don’t have a problem anymore; I have a promising solution.”

Debbie Lin Teodorescu, MD
Founder & CEO, SurgiBox

SurgiBox, generation 5

SurgiBox

SurgiBox is an ultraportable inflatable surgical environment designed to reduce surgical site infections by:

- Making surgery safer for patients by reducing intraoperative air/skin contamination of incisions.
- Making surgery safer for providers by reducing provider exposure to bodily fluid splashes and aerosol.

In resource-poor areas of the world, surgeons without access to high-tech medical facilities and equipment are left to worry about dust, dirt, bacteria, flies, and other contaminants. According to a 2015 study in The Lancet, five billion people don't have access to safe, clean surgical care.

In 2012, while Debbie Lin Teodorescu was at medical school, she decided to address this need, and the original SurgiBox concept was born. The idea was to create a way to keep the area right around a wound sterile by covering it with a container and operating through ports.

But she had no idea how to make it a reality and came to D-Lab with her idea, where, under Debbie's leadership, the project has advanced through three generations with the help of MIT graduate students and faculty, along with medical professionals.

The SurgiBox team stepped back from the classic paradigm that safe surgery requires a safe operating room and protection of everyone within it. Instead, they focused on what actually matters: the patient and providers.

They redesigned the "safe surgery" concept by shifting the focus of protection to the actual surgical field. The designers knew that there had to be a simple and inexpensive solution that could be easily incorporated into existing workflows.

The time from walking into the room to starting the surgery was shorter than the time it took for Suzanne Van Wijck (circled), a surgical research fellow at Massachusetts General Hospital, to "scrub in."

SurgiBox is working closely with humanitarian and military organizations that currently must provide field surgery without a sterile environment.

With SurgiBox, doctors and attendant scan reach the patient and surgical site through carefully sealed glove ports.

The entire SurgiBox set-up fits in a backpack!

- User seals sterile clear system to patient and operates via ports
- Setup and disposal fit into existing workflows
- Integrated environmental control system
- Fully self-contained; just open and use
- Reduced scrub gear requirements
- Excellent visual quality of the field to varying lighting conditions
- Reusable components

THE DESIGNERS

Co-developed by D-Lab, Massachusetts General Hospital, Beth Israel Deaconess Medical Center, and EPFL EssentialTech, SurgiBox is led by a team of seasoned physicians, engineers, global surgery experts, logisticians, and entrepreneurs under the direction of founder Debbie Lin Teodorescu.

Debbie Lin Teodorescu started Project SurgiBox while in medical school and is excited to take it to clinical impact. She is a Research Affiliate at MIT D-Lab and Clinical Fellow at Brown University (Lifespan Healthcare and VAMC-Providence).

The inaugural graduate of the joint MD/MEng program between Harvard Medical School and Boston University College of Engineering, she helped launch the Harvard Medical Makerspace Initiative and co-directed the CCC Cambridge free clinic for women and refugees. She also continues to see patients at Rhode Island Hospital's Refugee Clinic program. She has received awards including the AAAS Science and Human Rights Coalition Sessler Award, the AAUW Selected Professions Award, and the Gates Millennium Fellowship.

D-Lab's additional representation on the SurgiBox team has included D-Lab Faculty Director **Dan Frey,** graduate student **Sally Miller,** D-Lab alumnae **Maddie Hickman** and **Amna Magzoub**, and D-Lab Special Projects Coordinator **Dennis Nagle**.

"We work with D-Lab because our community members not only learn design skills, they become equal design partners on projects that matter and then design *leads* as they move projects forward and start others."

Thabiso Blak Mashaba
Founder & CEO, These Hands,
Botswana

Deep Sand Wheelchair

The terrain in D'Kar, Botswana, in the Kalahari Desert near the border of Namibia, discourages travel by wheelchair. Deep, loose sand—exhausting even to walk in—bakes in the sun and hides scattered thorns of every description, from thumbtack-size thistles with a single barb in the center to slim, fallen branches radiating dozens of hardened needles the length of a little finger. Yet people with disabilities live here, as they do everywhere human beings are found.

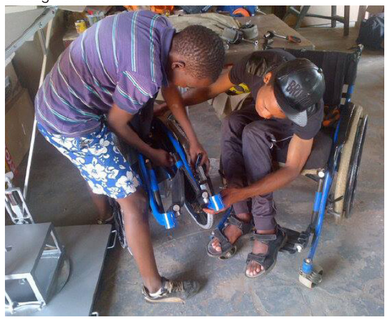
The idea for the Deep Sand Wheelchair got its start at IDDS Botswana in 2016. The summit was the second in the area collaborating with the San community, traditionally nomadic hunter-gatherers seeking to create new options for their survival and prosperity.

The team created a modular set of accessories that would transform a standard wheelchair into a device capable of crossing deep, thorn-filled sand. The device could be propelled efficiently and comfortably by family and friends, or independently by the rider, using components that could be sourced in major cities in Botswana.

While the team proved the value of the concept and set up a young team member, Keemenao Matale, to continue to work locally, the project was advanced in parallel in the D-Lab: Mobility class taught by Matt McCambridge and during subsequent D-Lab trips to D'Kar to support Keemenao's ongoing work.

Supported by IDDS, D-Lab, and local organization These Hands, GSSE, an international team in Botswana adapted an existing wheelchair by developing accessories such as wider wheels and hand cranks to drive the wheelchair more easily through the sand while maintaining the user's comfort level. The wheels are also more durable to protect from sharp stones or thorns buried in the sand.

Fitting a Deep Sand Wheelchair prototype with a smaller but thick front wheel, both for stabilization and to cut through the terrain.

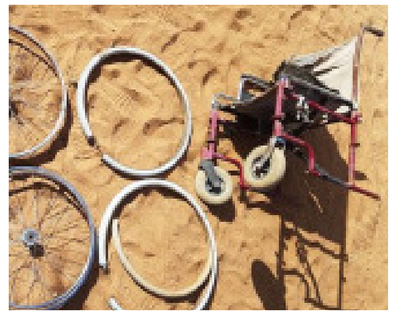


Community youth contributed to the design and build of Deep Sand Wheelchair prototypes along the way.

Parts of existing chairs were dismantled and re-assembled in early prototypes.

This Deep Sand Wheelchair prototype uses a unique handcrank to propel the chair.

Community members, IDDS participants, and D-Lab students all contributed ideas to the engineering.



An early Deep Sand Wheelchair prototype under construction.

DESIGNERS & COLLABORATORS

Team Huiku, IDDS Botswana, 2016.

Keemenao Matale, a 22-year-old from Moshupa Village in Botswana. An IDDS Botswana 2016 alumnus, he is an avid and passionate bicycle technology lover and follower, aspiring mechanical engineer, and wheelchair maker.

Matt McCambridge, the MIT instructor for the D-Lab: Mobility and Design courses who attended the IDDS where the Deep Sand Wheelchair got its start.

MIT D-Lab students from the Mobility and Design courses, who also traveled to Botswana to contribute to the design of the Deep Sand Wheelchair.

Disacare, longtime wheelchair builders and disability advocates in neighboring Zambia.

Deep Sand Wheelchair contributing designers Keemenao Matale (left) and Matt McCambridge (right)..

"The corn sheller is one of my favorite technologies to teach. In just one hour, a woman who has never held a hammer before in her life can make a tool that will save her 100 hours of labor each year. She thinks about herself differently after that."

Amy Smith
Founding Director, MIT D-Lab

Corn Sheller & Jig

Handmade, handheld corn sheller, El Salvador.

Corn Sheller & Jig

Existing alternatives to shelling maize by hand are often unaffordable or difficult to obtain for subsistence farmers. D-Lab teaches communities around the world to construct a simple handheld sheller from sheet metal, using a jig designed by D-Lab, and supports people in coming up with their own variations of the sheller.

In many rural areas of developing countries, maize kernels are removed from the cob by hand in a process called shelling. Shelling the annual maize harvest by hand typically takes weeks and may pull children out of school, since processing food for survival takes priority over education in subsistence farming households. The hardened, dry maize can also be painful to shell and lead to hand injuries.

The burden of shelling corn can be significantly reduced through the use of a simple-to-make hand tool. The sheet metal corn sheller was developed by a number of D-Lab staff members and community partners. The process requires only a hammer, pliers, and a tool to cut the sheet metal into the appropriate size to accommodate the local varieties of maize.

This method has been used in many countries, both to produce maize shellers and as part of Creative Capacity Building workshops in which participants not only learn to make this useful device, but also learn that they can adapt the sheller to their own needs. In some places, small manufacturing cooperatives have been formed to produce shellers and generate additional income.

Other communities may not have abundant sheet metal for making maize shellers, so D-Lab and its partners developed versions of the sheller made of different materials based on what is available in each region, including a rebar sheller, a sand-cast aluminum sheller, and a tin can sheller, all of which have the potential to save a family literally hundreds of hours of manual labor each year.

Making a handheld, sheet metal corn sheller using inexpensive materials and simple tools.

Shelling corn using an inexpensive hand-made sheller can be up to 13 times faster than using just your fingers.

Using a corn sheller can save a family hundreds of hours of manyal labor each year.

Testing three models of corn sheller: a welded sheller (in use), a molded plastic sheller, and a handmade sheet-metal D-Lab-style sheller.

Sheet-metal hand-held corn sheller.

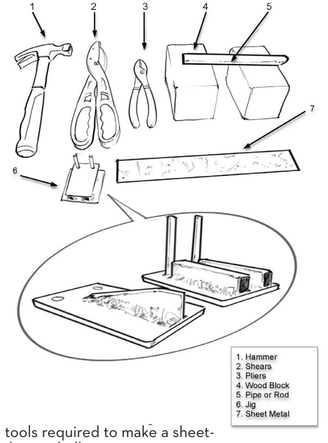
The D-Lab corn-sheller jig.

THE DESIGNERS

This device was developed by **Marco Villagarcia,** an engineer from Cuzco, Peru, based on an injection molded plastic corn sheller from Malawi.

The design was simplified by **Ralf Hotchkiss** of Whirlwind Wheelchair International and **Dennis Nagle** of D-Lab, who used a straight piece of sheet metal with tapered ridges to produce a similar surface.

A simple jig was developed by D-Lab founder **Amy Smith** and **Kofi Taha** (now D-Lab Associate Director) for making these shellers quickly and easily.



The tools required to make a sheet-metal corn sheller.

"Traditional designs have been proven through use over generations. Evaporative coolers are a great example. MIT D-Lab is working with communities to assess the value they provide, tweak designs for local needs, and help spread a great idea."

Eric Verploegen,
Research Engineer , MIT D-Lab

Evaporative Cooling

For fruit & vegetables

Evaporative Coolers for Fruits and Vegetables

The lack of affordable and effective post-harvest vegetable cooling and storage poses a significant challenge for smallholder farmers that can lead to vegetable spoilage, reduced income, and lost time.

Most techniques for cooling and storing vegetables rely on electricity, which is either unaffordable or not available for many smallholder farmers, especially those living in remote areas on less than $3 a day.

Evaporative cooling technologies hold great promise to address this challenge. Utilizing the natural cooling effect generated by the evaporation of water, these technologies can provide a cool and humid environment to prevent rot and dehydration.

Evaporative cooling devices are best suited for use in regions with a hot and dry climate, some access to water, a need for improved vegetable storage, limited or unaffordable access to electricity, and local access to the materials needed to construct evaporative cooling chambers (ECCs). These conditions are present throughout much of the arid Sahel region of Africa, stretching from Senegal to Eritrea, which has a population of over 150 million.

For individual or family use, a clay pot-in-pot design is a great choice. Commonly known as a "Zeer pot," this design was popularized in 1995 by Mohammed Bah Abba in Nigeria. But farmers and communities wishing to pool their resources may require something larger. In the early 1980s, Susanta K. Roy and D.S. Khuridiya developed larger capacity evaporative cooling chambers made primarily from brick – commonly known as "zero energy cool chambers" or "ZECCs" – for use by farmers in India. These chambers can store several metric tons of fruits and vegetables.

Attaching a sensor to a pot-in-pot evaporative cooler in Bamako, Mali. Photo: Ousmane Sanogo

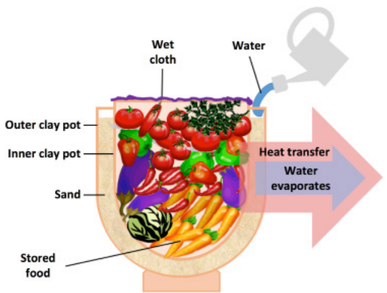


Diagram of a clay pot cooler with a pot-in-pot configuration, covered by a wet cloth.

A plastic pot in ceramic pot variation evaporative cooler (with temperature sensor), Rubona, Rwanda.

A completed brick Zero Energy Cooling Chamber in Gatisbo, Rwanda.

A brick Evaporative Cooling Chamber (with performance monitoring sensor attached), Rubona, Rwanda.

Adding water to an evaporative cooling chamber in Bamako. Mali.

THE TEAM

Eric Verploegen joined D-Lab in 2014 to expand D-Lab's research efforts in the off-grid energy sector. Currently his work focuses on evaporative cooling for vegetable preservation and additionally is a co-instructor for D-Lab's Energy classes. He is passionate about helping organizations based in off-grid regions identify technologies, products, and distribution strategies to increase energy access in their communities. He has a background in materials science and received his Ph.D. in Polymer Science and Technology from MIT in 2008.

Dr. Jane Ambuko is a senior lecturer and Head of Horticulture at Department of Plant Science and Crop Protection, University of Nairobi. She holds a B.Sc. Agriculture, M.Sc. Horticulture from University of Nairobi (Kenya) and a PhD in Agricultural Sciences (Pomology and Postharvest Major) from Tsukuba University (Japan). Her area of specialization is Postharvest Science and Technology.

Edoh Ognakossan Kukom joined the World Vegetable Center in 2017 as the Production and Postharvest Specialist for the USAID-funded Mali Horticulture Scaling Project. Edoh has more than seven years of experience in agricultural research working on postharvest management of staple crops. His research interests include participatory development, testing and transfer of innovations that focus on reducing losses and adding value along value chains of common staple foods.

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