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Barefoot Engineers: Cases of Simple Tech Innovations from the Bottom-Up

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ABSTRACT:
This article reports on several low tech solutions designed and applied in rural Third World settings in which U.S. university students developed various simple prototype projects in social entrepreneurship courses that were designed, tested, refined and then implemented by students NGO teams as they spread across the world to build capacity and empower impoverished villagers in recent years. The settings include Guatemala, India, Haiti, Thailand, Ghana, and Honduras.
Keywords: Socio-Technology, Appropriate Technology, Social Entrepreneurship, NGOs, International Development, Grassroots Innovation

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I. INTRODUCTION

The great Mahatma Gandhi once said, "You must be the change you wish to see in the world." We examine several innovative start-ups using simple, low cost engineering methods to invent, produce and sell solutions to enhance village life in various parts of the globe so as to improve the quality of life among struggling families, especially women and children. The academic settings in which these innovations were created are described by summarizing course designs, teaching methods, and the mix of students on campus. Then we turn to their specific inventions and how such technologies were developed. Finally, the processes used and the resulting outcomes are briefly highlighted, as well as ongoing outcomes reported over the years.

The Academic Context

My career has been that of an academic activist, a social innovator, disruptor, change agent, renegade, catalyst, mover and shaker. I've always sought to work with students, faculty colleagues, and researchers in doing applied work that empowers workers with organizational democracy tools, and to also utilize our academic efforts to reduce human suffering. My professional and personal questions center on how we may tap into concepts theories, and the application of management science to serve the interests and needs of the global poor.

Thus, the context for this paper is related to my work as a Professor of Organizational Behavior in the Marriott School of Business (2020), Brigham Young University (2020), in Provo, Utah, a western state of the USA. I've invented and taught new courses on Microfinance, Social Entrepreneurship, Appropriate Technology as well as other more traditional courses such as Leadership, Management Consulting, Teamwork, and Organizational Development. a variety of social enterprises emerging from my action research courses over some 40 years (Smith and Woodworth, 2012). The first start-up emerged in my little microfinance course. It was the first of its kind taught in the United States in 1988, and the concept of providing tiny microloans so poor women could start their own microenterprise was a radical new idea. The course began with a small group of students I recruited for gathering data on poverty and unemployment in the Philippines, and we then collaborated with Filipino managers and academics, to plan and roll out a microcredit nonprofit in that country. In spite of criticisms from academic colleagues, deans and other campus administrators, our little start-up survived, growing to have some 600 employees operating a dozen offices throughout the Philippines, as well as Peru, Mexico, Guatemala, and El Salvador. Thus far, we have raised some $141 million, trained, mentored and given microloans to over a million microentrepreneurs, creating hundreds of thousands of new jobs through self-employed microenterprises that have benefitted some five million Filipinos. Our success over 30 years has helped me learn that we as academics can change the world, not just teach theoretical courses, do research and publish.

Then there is the case of an NGO launched from my social entrepreneurship course in 1999that has operated in 17 nations from Fiji to Tanzania in which some 3,200 university students from 15 or so schools across the United States have been implementing programs such as appropriate technology, social entrepreneurship, sustainable development, literacy and computer skills, microentrepreneurship training, and so forth. I recruited management students from MBA and MPA programs, engineering students from across campus, computer and other tech students and we began sharing tools and methods to empower rural people across the globe.

A third example is of local college students and me using the university as an incubator to recruit, train, mentor and give $500 microloans to Latino immigrants in our local valley of the United States where the school is located starting in 2003. Going stronger today with financing from banks and credit unions, this experiment has convinced me that we can generate changemakers and empower poor refugees and migrants locally, as well as globally.

Finally, I mention a major microfinance institution (MFI) accelerator which I co-founded with students, engineers and successful entrepreneurs that I served as the first board chair, showing how like-minded people can come together, share how their best practices, and be integrated in assisting small MFIs around the world to rapidly scale up with our financial backing. We learned how to be laser-focused, bring together a mix of management competencies with young students' energies, and become a major player around the world in scaling up the global field of microfinance. Over 15 years, we garnered loan capital for some 20 MFIs which totaled over $1.2 billion in loans and investments in Africa, Latin America, and Asia. With the financing we did, these once small MFIs rapidly ramped up from their early years when they had a total of less than 300,000 clients, today they have an astounding 40 million borrowers.

Major concepts and themes about these interventions, their founders, and a few key books include the following literature: E.F. Schumacher and the Intermediate Technology Development Group (ITDG) he founded in the UK, along with his classic*Small Is Beautiful: A Study of Economics As If People Mattered*(1973*)* and subsequent volumes. From Latin America, the little volume, *Tools for Conviviality* by Ivan Illich about the proper use of technology (1973) was useful. It was published only two years after Illich's other classic, *Deschooling Society*. In the United States a more free market-centric view emerged, founded by Paul Polak of the NGO, International Development Enterprises titled*Out of Poverty: What Works When Traditional Approaches Fail*(2008). Other key groups consist of America's Engineers Without Borders and the IEEE (Institute of Electrical and Electronics Engineers) have begun cooperating to produce Engineering for Change, that supports the development of affordable, locally appropriate and sustainable solutions to the most pressing humanitarian challenges.

So with these quick introductions to our efforts and early sources of inspiration, let us turn to highlight a few practical examples of hands-on engineering with NGO and innovative financing strategies designed and rolled out from our classroom to the global poor. It should be emphasized that most of these efforts are designed to not just provide new engineering methods for efficiency, but also to create jobs and devices to enhance production and reduce global suffering. Two centuries ago some 90 percent of the world lived in abject poverty. While the picture is improving, too many people still struggle to make ends meet. Today's gap between rich and poor is enormous. In 1800, the ratio between haves and have-nots was roughly 4:1. Today, for instance, the gap between Switzerland and Mozambique is roughly 400:1. These innovations seek to change this reality in many nations.

H2O For Humanity: Clean Water in India

In 2009, several engineering students were taking my course, ("OB: 682: How to Change the World") when a BYU alumnus, Kevin Cluff came to Utah from the Chicago corporation where he worked and informed me about his dream to begin providing clean drinking water to areas of India where children were dying because of contaminated water. He, his engineering brother and their father in Texas, were all successful researchers at various firms, but wanted to invent new solutions for the masses in the hot regions of India. They decided to stop talking about social change and do something. Several graduate engineering students in my course were enlisted to help achieve this as their required course project for the semester. With water purification technology developed by the father, Dr. Brent Cluff, the group created a new organization, "H2O for Humanity."

Why water? There are some 800 million children, women, and men in developing countries who get their drinking water from unsafe sources. They suffer from more than a billion episodes of gastroenteritis annually due to poor water quality. Approximately 1.7 million human beings die every year from water borne illnesses, including 5,000 children per day who tragically die from diarrhea. Within India itself, some 38 million

people annually get sick from contaminated water and over 450 Indian children die each day from this sad reality. So the Cluff brothers, both trained engineers, decided to take action.

To do this, they decided to establish H2) as a"social business" which is a relatively new business entity according to U.S. law. Itis a hybrid organization using business techniques and solutions, but without seeking profits as most American companies do. Within this model, the owners participate primarily for social reasons and may only be reimbursed for expenses and compensated time, not for business profits. Instead, the financial returns are plowed back in to the company so as to develop further technologies and other new products, having the required capital to create more engineering innovations and further grow the business. Dr. Muhammad Yunus, Nobel Peace Prize Laureate in 2006 and founder of the Grameen Bank in Bangladesh coined this concept. This author's partner in other NGO ventures, Yunus established the term in a post-Nobel book by that name,*Building Social Business: The New Kind of Capitalism That Serves Humanity's Most Pressing Needs*(2010) which offers avision of the ideal social business.

Instead of maximizing profits, the financial returns are plowed back in to the company so as to develop further technologies and other new products, havingthe required capital to create more engineering innovationsand further grow the business. Technically and speaking per legal regulations, H2O is thus incorporated as an L3C firm (Low-Profit Limited Liability Company). L3Cs are a new form of business entity in only some U.S. states which operate as hybrids between a non-profit and a for-profit organization. L3Cs have been structured to take loans and equity investments from U.S. non-profit foundations. By providing a financial return, the company can become a sustainable business which strives for the social good.Initially funded with personal savings, a home refinancing, and a seed grant from the Deshpande Foundation in America, Kevin and Eric Cluff launched H2O for Humanity in five villages in Karnataka, India, and a sustainable social business was born.

The engineering model the firm uses is reverse osmosis technology to tailor the system to the local water quality. The water is softened and harmful bacteria and excess fluoride is removed making healthy, tasty water. H2O hires and trains an all-Indian staff who understand the local culture and values of rural communities. It creates partnerships with Non-government Organizations (NGOs) and establishes operations to also provide jobs and minimize capital requirements. The business is sustainable through a tiny 0.2 cent per liter charge to the water customers – affordable by the poorest households. These funds are then used to capitalize and maintain the installations.

In 2010 the Americans launched H2O to 13,000 customers in five villages within the state of Karnataka, India. Early on, H2O partnered with the Shri Kshethra Dharmasthala Rural Development Project**,** popularly known as SKDRDP (2019)**,** a charitable trust. SKDRDP concentrates on the empowerment of people by organizing Self-help Groups (SHGs) on the lines of Joint Liability Groups (JLGs) and provides infrastructure and finance through microcredit for rural people. SKDRDP takesH2O's water purification strategy to increasingly larger areas where the need is great.

The business model is rolled out as follows: The NGO partner or a village finances and builds an water store. It serves as a convenient location where villagers can collect their daily water. H2O for Humanity provides the equipment, technical support and expertise for a small monthly charge and no up-front capital costs. Customers bring their 20 liter containers and fill them at the store. Production water is tested for Total Dissolved Solids (TDS) three times daily to assure the system is working properly. H2O for Humanity technicians replace the pre-filters and wash the membranes regularly. They also test the water for other key parameters.

Within India, the firm began using the name "AquaSafi" to designate its brand and water stores to dozens of villages. They continue to expand clean water possibilities into as many villages as possible. SKDRDP is involved in many additional sustainable development projects across India. By 2014 they grew to over 70 water systems serving more than 20,000 families throughout western India.

Depending on the village size and available electrical power, three sizes of AquaSafi Water Systems may be installed. For example, the AquaSafi-200 can typically purify 1300 liters per hour. Village employees are trained to operate and perform daily maintenance on the system. The footprint is less than 250 cm2 making it easy to transport and install.

The operational systems use only top quality membranes and filters from a leading manufacturer. Many systems have been sold commercially and so far, customers have been pleased with their high reliability and performance. Recent advances in SMS-based technology have allowed H2O to remotely monitor its water purification systems. By providing real time updates regarding water usage, contamination levels, and system diagnostics, this new technology allows the

social business to collect useful data and monitor equipment in remote locations.

The latest evolution of the business model is that AquaSafi sells equipment to a local NGO which then owns the store or gifts it to a village. Then it is installed and maintained by the local organization along with H2O ongoing support. The NGO goes on to staff and manage the store. In many instances, villages provides the store or building and by providing the water source, the village leaders have a direct incentive to make the enterprise successful.

To summarize the enablers that allow H2O to achieve success as an innovative engineering enterprise, it needs to be noted that there are several factors operating: a) A large untapped market that is well understood, knowing such facts as that less than 3 percent of people in the region have affordable, safe drinking water; b) This allows H2O/AquaSafi to cluster operations and select villages, targeting appropriate communities based on their needs; c) Benefits accrue such as lower cost operations due to lean design, local manufacturing and remote maintenance; d) Driving down costs enables direct model and revenue sharing; e) Revenue sharing strengthens relationships with H2O partner villages; f) Machine operation and water distribution will keep building barriers against any future competitors who may try to enter the region.

Of course, there are still challenges including the fact that H2O's financial debt for more equipment has grown to approximately $1.9 million. But it is assumed this can be reduced as more customers emerge. From its small start-up in 2010-11 in just two villages with 3,400 people, over half a million people are being served today. Cumulatively, approximately two million Indians have benefitted from access to clean, good-tasting, inexpensive water for their pleasure and more importantly, for their health.

Over the past several years, AquaSafi units have served on average 300 households with 1200 - 1500 individuals in steady state. This means increasingly morevillages served while reducing a family's cost for healthcare since some 70 percent of diseases are water borne. In terms of economics, it creates entrepreneurs and local employment for operators. Then there are the jobs of servicing, maintenance, and operating each unit using strong processes and a good training program. Additionally, there is the work of daily online performance monitoring of water quality (TDS), unit performance (pressure, product, reject), flow volume, and tracking the number of customers. All offer decent jobs in communities where work is scarce and wages are low. AquaSafi promises a better future for its employee families.

In terms of business strategy, today in many areas of the state of Karnataka there is currently a 30-35 percent market penetrationby H2O now operating with hundreds of thousands of impoverished customers served daily. There were over 210 stores serving customers in 2017, but the number increased to over 500 last year(2019) and expansion continuesincrease in order to serve more Indians. Plans are now in the works for H2O to expand resources for clean water to other parts of the world. The business has already launched in Mexico with a few beginning stores offering clean water.Africa is next on the horizon, and the plan is to go beyond.

Other Engineering and Appropriate Technology Cases

With the detailed H2O clean water campaign described above, we turn to briefly highlight additional engineering examples in which BYU students taking the author's "How to Change the World" course designed other innovative start-ups. Several are high tech, some are based on agricultural innovations, as well as other technologies. In each case, students researched possibilities, debated with each other on their team, and then put together a project that could be experimented with during the summer, and then taken to the Third World the following summer to be rolled out in behalf of struggling village families, usually in rural regions of either Asia, Latin America, or Africa. They often sought advice and feedback from faculty of BYU's College of Engineering, as well as at times seeking input from professors in the Accounting School or the Kennedy Center for International Studies.

Kenyan Interventions: Affordable Housing, Lumber Mill and Coconut Oil

Appropriate technologies in Kenya were developed through the Asante Foundation which was launched by my graduate students in collaboration with local engineers and executives of the first synthetic diamond maker in the USA. With an entrepreneur's money, students helped establish this social venture fund that invests financial and managerial support in social business start-ups in Kenya. The mission was to combat poverty through enterprise. The core belief was that creating sustainable businesses that employ, serve, and empower Kenyans is the most effective tool in combating poverty. Among its projects: A revolutionary, affordable housing project designed to make housing, clean water and electricity accessible to rural Kenyans within a safe walking community in villages outside Mombasa, filling a real need in a nation in which some 50 percent of

families live in squalor because they attempt to survive below the national poverty line; Serving 26,000 rural Kenyan women entrepreneurs with capital to start and grow their microbusinesses through an NGO, Yehu Microfinance that employees 65 workers and enjoys a 96 percent payback rate; Bringing in U.S. engineers and students to create an organic coconut oil mill designed to create employment for both farmers that harvest coconuts and employees who process the coconuts and press the meat into edible oils for export. Coast Coconut Farmshas grown to employ 40 Kenyans and provide livelihoods for 200 farmers.

Asante continues to spin-off additional promising new ventures to organizations capable of growing and scaling businesses andincubatesmore innovative agricultural, housing, energy and water businesses in Kenya. Among the latest are aquaponics sustainable fish farms to create better rural jobs and provide plentiful fish so people have more protein in their daily diets. A central theme of this engineering effort? For this project, the old adage "Give a man a fish" was rephrased: "Teach a woman to fish and she will sell the produce and have food for her children during a lifetime." Also, Asante has begun eucalyptus tree farms to assist hundreds of rural farmers who were living on empty lands with rich soil. Why? Africa has a multi-billion dollar demand for wood products along with dwindling supply and inefficient value-chains that have kept the industry in failure.Why Eucalyptus? Because it's fast-growing with straight trunks. It's also drought-resistant and pest-resistant with high timber yields and is highly profitable. Furthermore, eucalyptus stumps can regrow repeat harvests providing decades of income and the economics of this venture so far are very strong. Thus, a new lumber mill has been built and is already a supplier of valuable lumber produced with high tech Chinese manufacturing equipment. Not only is the lumber being shipped to other parts of Africa and Europe, but the scrap from leftover pieces of wood is utilized for another business, that of producing briquettes for mass consumption in the region that are needed for clean cooking and heating.

Guatemalan Lorena Adobe Stove Projects

An instance of a hands-on intervention using simple, low cost technology is that which emerged from a Marriott School initiative called HELP International (HELP, 2018) that grew from the author's microfinance course back in 1999 and continues growing today. It is an innovative example of utilizing engineering and social sciencestudent volunteers, local entrepreneurs, alumni, and faculty in mobilizing collective efforts to serve the poor in Latin America. HELP began in response to the terrible destruction of Hurricane Mitch in Central America and has led to more than three thousand students from over 30 universities doing in-depth summer volunteer service to countries around the world.

The case herein occurred when several young women took HELP's training before departing to spend a summer laboring in Guatemala. They especially wanted to empower indigenous women in rural regions so they were given extra training in Lorena adobe stove building (called *estufas*in Spanish). The technology utilizes compacted earth or adobe rammed tightly together, and a simple chimney is made from soldered empty tin cans to channel the smoke from the residence. Once on the ground in Central America, one of the women students in particular became completely enthralled with the simple appropriate technology and became the team's "stove queen" or leader (*La Reina de las Estufas*) on the project in Guatemala by making and also teaching Mayan villagers how to construct their ownlow tech adobe stoves. Why was this so critical? Because peasant mothers typically do the family cooking in an open pit in the middle of their simple shacks and shanties. The thatch roof might have a hole cut to supposedly allow some smoke from the fire to escape, but generally it is minimal. Instead, she and family members are victims of thick smoke trapped in the enclosed space as well as in the outside air engulfing the community environment. The health results are tragic as the smoke and tint particles would get in family members' eyes, nostrils and eyes. From such conditions, individuals grew blind at a young age, lung and other cancers were prevalent, and the death rate was awful. Some Three billion people suffer these problems leading to heart and lung disease. Smoke inhalation is a significant cause of death in children, Kids who remain alive spend hours each day scrounging for logs and other wood sources with which to heat homes or cook food, thereby missing educational experiences (National Geographic, 2017).

So armed with simple engineering plans and medical knowledge to educate villagers, the HELP group began to changes the culture with new insights for a better future. The "Queen" managed the team because of both her leadership skills and technical expertise. She managed the stove building calendar, working closely with the local NGO leaders who arranged with the indigenous communities for stove building activities. With a group of 6 to 20 of her colleagues she would go to a village, working with the men and women of the village, teaching them how to make low cost adobe

stoves by building one or more stoves with them. At the start, the volunteers built 14 stoves. Then the villagers went on to build more than 140 stoves that summer benefitting some 500-plus people. Later, under her leadership, the volunteer teams moved on to another community, building about 45 stoves. The villagers there built over 400 stoves. As the summer wore on, stove-building requests increased and came from new sources as word of mouth spread about the benefits of stoves and the availability of training on how to build and use them.

Key elements of this NGO strategy included the following: Mastering the technical knowledge necessary to design and execute the project; Partnering with NGO leaders and staff to create a series of small but complex projects; Sustaining enthusiasm and commitment over a long period of time; Building relationships with NGO leaders and staff, village leaders, mothers and children; Doing ongoing, persistent, constructive coordination with NGO partners; Exercising initiative, creativity, and project management; Influencing without authoritarian behaviors; Using participation to build commitment and ownership; Extending the project's scope; Using temporary project teams with shifting membership and roles as HELP volunteers came and went; Demonstrating openness to reflective thinking and feedback through the use of After Action Review, an action research and action learning technique; Demonstrating innovation, flexibility, and adaptability.

The result of this work was much improved health for impoverished Mayan families who came to understand the benefits of new technology. On the part of the U.S. students, there was an amazing sense of fulfillment in knowing that hard work and simple solutions could improve the world.

Water Systems in Post-Earthquake Haiti: In 2010 a terrible earthquake destroyed much of Haiti resulting in 20,000 dead, 20,000 missing and a million homeless as the quake flattened or mostly destroyed nearly all buildings in the island nation. My microfinance class at BYU responded to my invitation for those willing to help and we launched a small project we called "Sustain Haiti." Throughout the semester interest kept growing with students from across campus hearing about our plans and joining the cause in weekly meetings, even when not earning academic credit. The project took off in the spring of 2010 and is still function today in 2020 as an NGO. The dozens who volunteered in Haiti that first summer engaged in many things including rebuilding orphanages and people's homes, training Haitians in microenterprise creation and offering microloans, doing entrepreneurship training, and much more. One of the engineering projects was helping develop a simple water system for getting clean water through new pipes we bought so thousands could have water to drink, cook with, bathe their children with, and so on. Not being water experts the team of student volunteers considered several options for doing this: 1) Go it alone; 2) Partner with another NGO such as Potters for Peace located in the neighboring country that shares the same island, the Dominican Republic; 3)Design a new filter system for channeling pure water beginning in Leogane which was the epicenter of the earthquake, as well as similar water systems for nearby towns like Jacmel. Ultimately it was decided to buy PVC and engineer a new water system from area wells that would shoot clean water through makeshift pipes to the many tent camps where Haitian refugees were trying to survive until major aid from the World Bank, USAID, the United Nations, and other organizations could ramp up with big sums of money and professional water engineers could design and build an entire new system. Sustain Haiti's humble little efforts providing yeoman efforts through the first two years of the nation's recovery. Additional outcomes occurred both for factory workers and the supply chain of materials needed. Over that time period these student efforts were a source for thousands of families to have clean drinking water, less disease and death.

Brief Highlights of More Applied Projects

The following paragraphs briefly summarize various other NGO interventions that used basic technology and business acumen to enhance Third World lives.

Thailand Wave of Hope:Following the tragic Asian tsunami, some 90 students in another social enterprise course of this author joined together to mount a rescue effort by assisting to rebuild villages in the coastal area of Khao Lak in the Pang-Na province of Thailand over a five month period. Rather than the destructive waves that wreaked havoc in the region, they called their new NGO, Wave of Hope, signifying a more optimistic future. Volunteers gave thousands of hours of service to many different projects, and also worked with others from around the world. Many spent their days in the hot sun on house rebuilding efforts. They worked in the villages of Tap-Tawan and Lam Pom preparing and pouring foundations, laying rebar, raising walls, building roofs and applying plaster finishes. In all they helped in the construction of over fifty houses. A team dug trenches and laid the pipes for a whole new water system to channel clean water into homes for the first time ever. Theybuilt a workshop with new equipment for wood working, and more. It was

named "Thaikea," combining the terms Thailand where the team was serving, along with the big Swedish company, Ikea. They helped build dozens of simple wooden homes to replace those destroyed by tsunami. They taught local women how to design and make their own simple furniture, constructing and painting bookshelves, chairs, and play sets for schools, and homes. Other volunteers helped worked on boats built for fishermen who lost theirs in the tsunami by applying the waterproofing caulk and painting the boats, as well as securing necessary capital to purchase some 40 motors so livelihoods could return to normal, in fact, to be even better. Also, volunteers taught English in the schools, and to adults who wanted to learn. An early analysis of the start-up of this project can be read at Woodworth (2008).

Equitech Cooperative:Within the BYU College of Engineering a colleagues and I mobilized business and technology students to design a worker-owned manufacturing cooperative called the Equitech Co-op to learn design, how to do graphic arts, make molds and learn other skills by running our nonprofit firm to produce brass and other medallions and plaques or sale, thus creating not only new skill sets for our students from Peru, Brazil and Argentina, but to generate employment while they not only learned technology skills but also leadership, marketing, decision-making, accounting, and more.

Peruvian Greenhouse Design and Construction:From an NGO launched in the author's Master of Public Administration, a small program was conceived by students called Chasqui Humanitarian that prepared to assist in building huge log and rocky greenhouses up in the Urubamba mountain range of the Peruvian Andes where we worked as volunteers in villages such as Patancancha, 14,000 feet high, so as to double the growing season for descendants of the ancient Inca civilization. In addition, teams of Utah computer experts raised the necessary funding to take numerous laptops and other tech devices to rural communities where they linked villages to government power grids and achieved internet connections to open up the region to new sources of information, including weather forecasts, agricultural services, educational programs on the web, and later, mobile phone access.

Mali Rural Village Technologies: In the *arrondissement* of Ouelessebougou in West Africa, my colleagues and students have been committed for over 30 years to reduce poverty and empower struggling villagers in an area that is one of the three poorest nations on earth. People have lived in mud huts with thatched roofs, lacking electricity, healthcare, schools, jobs and many of the features of modern society. With decades of draught, lack of water and irrigation, and being disconnected to the larger but still impoverished capital of Bamako, dozens of villages languish. So in the mid-1980s, a group of citizens in Salt Lake City, Utah formed an NGO to learn more of the plight of Malians, especially women and children, and the Ouelessebougou Alliance was borne. Since then college students, doctors, farmers, engineer, school teachers, entrepreneurs, and Christian religious congregations and Utah Muslim societies, along with other charities have mobilized their talents and financial resources to learn more and offer help. Structured as a partnership with Africa, many changes have borne fruit. Engineers, for instance, designed new reservoirs to capture precious water during the limited rainy season for storage through the year. They dug new village wells in some 40 communities, drinking wells and garden wells for agriculture. With simple designs, wells could be accomplished for $2,500 each rather than the big, "gold-plated" wells proposed by Africare at a cost of $35,000 each. Other technicians helped plan and construct schools with 4-5 simple rooms each in every village so children from age 6 up to 14 would have the chance at an education. Later, solar power technology was installed so there would not only the dark dreary rooms could have more light in the day, but adults could attend literacy courses at night. Eventually engineers and medical doctors from Utah built a rural pharmacy to dispense medicines, and healthcare workers (a male and female) in each village were taught to provide simple first aid, teach the need for handwashing, dispense mosquito netting for every household, and more. Today statistics document the improved levels of reading and writing capacities of most children, the improved nutrition, empowerment of women with their own cooperatives and microenterprises, and more. People are living longer, healthier lives.

II. CONCLUSION

As a professor teaching at universities through four decades, I've saved anonymous feedback from many students in most courses. I've never forgotten the words of one that stands out from 2012. Here are the thoughts of a young engineering student who took my social enterprise course, and then afterward spent 3 months on the ground in Uganda. Said he: "Ever since I was a little kid, I dreamed of living in Africa when I grew up. Now, I'vespent the summer among villagers in Uganda, providing high technology products for use in rudimentary schools (solar powered energy,

laptop computers, and internet access). It's been so meaningful to install and also train the people so they might use them to improve their lives. I finally have a sense of how I can give ongoing services in my life and career to make humble families, especially mothers and kids, enjoy more knowledge and security for their long-term futures."

Through all these engineering innovations over several decades, the university volunteers' lives have clearly been changed as they went out and served those who could not help themselves. Likewise, the beneficiaries in villages globally were helped along in their efforts to improve their quality of life and were blessed by the efforts of the volunteers. Essentially, such efforts have been the making of a "practical turn," a "hands-on" collaboration across nationalities, professions, and varieties of action research for benefit of the entire world.

REFERENCES

[1]. Brigham Young University. (2020). https://www.byu.edu/. April 22.
[2]. H2O For Humanity. (2019). Water purification social business in India. http://www.h2oforhumanity.com/. November 16.
[3]. HELP. (2019). HELP International, NGO. https://help-international.org/.
[4]. Illich, I. (1973). *Tools for Conviviality.*Through World Perspectives Publishing by Harper and Row.
[5]. Marriott School of Business. (2020). https://marriottschool.byu.edu/. March 9.
[6]. National Geographic. (2017). "Three Billion People Cook Over Open Fires—With Deadly Consequences."August 14.
[7]. Polak, P. (2008). *Out of Poverty: What Works When Traditional Approaches Fail*. Berrett Koehler.
[8]. Schumacher, E. F. (1973).*Small Is Beautiful: Economics as if People Mattered.* Blond and Briggs.
[9]. Shri Kshethra Dharmasthala Rural Development Project (SKDRDP). (2019). Large Indian NGO with multiple development programs. https://skdrdpindia.org/. December 22.
[10]. Smith, I. and Woodworth, W. (2012). Developing Social Entrepreneurs and Social Innovators: A Social Identity and Self-Efficacy Approach. *Academy of Management Learning & Education,* Vol. 11, No. 3. pp. 390-407.
[11]. Woodworth, W. (2008). "Youth-based Social Entrepreneurship: Post-Tsunami Crisis Interventions." *Social Science Research Network.*Elsevier: SSRN. March 8.
[12]. Yunus, M. (2010).*Building Social Business: The New Kind of Capitalism That Serves Humanity's Most Pressing Needs,* Public Affairs.

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