28th Australasian Association for Engineering Education Conference (AAEE2017)
MACQUARIE University

10-13 December, Manly, Sydney

Changing Role of Modern Engineers and Social Responsibility

Sangeeta Karmokar
Faculty of Design and Creative Technology
Auckland University of Technology
Corresponding Author Email: Sangeeta.karmokar@aut.ac.nz

SESSION

C4: The role and impact of engineers and the engineering profession in the wider community

CONTEXT

The role of modern engineers is constantly changing. It is argued that a focus on employability alone is not sufficient to prepare socially responsible engineers as it fails to address t social issues and challenges of wider society. By examining case studies, paper provides analysis of the challenges in engineering discipline.

PURPOSE

The purpose of this paper is to highlight the importance of the social sciences in helping engineers understand the context in which they will work and how it both constrains and enables their capacity for social responsibility.

APPROACH

The framework used for this paper is case study analysis. This paper critically examines few case studies that highlights how engineering knowledge has been used for addressing social issues and empower rural areas to create self-sufficiency.

RESULTS

The results that will assist to broadened the focus on the social structure and the way it enables and constrains socially responsible in engineering education.

CONCLUSIONS

This paper provides an analysis of the challenges in integrating social responsibility in engineering education that can be used by educators wanting to pursue this direction.

KEYWORDS: Social Responsibility, Engineering Education, Modern Engineers

Introduction

With the changing societal landscape, engineers are increasingly being called on to embrace responsibilities of serve the public and understand the social context of their work. This may be termed as “Modern Engineers” or the “New Engineers” (Zandvoort, 2008), who have social responsibilities and act as potential enablers in the society. They are enablers who constantly deal with the uncertainty and competing demands from clients, governments, environment and landscape of society.

The reasons behind the demand for Modern Engineers are critically examined and it is argued that a focus on employability alone is not sufficient to prepare the future generation. It is not about looking at the economic profitability of the organization but also the sustainability and the wider social context in which engineers’ work. The spectrum of activities of modern engineers span from diverse range of stakeholders to be engaged in the engineering process to the social contribution for addressing social issues in the community. It is argued that focus on employability alone will not equip engineers to be socially responsible to work in the current structure and society.

The demand for the modern engineers is reflected in changing approaches in few of the professional engineering programmes such as Engineers Ireland, Engineering Projects in Community Service (EIPICS) at Purdue University and Creative Capability Building in Massachusetts Institute of Technology (MIT). These programs have changed accreditation criteria to include outcomes focused on ethical standards and responsibilities towards people, environment and society.

The programs and educational system that reflects above engineering program are very rare. Is our wider educational system are preparing modern engineers? It is argued that the focus of education should be broadened to include social structure and the way it both enables to connect the engineering knowledge and social responsibilities. There is a call to refocus on our educational pedagogies and the engineers’ attitudes towards the systems of regulation and be potential enablers contributing to social cause.

It calls our education system to refocus on the attitudes of our future engineering graduates and preparing them to be potential enablers supporting social responsibilities and making a difference through their profession. Paper provides analysis of the challenges in educating social responsibility in engineering discipline by looking into few case studies.

This paper critically examines how engineering education can adequately address the demands that are to be imposed on future engineers. It argues the importance of social responsibilities in helping the engineers understand the context in which they work and enables them to contribute to the social cause. This paper critically examines some case studies that have focused engineering education in addressing social issues and provides recommendation for engineering educators if they want to perceive this path. It provides conceptual evidence and case study results that will assist in broadening the focus on the social structure and the way it enables and constrains socially responsible in engineering education. This paper provides an analysis of the challenges in integrating social responsibility in engineering education that can be used by educators wanting to pursue this direction.

Ethos of Engineering Education

The role of modern engineers is constantly changing with the change in the government, cliental demands and real world social issues. It requires a new skillset of social science, human relationship as well as technical competence (Mills & Treagust, 2003). While coping with the continual technological and organizational change in the workplace, engineers are trying to incorporate social and human skills in their professional practice. Despite these challenges, the predominant model of engineering pedagogy still remains "chalk and talk", with large class size, lecture based delivery and teaching core engineering subjects (Mills & Treagust, 2003). There is very little scope for inter disciplinary teaching or incorporating knowledge from other areas such as sociology, social science, creative industries and community services. Moreover, lecture based teaching does not advance problem solving skills or critical thinking ability or prepare students for the real- life problems they will face as professional modern engineers.

Traditional engineering education is deductive, beginning with theories and fundamentals, progressing to the applications of those theories. Starting with the core principles of engineering and working down to the applications of those principles that is already understood (Felder, 2002). One problem with the deductive teaching is that it gives seriously misleading impression about the real world which the students are going to face in the future. Unfortunately, students never get to see the real process, they start with a false scenario and extensive trial and error efforts that eventually leads to an excellent presentation. Moreover, students learning is also very different. Some students learn by seeing and hearing; reflecting or acting; reasoning and intuitively; aligning to the real scenario or memorizing and visualizing. On the other hand, most of the engineering education is deductive in nature. Some instructor use lecture based teaching, others demonstrate and discuss and other use project based learning.

As an educator, how are we preparing engineers for the future and making them responsible for their sustainable career? Are we equipping the new generation with skills and knowledge to tackle most pressing issues facing society along with the technical fundamental knowledge? The engineering education needs to become more proactive to the needs of tomorrow's job market, preparing students for the new, complex challenges they will be facing in the future. From our current teaching styles, we are preparing our students to purse corporate jobs after graduation, but they also must be aware that alternative (Example, jobs in non-profit organization) career pathways are available. Acquisition of technical knowledge is important, but it is inadequate if not retrieved and connected to the real-world conceptions. To integrate the new expectations of modern engineers to the existing one, thorough reconstruction of education system is necessary. In recent years, the engineering profession and the bodies responsible for accrediting engineering programs have called for change (Perrenet, Bouhuijs, & Smits, 2000).

The entire ecosystem of engineering educators including career advisors, internship, coop educators, and career fair needs to adopt a student-centered approach that helps students prepare for both traditional and non-traditional career pathways (Mehta & Gorski, 2016).

Engineering and Social Responsibilities

In engineering education is a demand for a broader education for modern engineers including sociology and social science. There is a broad agreement that like any other education, engineering education should prepare graduates for social responsibility (Zandvoort, 2008). As Conlon (2008) mentions, focus on employability alone will not equip

engineers to be socially responsible because it fails to reflect the current structure of work and society. Some research and academia are in agreement that there is a task for educators to prepare graduates for social responsibility but there is a very little clarity on what social responsibility entails and how it impacts the curriculum to prepare modern engineers equipped with social responsibility.

The importance of social responsibilities among engineers raises questions as to whose problems engineers are trying to solve. In most education institutes, the graduates are prepared to be absorbed in corporate role and tend to use business consideration as criteria for decision making. Engineers are mainly focused on productivity they do not see the fair distribution of the benefits of economic activity as their concern (Johnston, Gostelow, & King, 2000). Generally, public perception of the engineers does not include the recognition that engineers are engaged with society and community issues (Mills & Treagust, 2003). To realise their full potential to positively impact society and individuals, it is important that engineers are socially responsible.

The technical competencies in engineering profession is important, but so is the mindset of way of seeing the world, thinking and doing unique for social and sustainability of the community. Currently, the engineering education is focused on teaching maths, physics and programming to prepare students for careers in solving specific kinds of problems (Mehta & Gorski, 2016). Real life challenges often cannot be solved with just this professional knowledge. These calls for engineers to have sense of social responsibility and extend beyond the understanding of the social implications to their project.

In a rapidly changing technology and globalization world where societies and problems are increasingly interconnected, career paths are rapidly changing to meet the new demands of society. Engineers are working on the real - world life social issues faced by communities in their day to day life. The contribution of engineers in various fields have always been motivated by the idea that their inventions would be useful to the society, yet engineering field is not viewed by the general public as a care giving profession (Mehta & Gorski, 2016). Today's, modern engineers are designing products that empower people in less developed countries, they are building future capabilities and educating the next generation of engineers.

Modern engineering profession focus on the relationship between their professional contribution and the impact in the society (Conlon, 2008). Academics and educators need to define strategies to better connect student's technical knowledge and build modern engineers eager to engage with higher education to solve global challenges (Ruyle, Boehm, & Lagoudas, 2016). There are few excellent models in engineering education for engaging students in practical problem solving and providing solutions for communities in the developing world such as Engineering Projects in Community Service at Purdue University, India's Barefoot College, Engineering for Change and Creative Capacity Building Workshops by MIT.

Case Studies

This section examines the new model of engineering education and provides recommendations for adequately addressing the demands that are to be imposed on future engineers. It emphasises the importance of the social science in helping engineers prepare for the future workplace and enables their capability for social responsibility.

Barefoot College

Barefoot College challenges the whole pedagogy of engineering education, the prestige associated with paper degrees and some of the artificial constructs that create hierarchies of learning. Barefoot architects, engineers, health workers and technical specialists in the energy and water sectors receive practical training at the college and then return to their communities to promote human and infrastructural development. The main mission is to disseminate the knowledge throughout the rural communities around the world, accomplishing what many less comprehensive approaches have failed to achieve (www.barefootcollege.org). It is a unique way of empowering community and transformation into a self–sustainable society.
Barefoot college is a voluntary organization started by started by social activist, Bunker Roy. Since then, it has spread to more than 70 countries especially in Africa, Latin America and Southern Asia. Some of their project includes, The International Solar Training Program (India), Women Barefoot Solar Engineers (Africa) and Rural Women Light Up Africa, where trainees are often illiterate or semi-literate mother / grandmothers who maintain strong roots in their rural village and play a major role in community development. It is a unique model of using engineering and technical knowledge to address social issues (http://spectrum.ieee.org/energy/renewables/barefoot-matriarchs-take-on-indias-electricity-gap.

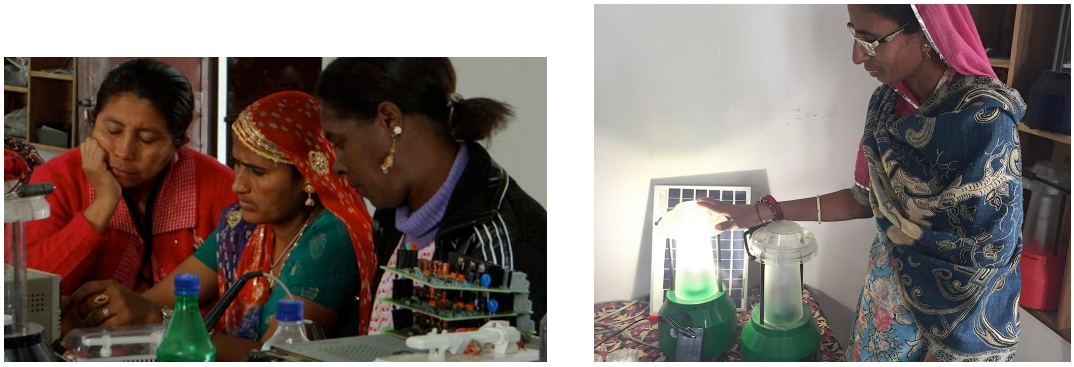

Figure 1: Some Projects of Barefoot College

Engineering Project in Community Service (EPICS)

EPICS was found at Purdue and introduced at Princeton University by co-founder Professor Ed Coyle. EPICS is a unique program in which teams of undergraduates are designing, building, and deploying real systems to solve engineering-based problems for local community service and education organizations. Students enrolling in this course earn credits by using their expertise to make a difference in the community. At the beginning of the semester, students choose one of the three existing projects and teams meet and work on that project throughout the academic year (https://kellercenter.princeton.edu/learn/epics/overview).
The main objective of the project is to provide graduates experience of real problems face by the communities and also develop a sense of social responsibilities among future engineers. It provides exposure to students with strong technical backgrounds and to take advantage of technology to improve, coordinate and deliver the services in the community. Modern engineers face a future in which they will need more than solid expertise in their discipline to succeed. They will be expected to work with people of many different backgrounds to identify and achieve goals. They need educational and social experiences that can help them broaden their skills.

The EPICS team is engaged in a number of projects throughout the academic year and students have the opportunity to select the one that best fits their interests. Some of the projects includes, Automated Tour Guide (disability center project), Deaf Kids Code Project and aero and Astro Engineering project. Most of the projects are collaborated with industry partner and community organizations.

Engineering for Change (E4C)

The main mission of Engineering for Change organization (https://www.engineeringforchange.org/who-we-are/) 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. It collaborates with external partners that share similar mission and passion for improving the quality of life. It is a multidisciplinary coalition between engineers, industry partners and the community helping global development practitioners to design and deploy fit-for-service solutions that address quality of life challenges.

Engineering for change breaks the barriers between the tertiary education, industry partners by provoking new ways of thinking in addressing the problems of the society. It promotes an interdisciplinary practice where practitioners integrate their technical training with an understanding of economics and business, social science and politics to benefit people living in poverty. It is a community of individuals who believe that engineering can change the world for the better.

E4C, works in partnership with various industry partners and engineering community such as Engineers without Borders (USA) and IEEE, helping them develop knowledge and re-invent method design. Projects are from wide range of areas such as water, health, sanitation, ICT and Energy.

Figure 2: Examples of E4C Projects

Discussion and Recommendation

There are several relevant insights from the above exemplars that are worth sharing at an educational conference. The core message is that engineers can pursue careers in the either corporate or social impact area, but they more likely to be successful if they understand the nature of these careers and the professional competencies (Mehta & Gorski, 2016). For example, a software engineer tasked with designing a new software / App for food delivery system, but engineer must combine this with problem solving mindset to ensure the food is delivered on time and is fresh, understand the traffic system of the area, knowledge of human emotions associated with food, motivating factors of users and cost

analysis. So, it is the overall social factors that needs to be considered along with the technical skillsets.

Research suggest that the engineering education needs to widen its focus if students are to be educated as socially responsible engineers. Focusing on the skills and values of individual students related to their employability in the corporate world is not adequate to prepare them for the challenges of the real world that they are going to face (Conlon, 2008). While there are, programs initiated by few universities and private institutes where students study problem solving, there is a need for a long-term community or social based problem solving educational system (Ruyle et al., 2016). Engineering Education system needs to become more proactive to the needs of the tomorrow's job market and prepare students for the new, complex and interdisciplinary challenges that they are going to face.

A growing number of students want to experience and leverage their engineering education and focus their career where they can directly see the impact of their knowledge in the society. The impacts of these changes will alter the way we teach in engineering education. Students may undertake community led or engaged projects that are real and empower communities in the longer term. It is essential to move beyond academic delivery methods and considering partnering with communities. As an educator, it is a challenging journey to set away from the core engineering principles and align with the social and community values.

How do the educational institutes rise up to this challenge and prepare graduates for the future?

What advice do we have for the educators and universities for building the next social innovators?

The recommendations presented below are some of the guidelines of how engineering education can be reframed to prepare graduates as problem solvers and social innovators for the rapidly changing world.

1. *Teaching Pedagogy of Engineering Education*

   The skillset and the understanding needed by modern engineers, it would appear that these demands are unlikely to be satisfied by a traditional engineering curriculum and "chalk and talk" pedagogy. The curriculum needs to address more than just technical skillsets such as ethos, attitude, pathos, emotion and social responsibilities. A mixed approach with some project based learning and integrating with multidisciplinary areas, appears to be the best way to satisfy industry, social and community needs without sacrificing the core skillset of engineering fundamentals.

2. *Building External Relationships*

   Forming a partnership and building strong relationships between business, technology, community and non-profit organizations, broadens the understanding of students. Participation in community and social projects benefits social responsibility attitudes of the students. Educators can stress the importance of networking especially in non-traditional field (Ruyle et al., 2016).

3. *Encourage Interdisciplinary / Cross disciplinary Projects*

   Most of the creative industry hopes universities will offer programs focused on interdisciplinary, collaborative sharing of knowledge in which students tackle real

problems and develop innovative solution (Mehta & Gorski, 2016). Although almost all departments in the universities work in silos. In real world, most of the social innovators are from a range of disciplines working together towards a common goal. In educational institutes, by creating interdisciplinary projects, educators can get students to think beyond their traditional career paths and bring new values in different domain. As a result, we are creating "T" shaped graduates who are well versed with many disciplines and capable of providing innovative solutions to a complex problem.

4. *Preparing Students to be Systems Thinkers*

A thorough understanding of both theoretical and operational level will help students to improve and develop thinking beyond their career path. Social and community development involves wicked challenges that needs understanding of interconnected world. Exposing students to intangible, large and complex problems that exist in the society, educators can encourage them to think creatively and challenges their thought process.

5. *Ethical and Social Responsibilities as Part of Learning Process*

Our current education is mostly focused on preparing graduates for corporate employability. For modern engineers, we need to broaden our educational system and see that engineering graduates are adequately prepared for the social responsibilities and contribute to the future generation. As Bucciarelli (2007), says that is not just a more expansive reading of the code of ethics, but need a substantial reform of engineering education across the board to enable more expansive and critical study of engineering, including social and political dimensions (Bucciarelli, 2007).

6. *Social and Community Focused Projects*

In order for modern engineers to realize their full potential to beneficially impact society and individuals, it is important that they work on social and community. It creates a sense of obligation and duty to perform to benefit society, the environment and the economy. Studies have proved that, students who have participated in social or community projects are more likely to cite engineering courses as contributing to their views of social responsibility compared to students who haven't participated (Bielefeldt & Canney, 2014).

7. *Keep it Real*

Educators can help students to understand what is actually practical and how they can use their technical knowledge to address complex challenges in the community by providing real projects. Student needs to be solving complex problems creatively, but at the same time understand that one idea that you come up in classroom is unlikely to be practical in real world. A significant amount of work, creativity, people, and resources are needed beyond their idea before they can have a large impact. Getting exposure to the reality of the competitive world can help students be more practical when they enter the workforce.

Conclusion

In the above we have seen that engineering education needs to widen its focus if students are to prepared for the future as a socially responsible engineer. A narrow focus on the technical skill and knowledge of individual students related to corporate employability is not adequate for modern engineers. Graduates need to develop the capability to relate their individual practice to the wider society. This has been practices in few programs and institutes but need to be integrated in the tertiary and wider engineering education. Educational institutions need to rise up the challenges of preparing graduates for the future.

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