Social Entrepreneurship and Engineering Education as a Means of Sustainable Development

Vasudevan Rajaram1 and Joshua Sperling2,3

1 President, IIG Sustainable Cities, Burr Ridge, IL 60527, USA Raj2468@comcast.net

2. Postdoc Fellow, New Concepts Incubator at the National Renewable Energy Laboratory, Golden, CO, USA and Urban Futures at the National Center for Atmospheric Research, Boulder, CO, USA Joshuabsperling@gmail.com

Dr. Rajaram is a geotechnical and environmental engineer with 41 years of experience in the areas of mining, tunneling, site remediation and innovative environmental management. He has a Ph.D. in Rock Mechanics from the University of Wisconsin, a M.S. from the South Dakota School of Mines and Technology and a B.E. from Osmania University. He has a J.D. from the IIT Kent College of Law. His interests include sustainable development and humanitarian service.

Dr. Sperling is a civil / environmental engineer and postdoc research fellow at the NREL New Concepts Incubator and visiting researcher at NCAR Urban Futures / Climate Science and Applications program in Colorado. He is a former Fulbright Scholar, NSF PIRE Fellow, and holds a PhD from the interdisciplinary Sustainable Infrastructure program at UC-Denver. His research combines engineering, planning, and policy approaches to the nexus of infrastructure systems, environmental change and public health. Recent NSF-funded research has focused on developing low-carbon, healthy and resilient cities / communities in the USA, China and India and on ‘Sustainable Cities and the Energy-Water-Climate Nexus’. He also works to integrate sustainable development goal efforts.

Abstract: Failed development engineering projects, increased demands for basic services, and the new sustainable development goals (SDGs) motivate a critical need for transitions from donor funds to self-reliance using entrepreneurial approaches to sustainable development. Social entrepreneurship can be defined as a business that addresses the social needs of society while being financially and environmentally sustainable. There are many engineers acting as social entrepreneurs around the world in order to solve increasingly complex problems of water, energy, food, education, housing, health and other pressing social issues. Efforts vary from working with small to large organizations and from single to multiple service areas, with these engineers and SEs bringing together diverse resources toward lasting systems-based solutions, in partnership with local communities. These SEs are not only building on access to knowledge, networks, and capital, but also continuously reflecting and learning to develop locally and globally-relevant skills. They are shaping and accelerating the use of multiple community innovations, designing new appropriate technologies and policies, and creating new practices and processes that can improve society and transform communities. With entrepreneurship and innovation as key drivers of human progress towards sustainable development, engineers and social entrepreneurs need to be trained and supported so they are effective in bringing about required changes in society and improving quality of life for all. Many engineering departments at universities are now building curriculum and programs in these areas and this paper highlights a handful of these programs across the US and India. We identify and describe recently evolving educational programs in terms of proposed skills, competencies, and knowledge that can prove useful in real-world projects and ventures. The development impact that social entrepreneurs in these engineering and interdisciplinary programs are having will be detailed. Recommendations for expanding such programs in engineering and business schools will be made, and the need for role models to guide the new generation of social entrepreneurs will be described.

Key Words: Sustainable Development, Social Entrepreneurship, Engineering Education.

Introduction

Large populations globally remain without basic infrastructure services. Over two billion live on less than two dollars a day with little access to clean water, energy services and are exposed to enormous unnecessary health risks (United Nations, 2010). Over the many years that development projects have been completed in various parts of the
world, a few themes emerge from research and practice on the failure of projects that start with good intentions, yet do not produce the impacts planned for. A major challenge is the lack of interdisciplinary, entrepreneurial and systems approaches so projects, activities, and institutions do not operate in silos. Additional challenges can be summarized as follows:

- Not allowing for meaningful participation processes together with the local community in the planning, design, implementation, evaluation and monitoring of development projects;
- Not understanding the uncertainties, complexities, and multiple costs, benefits, and risks involved;
- Solving for the apparent or short-term needs of the community (e.g. one-off interventions), without full comprehension of priorities and integrated approaches to better address short and long-term needs;
- Lack of cultural sensitivity and improper understanding of the social, economic, technical, environmental, and governance processes impacting the project planning, design, implementation;
- Inadequate training and finance for on-going operation / maintenance of project components;
- Weak institutional capacity for governance toward sustainability/resilience under changing conditions;
- Lack of complete data / integrated coordination in planning, design and implementation of projects;
- Lack of innovations that are able to transition from donor funds to self-sustaining ventures; and
- Lack of adequate monitoring, evaluation, reflection, and models for corrective action in a timely manner (Note: pay-for-performance models with incentives for performance remain in early stages).

There are many examples of development projects in India and globally where millions of dollars have been spent and significant time wasted without making a real dent in the quality of life for the beneficiaries. In Delhi on the Yamuna River, many sewage treatment plants have been built to reduce the undiluted sewage flowing into this major river. However, they do not capture all the sewage and many of the plants do not operate optimally with the result that the drinking quality of the water in the river has been adversely affected, and many poor people who depend on it get sick and many young children die prematurely. Similarly, many millions of dollars have been spent to build treatment plants in cities along the Ganges River, but still raw sewage flows into tributaries of the Ganges and this dismal failure is due to inadequate comprehensive planning and not building capacity in the local urban bodies that are responsible for operation and maintenance of the plants. Many people from around India come and bathe in the Ganges, and many poor people depend on it for their daily water needs. The pollution in the Ganges is affecting the lives of many since treatment plants have been setup in locations that do not capture all the sewage that are flowing into the river body. Sophisticated technologies with high costs or maintenance requirements have been used which are not appropriate for local conditions, and projects are planned and financed for the initial design and construction, but adequate funds are not provided for on-going operation and maintenance.

**Education as a First Step to a BetterFuture: Education of Global Engineers and Social Entrepreneurs**

This track record suggests that training of engineers and SEs to operate in global environments and to work with cross-disciplinary systems-thinking teams is necessary. In addition, we need engineers to understand the ethical, political and governance issues impacting their planning, design and implementation efforts.

The University of Colorado Boulder offers one example of an educational program that has developed courses for a professional certificate and masters of engineering professional degree that is focused on Engineering for Developing Communities (MC-EDC, 2015). MC-EDC includes courses on Social Entrepreneurship and other topics relevant to addressing the challenges mentioned earlier in failed development projects. Additional novel university programs are under development at the University of Wisconsin, Milwaukee (e.g. the UWM student start-up challenge), University of Minnesota (e.g. the Acara program at the Institute for the Environment), Drexel University (e.g. the new PeaceTech: Conflict Management for Engineers online program), Ben Gurion University (e.g. the Bengis Center for Entrepreneurship and Innovation), and with many other US and international institutions (Alliance for Social Entrepreneurship, 2013). A few additional programs in India are described briefly below:
• The Indian Institute of Management – Ahmedabad has a Center for Innovation Incubation and Entrepreneurship (CIIE) which has helped many startups in the state of Gujarat (India), and they offer Grow Gujarat Startup Awards to provide a platform to entrepreneurs to showcase their achievements.
• IIT-Madras in Chennai offers C-TIDES and the Incubation cell as novel programs now receiving high-level institutional support for students to even take semesters off for focusing on their startup ventures.
• Indian Institute for Human Settlements offers a short course titled ‘Social Venture Design’ together with the University of Minnesota Acara program, providing intensive, hands-on experience with social entrepreneurship bringing together experienced corporate leaders, panels of investors, and incubators.

Based on a review of literature, experiences with interdisciplinary and international education programs, and discussions of the authors with a leading US Professor in transforming engineering education (Professor Bernard Amadei), a set of skills, competencies and body of knowledge are proposed below as relevant to training global engineers as social entrepreneurs who can undertake sustainable development in communities around the world (Amadei, Sandekian and Thomas, 2009; Sandekian, Chinowsky, and Amadei, 2015).

1. Multi-dimensional and cross-scale perspectives, from local to global, and past to current to future;
2. Field experience, qualitative and quantitative data collection and analysis,
3. Integrated design, planning, monitoring, evaluation and learning,
4. Systems thinking involving cross-disciplinary and cross-cultural understandings and approaches;
5. Integrative, participatory, and context-sensitive approaches;
6. Appropriate technology, planning, policy, and financing processes for sustainability and resilience;
7. Public Health and Behavioral Science Perspectives (including for communication / engagement);
8. Teamwork, Communication towards Consensus Building and Conflict Management;
9. Cultural sensitivity, social entrepreneurship, ethical behavior and sustained engagement/partnership;
10. Governance / institutional issues;
11. Decision Making and Risk Analysis;
12. Use of Geographical Information System and other information communication technologies; and

Training global engineers is the responsibility of universities around the world and with the availability of online programs in many universities, there is a trend towards increased access to education, skills and formal training on engineering and social entrepreneurship towards sustainable development. However, practicum courses play an important role towards enhancing entrepreneurship attitudes and outside-the-classroom learning is important to making impacts in communities worldwide. Business and finance courses are complementary aspects of these programs, and many business schools in the US are now offering subspecialties in social entrepreneurship.

Social entrepreneurs need an environment in which they can succeed and solve the problems of the poor in communities worldwide. The rise of crowd funding and major corporate foundations that provide the seed funding for social entrepreneurs is helping many young people to become social entrepreneurs. A case in point is Skilled Samaritan in New Delhi, India, that has completed solar lighting programs and provided water to communities in need in northern India. Ms. Gauri Agrawal, a young social entrepreneur who started Skilled Samaritan was assisted by Bechtel India with seed funding for its first solar lighting program in the village of Sirohi, Haryana, India. With the success of this project, she used crowd funding to finance her solar lighting program in a second village (personal communication, 2014). Such social entrepreneurs are driven by a need to solve problems in society while making a good living. Ms. Sivan Ya’ari is another case of social entrepreneurship which has helped many villages in Africa (Seth Siegel, 2015). Her young firm Innovation:Africa (i:A), based in Israel, uses solar power and Israel technology to help bring clean water and electric power to people living in small, often remote villages in Africa. Using wireless technology, i:A monitors the projects in Africa and ensures that the projects they install work properly and improve the lives of the people in seven African countries.
Additional examples, with links describing programs on global business and SE training, are below:

- The CU-Boulder Leeds School of Business CU CleanTech, which helps students secure internships in solar, wind, smart grid, and other clean energy technology companies, while providing opportunities for students to work with business leaders to commercialize clean technology research coming out of CU)
- Acara Program at University of Minnesota on social entrepreneurship: [http://acara.environment.umn.edu/](http://acara.environment.umn.edu/)
- Center for Advancement of Social Entrepreneurship (CASE) at Duke University: [www.caseatduke.org](http://www.caseatduke.org)
- MIT Social Innovation Lab with Transformative Action Institute funded by Dell Social Innovation Challenge
- Agora Partnerships and Agora Accelerator intensive six-month programs: [http://agorapartnerships.org/accelerator/#howitworks](http://agorapartnerships.org/accelerator/#howitworks)
- Ashoka University: [www.ashokau.org](http://www.ashokau.org)

A variety of courses exist from practicums to incubator and accelerator courses, covering leadership training, market intelligence, branding, strategy and planning, venture capital, field experiences, case studies, start-up law, and ethics. While many social entrepreneurship courses exist, there are still few courses that bridge engineering with social entrepreneurship.

Joint graduate education programs across borders and focused on solutions at the food-energy-water nexus are under development between CU, NYU and ARAVA, with applications toward transboundary resource management and social entrepreneurship. Courses as part of a new certificate program are being planned to include financial management, global environmental public health, water management, food production / security technology, fundamentals of and systems approaches to development engineering, infrastructure / metrics for sustainable-healthy-resilient communities, environmental and peace-building leadership, alternative energy, comparative environmental law, geographic information systems, entrepreneurship and integrated practicum experiences.

Finally, just as entrepreneurs are funded by Venture Capitalists to get their ideas to the marketplace, social entrepreneurs need a source of funding from the government and corporate foundations. There are many corporate foundations that have helped social entrepreneurs reach amazing heights. For example, when Google, Microsoft and Hewlett Foundations provided a 3-year fund of $9 million to PrathamUSA ([www.prathamusa.org](http://www.prathamusa.org)) , Pratham could launch Read India in 2007 which reached over 30 million in India with basic reading and writing. Since then, continuing support from Foundations and wealthy individuals has spurred innovations and expansion of Pratham programs all over India, benefiting millions of children with education and vocational training. These kinds of support should be supplemented with government programs that encourage social entrepreneurs to continue with their work and make a change in poor communities around the world. Products and services to serve the bottom of the pyramid provide unlimited opportunities for social entrepreneurs, and with adequate training and funding described here, they can accelerate development around the world to improve the quality of life for the poor.

**Development Impacts**

Social entrepreneurs have made a huge impact in the world in many areas of need such as water, sanitation, solar energy, and education. A social entrepreneur organization that has impacted the education of poor children in India and several other countries is Pratham ([www.pratham.org](http://www.pratham.org)). Co-founded by Dr. Madhav Chavan of Mumbai, India, Pratham has transformed the lives of millions of children in rural India and in India’s poor neighborhoods. Over the last 20 years, Pratham has accomplished the following breakthroughs in elementary education, assessment of education quality and vocational training.
1. Educated 5 million children in 2014 at the cost of $25/year/child. This is accomplished by using the existing infrastructure of schools in India and sending trained teachers to provide remedial education. Involving the community at every step, Pratham ensures that every child is in school and learning well.

2. For the past 10 years, Pratham has successfully completed Annual Survey of Education Report (ASER) for children all over India. Using simple measuring tools and a rigorous analysis methodology, the ASER releases have spurred the government and the private sector to put the resources needed to improve the quality of the schools. The model is now used by many countries in Africa, in the Indian subcontinent and Mexico.

3. Provided vocational training to 20,000 youth in 2014 by working in partnership with industry leaders. The skills covered by the training programs include construction, hospitality, automotive, healthcare and beauty salons. The placement rate for the graduates (who get only 3 months of training) is from 60 to 95%. Considering that the youth involved in the training programs are from rural India and from poor communities in cities, this is a remarkable achievement.

4. Online software and other educational tools to reach more children through internet teaching modules.

We have already discussed the impacts on solar energy and water done by social entrepreneurs in India and Israel. I know of many young entrepreneurs in the US who are passionate to serve the needs of the poor in communities around the world. Ms. Shilpa Alva is a Co-Founder and Executive Director at Surge, Chicago, a global non-profit organization that manufactures filters, constructs fresh water wells, rain water harvesting tanks, and installs sanitation systems in Asia. She also works to educate and inspire thousands of youth and adults through interactive education programs.

These impacts will be multiplied hundred fold with the proper education and training discussed earlier in the paper. The only way to eradicate poverty in many parts of the world is to unleash the passion and expertise of the social entrepreneurs who are driven by altruism but ensure sustainability through the use of business management tools.

As specific to the goals of world energy justice, below are success stories on impacts in terms of linking engineering with social entrepreneurship to provide safe, clean, affordable, reliable, equitable and efficient energy in diverse geographic regions. These models demonstrate how energy access can help meet basic needs such as cooking, boiling water, lighting, and heating:

1. Carbon credits fund local enterprises for solar-powered UV water purification systems, biogas generators, and high-efficiency cook stoves for remote villages, orphanages, medical facilities, and vocational schools in Rwanda. For more information, go to www.mannaenergy.org
2. Clean-efficient stove designs built locally for Darfur refugee camps in Sudan address growing fuel shortages and rising cases of rape and violence for women and children who have to leave safety of camps, walking 25 hours per week, to collect fuel for cooking. Some women sell part of their food rations to get cash to buy fuel-wood. For more information, go to: www.darfurstoves.org and http://darfurstoves.lbl.gov/benefits.html
3. Fuel briquettes that began with technology transfer from Kathmandu, Nepal to Kabul, Afghanistan and resulted in a replicable model for sustainable technology entrepreneurship for internally displaced people. The project trained and employed hundreds of individuals—handicapped young men as well as young girls ages 18–25—who can now go to school as a result. More information at: www.afghans4tomorrow.com
4. A combined hybrid wind-solar system built for children orphaned by the Tsunami in Sri Lanka provides power to residential dormitories housing 50 girls and boys orphaned by the tsunami of 2004 (who had lost both parents). For a tribal village in India, the system yields annual savings of about $USD 550 per year while supplying a 10kWh per day renewable electricity supply, displacing 2.5 metric tonnes of CO2e per year over the life of the project. More information at: http://www.epa.gov/ncer/P3/
5. A program in Bangladesh has successfully installed over 50,000 solar panels bringing renewable energy to 250,000 rural people in over 50,000 villages outside of the national power grid. The program is directed by BRAC, the world’s largest NGO (employing over 55,000 in a country where 70% of the total population does not have access to electricity), and has provided multiple benefits with its projects including income-generating centers. More information at: http://www.lged-rein.org/ and http://www.brac.net/
We have both the means and the know-how to provide the developing world with practical and sustainable energy that bridge engineering and social entrepreneurship solutions. Small scale and region-specific innovations which transition from donor funds to self-reliance are critical to success in other communities around the world.

**Recommendations**

We offer two recommendations for moving forward, including on training and leveraging resources toward scaling solutions to development in poor communities worldwide:

1) **Training 100,000 social entrepreneurs by 2030 to reach the SDGs set by UN.**

Given proper training and the tools to launch social entrepreneurship, many social entrepreneurs will emerge in all parts of the world to solve the 17 sustainable development goals (e.g. via these 50+ fellowship programs and many others now available for social innovators www.innov8social.com/2011/10/50-fellowship-programs-for-social). Even affluent countries like the United States have pockets of poverty, and social entrepreneurs can find ways to solve these problems. Engineers Without Borders – USA has launched many community projects in poor parts of the US using its volunteers in addition to doing development projects around the world. The current training programs have to be expanded and more online programs have to be launched in the area of social entrepreneurship.

For example, Dr. Darsh Wasan has the vision of creating a Global Engineering program at Illinois Institute of Technology Chicago (IIT) where students from around the world will live together and be educated in teams to focus on and solve development problems in a sustainable manner. Many universities have Innovation Centers, and these should devote some of their resources to work on basic needs of people in the bottom of the pyramid. For example, the Institute of Design at IIT devoted 3 years to understand the needs of the poor slum dwellers in Mumbai, and developed simple devices for carrying water on their bicycles and other needs in their homes.

These new training programs coupled with funds allocated for social entrepreneurs by funding agencies and private foundations will enlarge the ranks of social entrepreneurs working on sustainable development within communities around the world. Therefore, our second recommendation focuses on:

2) **Creating a fund for seed funding, incubation, and acceleration of social entrepreneurship ventures, globally.**

Below are details on foundations that can be leveraged to increase impact and support engineering & SE programs:

- Skoll Foundation is providing over $11 million in their Social Entrepreneurs Challenge to support solutions to the world’s most pressing problems: www.crowdrise.com/skollsechallenge
- Hewlett Packard: “HP launched the global training program, HP Learning Initiative for Entrepreneurs (HP LIFE), to help students, aspiring and established entrepreneurs, and small business owners develop IT and business skills to be successful. Since 2007, HP LIFE has provided approximately 1.2 million people worldwide with training, access to technology, and online activities.” http://www.hp.com/hpinfo/globalcitizenship/society/social.html
- Gates and Ashoka: “Ashoka announced a $15 million grant from the Bill & Melinda Gates Foundation to support social innovation and entrepreneurship in agricultural and sustainable rural development. The foundation’s grant will allow Ashoka to elect more than 90 Fellows who will spread promising innovations aimed at helping small farmers living in poor, rural communities in Sub-Saharan Africa and India move out of poverty.” Gates GCE grants and grand challenges grants also fund innovative ideas to tackle persistent global health and development problems. http://gcgh.grandchallenges.org/about
As shown, available education programs and capital for SEs is increasing. New data collection approaches, mobile applications, and foundations / corporate involvement in supporting social entrepreneurship are promising trends. Fellowship programs for social entrepreneurs / innovators that link with engineering education can also bring significant advances to sustainable development and in addressing the new sustainable development goals.

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