The Making of Green Engineers: Sustainable Development and the Hybrid Imagination (Synthesis Lectures on Engineering): A Book Review

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Abstract
"Green engineer" is a connotation that needs to be worked so that the public is more aware that engineers nowadays are humanistic in implementing any related projects and it in line with the Sustainable Development Goals 2030. *The Making of Green Engineers: Sustainable Development and the Hybrid Imagination (Synthesis Lectures on Engineering)* emphasizes the intersection of sustainable development and engineering education, focusing on the formation of "green engineers." It delves into the role of imagination, creativity, and interdisciplinary thinking in preparing engineers to address environmental and sustainability challenges. The book also examines how engineering education can foster a hybrid imagination, combining technical expertise with a deep understanding of social, environmental, and ethical dimensions. It explores pedagogical approaches, curriculum design, and educational practices that nurture sustainability-oriented mindsets among engineering students. The book emphasizes the importance of interdisciplinary collaboration, systems thinking, and a holistic approach to engineering education. It offers insights into the integration of sustainability principles into engineering curricula and the development of green engineering professionals who can contribute to a more sustainable future. The book is highly recommended as a resource for engineers, students, researchers, or professionals seeking to deepen their understanding of sustainable development and the role of green engineering within it.

Keywords: Green engineer, quality education, ecocentrism, humanistic, sustainability.

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Introduction

The Making of Green Engineers: Sustainable Development and the Hybrid Imagination (Synthesis Lectures on Engineering) is authored by Prof. Dr. Andrew Jamison, professor of Technology, Environment and Society at Aalborg University in Denmark since 1996 who has taught in a wide range of science and engineering programs. Before coming to Aalborg, he taught a course in science and society for many years for natural science students at the University of Copenhagen and served as founding director of a graduate program in science and technology policy at Lund University in Sweden.

The book has been written as part of the Program of Research on Opportunities and Challenges in Engineering Education in Denmark (PROCEED), funded by the Danish Strategic Research Council, for which Prof. Dr. Jamison has served as coordinator. The book consists of seven chapters which are (i) Turning Engineering Green; (ii) Contending Approaches to Engineering Education; (iii) The Emergence of Green Engineering; (iv) Educating Green Engineers; (v) Fostering Hybridity; (vi) A Case Study: The Alley Flat Initiative in Austin, Texas; and (vii) Conclusion.

In the book, the author discusses and exemplifies three contending response strategies on the part of engineers and engineering educators: a commercial strategy that links scientists and engineers into networks or systems of innovation; an academic strategy that reasserts the traditional values of science and engineering; and an integrative strategy that aims to combine scientific knowledge and engineering skills with cultural understanding and social responsibility by fostering what the author terms a "hybrid imagination." The author combines scholarly analysis with personal reflections drawing on over forty years of experience as a humanist teaching science and engineering students about the broader social, political, and cultural contexts of their fields.

Even though there are seven chapters in this book, I am most interested in the first, fifth and forth chapters because these explain the book's uniqueness in the context of the creation of "green engineer" better than the other chapters.

Summary and opinions

Turning Engineering Green

In the first chapter, it highlights the "Turning engineering green" where in the context of cultural transformation it refers to the shift in engineering practices, values, and norms towards sustainability and environmental consciousness. It involves reorienting engineering culture to prioritize environmental considerations, embrace sustainable design principles, and foster a mindset of responsible stewardship of natural resources.

Cultural transformation in engineering requires a collective change in attitudes, beliefs, and behaviours within the engineering community. Here are some key aspects involved in turning engineering green through cultural transformation:

1. Environmental Awareness: Cultural transformation starts with raising awareness about environmental issues among engineers.

It involves educating engineers about the impacts of engineering activities on the environment and promoting an understanding of the interconnectedness between engineering and sustainability.

2. Values and Ethics: Shifting engineering culture involves re-evaluating values and ethics to incorporate environmental considerations.

This includes recognizing the intrinsic value of the environment, adopting a long-term perspective, and embracing the ethical responsibility of engineers towards sustainable practices.

3. Interdisciplinary Collaboration: Cultural transformation requires fostering collaboration between engineers and professionals from other disciplines, such as environmental science, social sciences, and humanities.

By working together, engineers can gain a broader perspective on environmental challenges and benefit from diverse insights and expertise.

4. Sustainable Design and Innovation: Transforming engineering culture involves integrating sustainable design principles into engineering practices.

This includes considering life cycle assessments, minimizing resource consumption, promoting renewable energy solutions, and incorporating eco-friendly materials and technologies.

5. Education and Professional Development: Cultural transformation requires rethinking engineering education and professional development programs.

This includes incorporating sustainability-focused courses, promoting interdisciplinary learning, and providing training on sustainable engineering practices and technologies.

6. Systems Thinking and Holistic Approaches: Turning engineering green involves adopting systems thinking and holistic approaches to problem-solving.

Engineers need to consider the broader environmental, social, and economic implications of their projects, and seek solutions that optimize multiple dimensions of sustainability.

7. Collaboration with Stakeholders: Cultural transformation requires engaging with stakeholders, including communities, policymakers, and non-governmental organizations.

By involving diverse perspectives and considering local context, engineers can develop solutions that align with societal needs and environmental goals.

8. Leadership and Advocacy: Transforming engineering culture involves fostering leadership and advocacy for green engineering practices.

Engineers can take a proactive role in promoting sustainability within their organizations, advocating for sustainable policies, and serving as role models for future generations of engineers.

It can be summarised that cultural transformation towards turning engineering green is an ongoing process that requires commitment, collaboration, and continuous learning. By embracing sustainability and environmental consciousness, engineers can play a crucial role in addressing global environmental challenges and building a more sustainable future.

Fostering Hybridity

The fifth chapter of this book is of particular interest to me because it emphasises that engineering education can foster a hybrid imagination by incorporating multidisciplinary approaches and emphasising the integration of technical expertise with social, environmental, and ethical concerns. It appears to be filled with the primary content of this book. Here are some keyways to achieve the hybridity through interdisciplinary curriculum:

1. The engineering programs can offer courses and projects that bridge the gap between technical disciplines and other fields such as social sciences, environmental studies, ethics, and policy.

In my opinion, the argument expressed by the author regarding bridging the engineering with other disciplines is very important in accordance with this industry 4.0 era. Furthermore, by exposing students to diverse perspectives and knowledge domains, they can develop a broader understanding of the interconnectedness between engineering and society.

2. Case studies and real-world projects can be implemented by integrating case studies and real-world projects into engineering education allows students to explore complex problems that require

technical solutions while considering the social, environmental, and ethical implications.

I agree that this approach encourages critical thinking and helps students recognize the broader context in which their technical expertise is applied.

3. Ethics and professional responsibility should be emphasised. Engineering programs can include dedicated courses or modules on ethics and professional responsibility.

In general, these courses may cover topics like codes of conduct, environmental stewardship, social justice, and the ethical considerations involved in decision-making processes. It is commendable that the author emphasised these values where educators should encourage students to consider the societal impact of their work and make ethical decisions throughout their careers in engineering.

4. In terms of collaboration and teamwork, it should be emphasised in engineering education that helps students develop the skills to work effectively in multidisciplinary teams.

By collaborating with individuals from different backgrounds and expertise, students can learn to appreciate diverse perspectives and integrate technical knowledge with social and environmental considerations. In my view, the gap between developed and developing countries can still be seen in this context.

5. Engineering education can emphasize the importance of sustainability and systems thinking.

This involves considering the entire lifecycle of engineering projects, including resource consumption, waste generation, and long-term environmental impacts. Students can learn to design solutions that optimize not only technical efficiency but also social equity and environmental sustainability.

6. Furthermore, encouraging community engagement and service-learning experiences allows students to apply their engineering skills in real-world settings while addressing social and environmental challenges.

This hands-on approach fosters a deeper understanding of the impacts of engineering on communities and the importance of considering social and environmental factors in problem-solving.

By incorporating these approaches into engineering education, students can develop a hybrid imagination that combines technical expertise with a deep understanding of social, environmental, and ethical dimensions. This prepares them to tackle complex challenges and contribute to a more sustainable and socially responsible future.

Educating Green Engineers

In the context of engineering education, the fourth chapter discusses pedagogical approaches, curriculum design strategies, and educational practises. Compared to the fifth chapter, which focuses on the quality of the future green engineer, this chapter places a greater emphasis on the effective delivery methods employed by educators in the production of green engineers.

The author highlights nurturing sustainability-oriented mindsets among engineering students involves adopting pedagogical approaches, curriculum design, and educational practices that promote awareness, knowledge, and engagement with sustainability principles. Active learning and experiential education are one of key aspects that need to be considered (Smith et al., 2020). The educators should engage students in hands-on, experiential learning opportunities that allow them to directly interact with sustainability challenges. This can include field trips, laboratory experiments, project-based learning, and internships that focus on real-world sustainability issues. By actively participating in problem-solving and critical thinking, students develop a deeper understanding of sustainability and its relevance to engineering. By considering the broader context, students can identify sustainable solutions that address multiple dimensions of a problem. Incorporate sustainable design principles throughout the engineering curriculum. Teach students to prioritize energy efficiency, resource conservation, waste reduction, and life cycle thinking when designing engineering solutions. Emphasize the importance of renewable energy, circular economy concepts, and sustainable materials in the design process (Garcia et al., 2022). Encourage students to reflect on the ethical and social implications of engineering decisions. Incorporate discussions on social justice, equity, and inclusivity within engineering projects. Address the potential impacts on marginalized communities and promote responsible and equitable engineering practices. Foster collaboration and interdisciplinary approaches by integrating coursework and projects with other disciplines such as social sciences, environmental studies, and policy. This enables students to understand and appreciate diverse perspectives and develop holistic solutions to sustainability challenges.

Next, offer elective courses or specializations that specifically focus on sustainability within engineering disciplines. This allows students to explore sustainability concepts in-depth and develop specialized knowledge and skills in areas such as renewable energy, green infrastructure, sustainable transportation, or water management. It is crucial to provide research opportunities that allow students to investigate sustainability-related topics. Encourage undergraduate and graduate students to work on research projects that contribute to sustainable engineering practices. This can foster innovation and promote deeper engagement with sustainability challenges. Next, it should promote sustainability engagement beyond the classroom by organizing sustainability-focused events, workshops, and guest

lectures. Encourage students to participate in sustainability-related clubs, organizations, and community service activities. This helps create a culture of sustainability on campus and fosters a sense of responsibility and activism among engineering students.

Through the implementation of these pedagogical approaches, curriculum design strategies, and educational practises, engineering programmes can foster in students a commitment to sustainability. I believe these author's highlighted strategies can equip them to become accountable engineers who can integrate sustainability principles into their professional work and contribute to a more sustainable and equitable world.

Conclusion

To sum up, the book is highly original and thought-provoking, and it reminds me that people must not simply predict a future they do not know, but instead attempt to create a future they should know. It is a required reading for everyone, not just engineering educators and those who wish to design engineering education. The exploration of "green engineering" and its relationship with sustainable development is likely intended for an audience interested in engineering, sustainability, and related fields. It offers insights into the integration of sustainability principles into engineering curricula and the development of green engineering professionals who can contribute to a more sustainable future. It may serve as a resource for engineers, students, researchers, or professionals seeking to deepen their understanding of sustainable development and the role of green engineering within it.

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