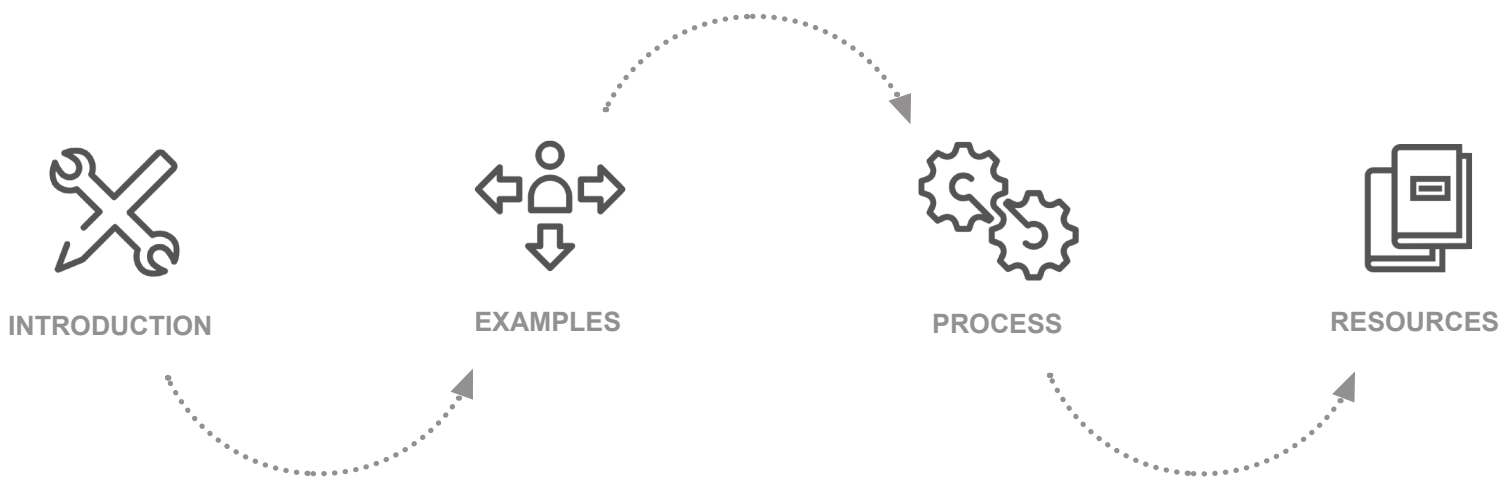
INTRODUCTION TO ENGINEERING FOR GLOBAL DEVELOPMENT

An introductory road map for technically trained people to achieving fit for service solutions for underserved communities.

These guidelines are not strict rules but are intended to act as a point of entry into working in global development.



Developed by Engineering for Change with Catapult Design
https://catapultdesign.org/
Catapult is a design firm that works with socially-oriented organizations to build and commercialize life-improving products and services for poor and underserved customers.

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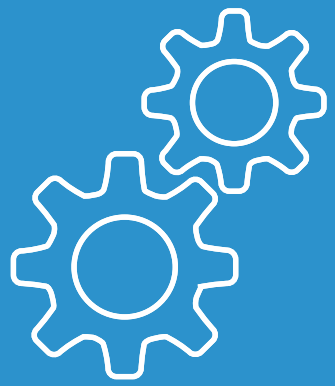
INTRODUCTION

Background and Definitions



ENGINEERING FOR GLOBAL DEVELOPMENT

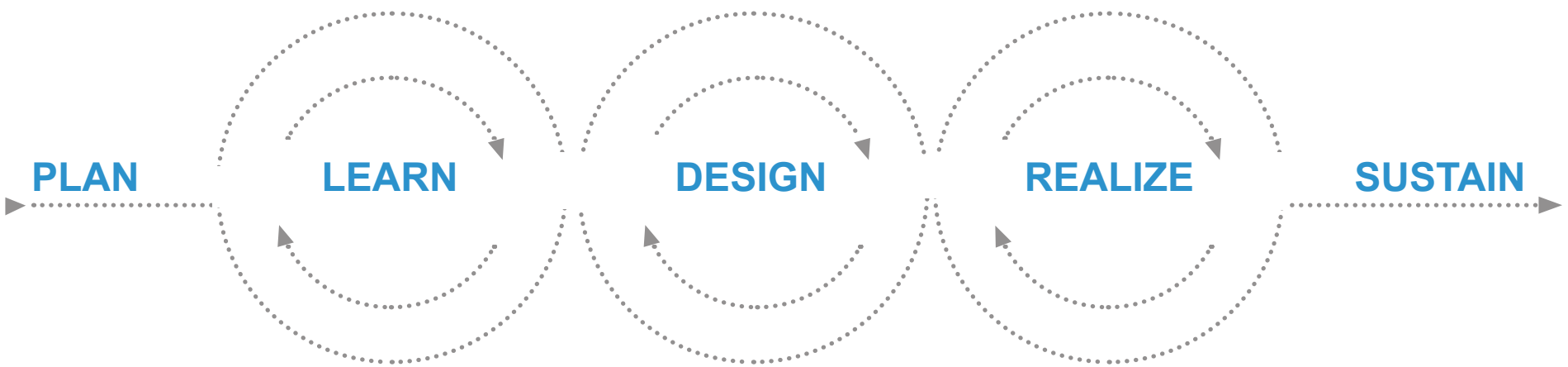
UNDERSERVED COMMUNITIES

FIT FOR SERVICE SOLUTIONS

ENGINEERING FOR GLOBAL DEVELOPMENT

Engineering for Global Development (EGD) is an interdisciplinary practice that aims to improve the quality of life of underserved communities worldwide through the design and delivery of technology-based solutions combined with building of local capacity.

EGD practitioners integrate their technical training with an understanding of economics and business, social science and politics to benefit people living in poverty. Pathways to EGD include volunteering, social entrepreneurship, commercial product and infrastructure development, to name a few. Other terms for EGD include Humanitarian Engineering, Engineering for Good, Development Engineering, etc...



UNDERSERVED COMMUNITIES

Communities in all parts of the world that lack access to basic products, services, education and health due to income inequality, remote geographic location, cultural discrimination, or some combination thereof.

Individuals in underserved communities face significant life challenges including lack of clean drinking water, food insecurity, inadequate health care, poor education, lack of sanitation, and short life expectancy. Despite these challenges and financial hardship, this market segment is discerning and aspirational in their purchasing decisions.

FIT FOR SERVICE SOLUTIONS

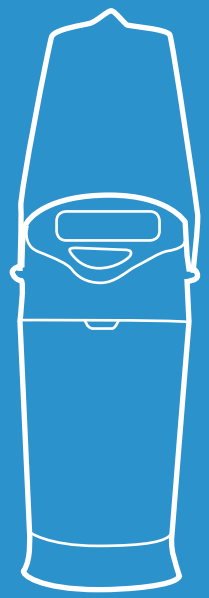
Demand-driven products and services demonstrating sustainability and impact within underserved communities.

Experts working in EGD characterize fit for service solutions as:

DESIRABLE	Demand-driven. Delivering on perceived value. Purchased by target users.
AFFORDABLE	Priced for target users. Considerate of financing. Available for direct purchase by customers.
SUITABLE	Appropriate for the context. Considerate of the user. Thoughtfully holistic.
EFFECTIVE	Solves a problem. Proven by testing. Achieves intended impact.
USABLE	Easy to use. Simple to maintain. Difficult to use incorrectly.
CONVENIENT	Serviceable locally. Accessible locally. Available supply chain.
VALID	Certified. Fits safety requirements. Reputable designer. 3rd Party recommended.
DURABLE	Quality controlled. Well-engineered. Sturdy. Hard to copy.
FEASIBLE	Thoughtfully distributed. Manufactured affordably.
ORIGINAL	Differentiates itself. Marketed creatively.

EXAMPLES

Fit for Service Solutions



D-LIGHT:
S20 SOLAR LANTERN

KICKSTART:
MONEYMAKER
HIP PUMP

COMING SOON

D-REV:
BRILLIANCE
PHOTOTHERAPY
DEVICE

d.light: S20 Solar Lantern

Designed by Sam Goldman & Ned Tozun

The d.light S20 is a solar-powered lantern with mobile-phone charging capability.

Distribution: 2,000,000+

Market Suggested Retail Price (MSRP): $10.10 US

Target user(s): Individuals living on less than $5 a day. Target regions include Rural India, Africa and China.

Heath Target: Alleviation of respiratory issues associated with kerosene fumes from traditional kerosene-powered lamps. Burns due to oil/gas lantern spilling.

See the E4C Solutions Library for full product details:
https://www.engineeringforchange.org/solutions/product/d-light-s20/

INTERVIEW

Ned Tozun
CEO & Founder of d.light

How did you achieve Fit for Service with your solution?

Our designers spent hundreds of hours in the field with customers and with several variations of prototypes in order to come up with a solution that delighted customers, was intuitive to use, and had the right trade-offs on costs vs specs.

What challenges did you face?

Hitting an affordable price point while at the same time maintaining a high quality standard was a challenge as affordability is key to getting solutions to scale and our customers live in tough environments that are hot, dusty and humid and demand rugged products. This required us having a team on the ground in China that worked very closely with our vendors and manufacturing partners to figure out how to optimize every penny in the cost and supply chain while maintaining a high quality standard.

What advice might you give for someone entering EGD?

Spend time in the field with customers and spend time with your manufacturers. Stay curious and continually ask “why”.

Kickstart: MoneyMaker Hip Pump

Designed by Kickstart International

The MoneyMaker Hip Pump is a portable, manually-operated pump. The design is based on a 'hand-pump' attached to a hinged platform allowing users to use their leg, body weight, and momentum.

Distribution: 45,739 have been sold. (July 2015)

Market Suggested Retail Price (MSRP): $50 USD (without hoses)

Target user(s): Small Scale/Smallholder Farmers

Heath Target: Small scale farmers are able to improve their health through increased food security and improved nutrition associated with improved yields.

See the E4C Solutions Library for full product details:
https://www.engineeringforchange.org/solutions/product/moneymaker-hip-pump/

INTERVIEW

Alan Spybey
Director, Product Intelligence and Development at KickStart International

How did you achieve Fit for Service with your solution?

The design evolved from a hunch built with a wooden base in 2000 into a series of prototypes, then into a salable product which launched in 2002. We spent large amounts of time interviewing users. This product turned out to have poor impact, telling us that ergonomics and reliability were not sufficiently addressed, so we pulled it off the market. The idea lay dormant for a year until the concept of the hinged base addressed ergonomics and brought the idea to life again. Several valve and cylinder designs were prototyped to address performance and cost and the Hip Pump hit the market in 2005. In 2015, after 45,000 sold, we are trying to cut the retail price in half with a new design taking advantage of CFD analytics and 3D printing for prototyping.

What challenges did you face?

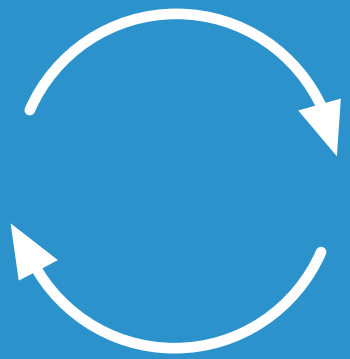
We strive for durability and easy maintenance, but we need the cost to be affordable and for the product to give good return on investment (in this case the increase in gross margin of the farmer's land, due to using the pump for one four month season, needs to give back the price of the pump). One of the biggest challenges was getting the pump to prime at only one and a half meters less than the physical atmospheric suction limit. One detail for example is the valve arrangement - they mustn't clog easily; they must seal effectively; there should be no small parts like bolts and nuts to get lost on the farm. This resulted in designing a valve which sealed on a surface which can never be seen, but can be visibly located. We wanted the high-quality sealing characteristics of stainless steel, so had to be frugal in other places without losing strength. We had to pay a great deal of attention to manufacturing and logistics. We designed all the tooling for Kenya manufacturing for the initial couple of years, then needed to visit China to set up manufacturing there when the distribution went Africa-wide.

What advice might you give for someone entering EGD?

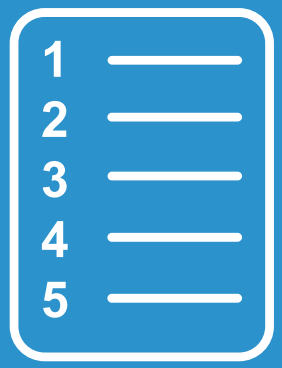
It's difficult to balance enthusiasm and loyalty to your idea, with the need to sometimes brutally and radically change it when users' needs don't align with the way the product is developing. It's even more difficult when different people in a team are focused on different parts, some of which are working out well, and some not. It's a challenge to manage egos: hard for someone to recognize that the idea they have cherished and tweaked and tried to bring into live several times actually needs axing for the sake of the user: a sunk thought cost. It's a cliché, but users are always right, because they're the ones who firstly make the decision to buy, and secondly have to live with that decision afterwards. As soon as an idea can crawl and be prototyped, take it to the field and learn from what happens. As soon as it can hang together for a few months, try to sell it (but promise to make good if things don't work out and keep that promise). That tells you if your idea is really worth something and also what to put right.

PROCESS

Creating Fit for Service Solutions



SOLUTIONS DEVELOPMENT PROCESS



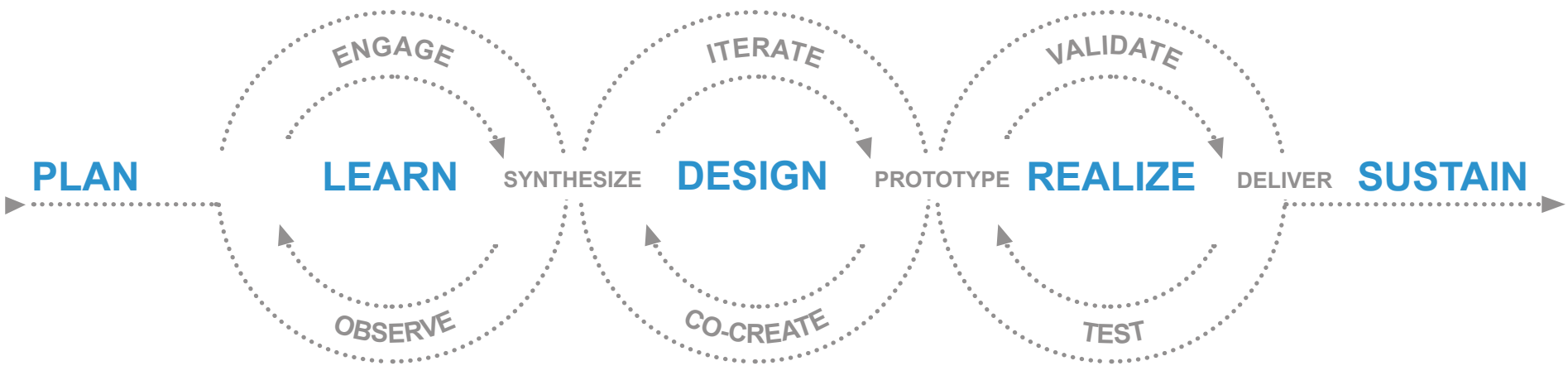
PHASES

SUMMARY

SOLUTION DEVELOPMENT PROCESS

Here's how we've mapped the path to fit for service solutions based on learnings from the field.

This process is non-linear, in the real world, lines between phases often blur.



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PLAN

Developing an intelligent strategy to achieve project goals & expectations, considerate of contextual realities and project constraints.

CONSIDER:

PROJECT SCOPE	Define the project boundary conditions and consider sustainability early. Consciously choose and implement a project management strategy, articulate everyone's responsibilities and hold all accountable.
CONTEXT	Get familiar with the project political, cultural and economic ecosystem. PESTLE analysis is a useful technique to get a bird's eye view.
FORECASTING	A good forecasting process leverages statistical techniques, but also acknowledges their limitations by integrating the organization's collective knowledge to obtain the best possible estimates.
PARTNERSHIPS	Identifying strategic partners and investing in relationship building can expedite learning, avoid pitfalls, and increase trust and access to end users.
BUDGETING	Write a detailed budget and be realistic about alignment to end goals. Value resources accurately and consider sustainability early.

Learn more about PESTLE and how to apply it here:
http://pestleanalysis.com/what-is-pestle-analysis/

PRO TIP Clearly defining a scope of work with the project team will assist by grounding the project expectations, assumptions and ideals with the realities of the context, budget and timeline.

LEARN

Uncovering obvious and unexpected knowledge, prior art, contextual nuances, and behaviors to form insights.

CONSIDER:

UNDERSTANDING STAKEHOLDERS	Map and profile the people involved in the development, distribution, and use of the solution. Consider end-users, customers, distributors, investors, manufacturers, etc. Be prepared to put aside your own cultural assumptions.
ENGAGING STAKEHOLDERS	Adequate, timely and effective consultation of relevant stakeholders is of paramount importance in the information gathering process. Choosing the right partners to trust can make or break a project.
CONTEXTUAL NUANCES	Research the specific social factors, environmental effects and economic barriers that could impact the design.
ALTERNATIVES ANALYSIS	A good competitive analysis not only produces usability metrics but also aids decision makers in their strategic goal-setting.
SYNTHESIZING	Use data modeling to visualize wisdom from the research phases to reveal opportunities and challenges.

Use Nesta's DIY Toolkit to help steer the to help steer research with worksheet templates.
diytoolkit.org/

PRO TIP Engineers are often at risk of becoming too hardware focused in their research. Design ethnography provides a framework for acquiring tacit information from stakeholders, which would not be obtained through commonly used methodologies in engineering design and market research.

DESIGN

Exploring insight driven solutions with stakeholders through iterative rounds of concepting, prototyping and testing.

CONSIDER:

OPENNESS	Remain open to review and input from many informed voices and search out uncharted territory.
ASSUMPTIONS	Look for inherent assumptions and challenge them; It is often within the “expected” that we can find opportunity to innovate.
VISUALIZING	Pictures are worth more than 1000 words. Use sketching and rendering to capture ideas, align comprehension and explore potential/initial response from stakeholders before investing time in prototyping.
PROTOTYPING	Make it and break it. Test as many concepts, parameters, and hunches as your budget allows prior to committing to piloting & manufacturing.
SAFETY	Codes and regulations exist to keep us all safe. Be cognizant and aligned with relevant local and international laws that relate to your solution during its design.
SIMPLICITY	Strive for as few parts/elements as possible and the least amount of mechanisms, and opt for cheap and strong materials to give your solution the best chance of survival.

Use IDEO’s HCD Toolkit to delve deeper into design methods and practices.
ideo.com/work/human-centered-design-toolkit/

PRO TIP The barrier that lies between well-intending engineers and fit for service solutions for the developing world is not engineering analysis. The barrier is in the design techniques. Leverage field-tested methods to achieve sustainable results.

Selecting the optimum solution and overseeing its production, piloting and distribution.

CONSIDER:

PILOTING Planning for pilots is usually overlooked; testing in-context with real users, or piloting, typically outweighs laboratory simulations.

ECONOMIES OF SCALE Centralized manufacturing can play a big part in making products affordable and their quality consistent. Mass production, more than any other phenomenon or idea, has increased global access to life improving products over the past century.

SUPPLY CHAIN Scope out existing and potential distribution channels for both the solution and its required spare parts.

DELIVERY How will the customer and user acquire the solution? Detail out the methods and required resources of distribution to ensure its feasibility.

LEGAL FRAMEWORK Make sure you consult local lawyers or law schools to help you to navigate any forecasted liability or establish intellectual property.

The Center for Advanced Studies offers a six-lesson course, "Intellectual Property for Engineers," that deals with patent applications, research and prosecution, the law of infringement, computer applications for software and hardware, as well as machines, processes, mixtures, manufacturing, compositions of materials, concepts, and methods of doing business. http://www.legalstudies.com/courses/IPLE.html

PRO TIP Be sure to vet your manufacturer and suppliers. Due diligence & logistics are hardly the most exciting aspects of the social innovation sphere, but in many ways they can be the most critical.

SUSTAIN

Ensuring responsible and scalable implementation through increasing access, providing user support, and evolving the solution.

CONSIDER:

:

MARKETING Marketing is about appealing to your customer's inherently emotional needs for safety, esteem, and actualization. Don't underestimate its value or expense.

CUSTOMER SERVICE Well curated after-sale service and parts and maintenance access will help build a strong relationship with customers.

OPERATIONS A solution needs a strong, suitable team and a healthy culture of organization to continue delivery and development.

MONITORING AND EVALUATION Data from the analysis of solution effectiveness will guide future decision making and design iterations, as well as validate or negate the solution.

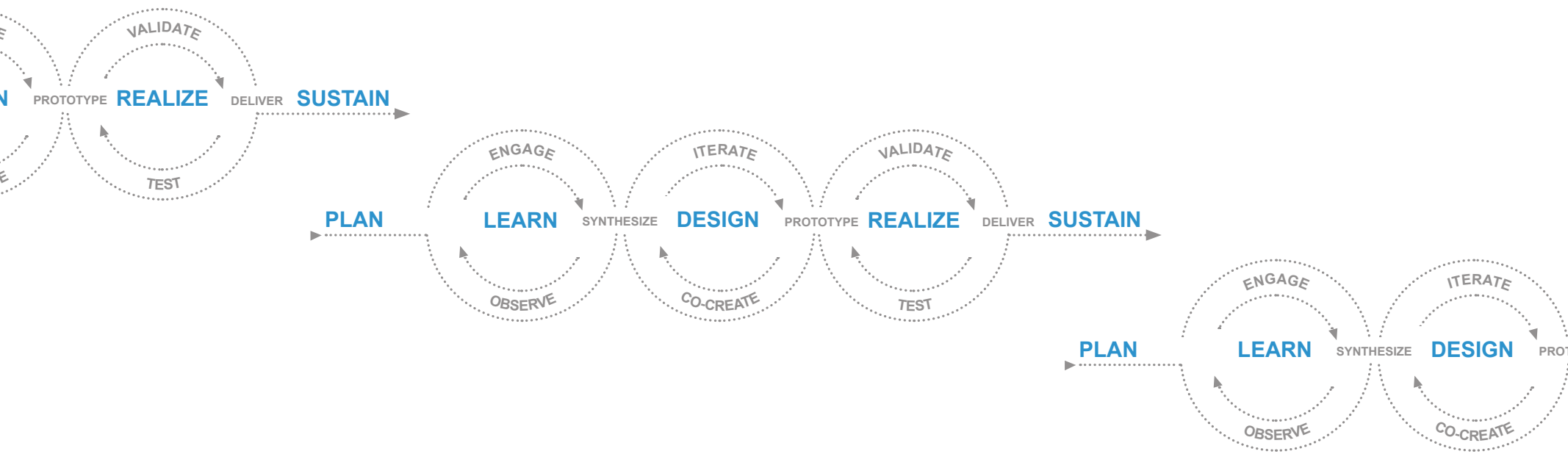
Case studies are a useful way to learn about sustainability approaches.
Check out DEMAND - ASME Global Development Review: go.asme.org/demand

PRO TIP Maintenance schedules (for long lasting products) and end-of life indicators (for consumables) are critically important, so that people know when a product should be serviced or discarded. Including product knowledge with every product sold has been documented to be a great way for designers and engineers to implement their products sustainably.

SUMMARY

There are a wealth of initiatives throughout the world focused on increasing access to food and clean water, effective sanitation, energy, housing and other basic needs of underserved communities. Solutions in these contexts can fail due to lack of base knowledge and access to information. As the number of products being developed and deployed increases, so does the need for engineering skills and rigor. In addition, solutions and processes will continually need improvement.

Following our **SOLUTIONS DEVELOPMENT PROCESS** does not guarantee success but it does provide a helpful guiding framework. Whether you follow this process or any other, be conscious of your approach, and considerate of the people you are working for.



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RESOURCES

Moving Forward

PATHWAYS TO EGD

REFERENCES

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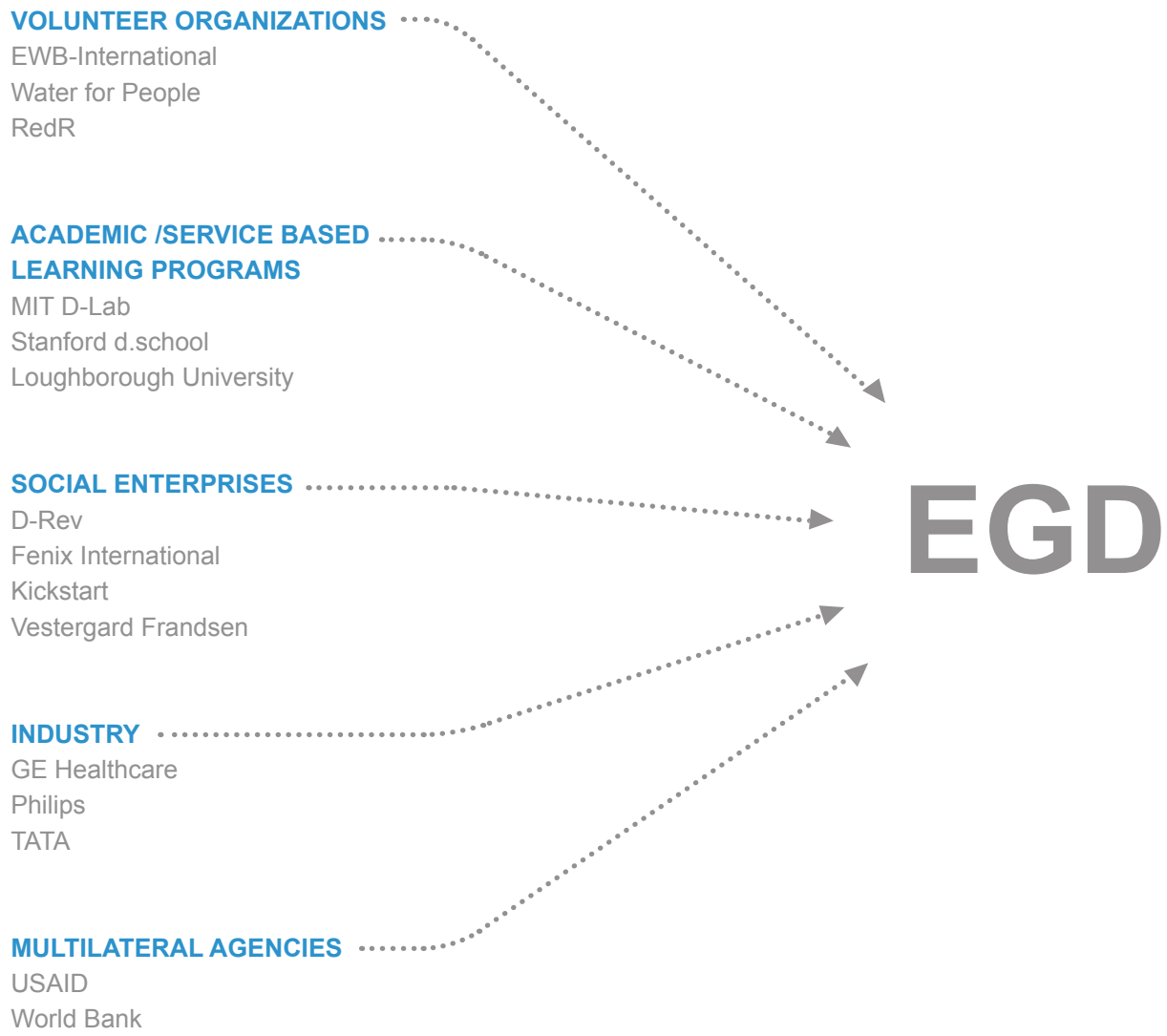
PATHWAYS TO EGD



REFERENCES

DEMAND ASME Global Development Review
A unique publication launched to help meet the needs of individuals and organizations working at the intersection of technology and global development. DEMAND showcases a mix of case studies, stories and original reports representing the diverse challenges and solutions emerging in the space.
http://www.asme.org/network/media/demand

Demand-Driven Innovation
Whitepaper addressing the translation of business practices applied to international development, so that poor customers worldwide can get better products and services.
http://demand-driven.net/

Frog's Collective Action Toolkit
Part of frog's commitment to social impact, CAT is a set of activities and methods to enable groups of people anywhere to organize, collaborate, and create solutions for problems impacting their community.
http://www.frogdesign.com/work/frog-collective-action-toolkit.html

IDEO Design for Social Impact Guide and Workbook.
Commissioned by The Rockefeller Foundation, this guide based on interviews with designers involved in social sector work in 2008 explores how design firms can work differently to bring a social impact perspective into their work.
http://www.ideo.com/work/design-for-social-impact-workbook-and-toolkit

IDEO Human Centered Design Toolkit
Commissioned by the Bill and Melina Gates Foundation is aimed at social enterprises and NGOs around the world. It is one of the most widely cited and linked social design resources. http://www.ideo.com/work/human-centered-design-toolkit/IDEO Design for Social Impact guide and workbook.
http://www.ideo.com/work/human-centered-design-toolkit/

Impact Design Hub
An online resource for architects, designers, makers, and others committed to designing a better world. The Impact Design Hub aims to bring together those working in public interest, social impact, humanitarian, and community design, and provide a platform for sharing and communication in order to collectively help grow and mature this field.
https://impactdesignhub.org/

Nesta's DIY Toolkit
How to invent, adopt or adapt ideas that can deliver better results. It's quick to use, simple to apply, and designed to help busy people working in development.
http://diytoolkit.org/

Unicef's Principles for Innovation and Technology in Development
These principles are not intended as hard and fast rules but meant as best-practice guidelines to inform the design of technology enabled development programs.
http://www.unicef.org/innovation/innovation_73239.html

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E4C

E4C's mission is to improve the lives of underserved communities by better preparing the global development workforce, optimizing the solutions development cycle, and ensuring public health and safety.

E4C's resources include:

NEWS AND INSIGHTS

E4C News focuses on deserving issues in the field of technology for global development, and adds informed opinion about current events, poorly understood situations and anything that matters.

Insights are provided by a talented network of contributing editors who are leaders in their fields and include funders, CEOs, professors, entrepreneurs, inventors and others.

http://www.engineeringforchange.org/what-we-do/news-and-insights/

PROFESSIONAL DEVELOPMENT

Stay ahead of the curve with E4C's Professional Development resources. From webinars with practitioners sharing insights from the field to compendiums of trusted programs, tools and more. You'll find everything you need to help you evolve as a development engineering practitioner.

http://www.engineeringforchange.org/what-we-do/professional-development/

SOLUTIONS LIBRARY

The E4C Solutions Library is a living database of products and services that are accessible and appropriate for those living in poverty. The curated data in the Solutions Library includes technical and market performance information that is normalized, enabling side-by-side comparison and analysis of market influences.

http://solutions.engineeringforchange.org

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