

Philosophy of Engineering and Technology 11

Steen Hyldgaard Christensen
Carl Mitcham
Bocong Li
Yanming An *Editors*

Engineering, Development and Philosophy

American, Chinese and European
Perspectives

 Springer

Engineering, Development and Philosophy

Philosophy of Engineering and Technology

VOLUME 11

Editor-in-chief

Pieter E. Vermaas, *Delft University of Technology, The Netherlands*
General and overarching topics, design and analytic approaches

Editors

Christelle Didier, *Lille Catholic University, France*
Engineering ethics and science and technology studies
Craig Hanks, *Texas State University, U.S.A.*
Continental approaches, pragmatism, environmental philosophy, biotechnology
Byron Newberry, *Baylor University, U.S.A.*
Philosophy of engineering, engineering ethics and engineering education
Ibo van de Poel, *Delft University of Technology, The Netherlands*
Ethics of technology and engineering ethics

Editorial advisory board

Philip Brey, *Twente University, The Netherlands.*
Louis Bucciarelli, *Massachusetts Institute of Technology, U.S.A.*
Michael Davis, *Illinois Institute of Technology, U.S.A.*
Paul Durbin, *University of Delaware, U.S.A.*
Andrew Feenberg, *Simon Fraser University, Canada*
Luciano Floridi, *University of Hertfordshire & University of Oxford, U.K.*
Jun Fudano, *Kanazawa Institute of Technology, Japan*
Sven Ove Hansson, *Royal Institute of Technology, Sweden*
Vincent F. Hendricks, *University of Copenhagen, Denmark & Columbia University, U.S.A.*
Don Ihde, *Stony Brook University, U.S.A.*
Billy V. Koen, *University of Texas, U.S.A.*
Peter Kroes, *Delft University of Technology, The Netherlands*
Sylvain Lavelle, *ICAM-Polytechnicum, France*
Michael Lynch, *Cornell University, U.S.A.*
Anthonie Meijers, *Eindhoven University of Technology, The Netherlands*
Sir Duncan Michael, *Ove Arup Foundation, U.K.*
Carl Mitcham, *Colorado School of Mines U.S.A.*
Helen Nissenbaum, *New York University, U.S.A.*
Alfred Nordmann, *Technische Universität Darmstadt, Germany*
Joseph Pitt, *Virginia Tech, U.S.A.*
Daniel Sarewitz, *Arizona State University, U.S.A.*
Jon A. Schmidt, *Burns & McDonnell, U.S.A.*
Peter Simons, *Trinity College Dublin, Ireland*
Jeroen van den Hoven, *Delft University of Technology, The Netherlands*
John Weckert, *Charles Sturt University, Australia*

For further volumes:

<http://www.springer.com/series/8657>

Steen Hyldgaard Christensen • Carl Mitcham
Bocong Li • Yanming An
Editors

Engineering, Development and Philosophy

American, Chinese
and European Perspectives

 Springer

Editors

Steen Hyldgaard Christensen
Aarhus University, Herning
Denmark

Carl Mitcham
Department of Liberal Arts and Int'l Studies
Colorado School of Mines
Golden, CO, USA

Bocong Li
Department of Social Sciences
University of Chinese
Academy of Sciences
Beijing, China

Yanming An
Department of Languages
Clemson University
Clemson SC, USA

ISSN 1879-7202

ISSN 1879-7210 (electronic)

ISBN 978-94-007-5281-8

ISBN 978-94-007-5282-5 (eBook)

DOI 10.1007/978-94-007-5282-5

Springer Dordrecht Heidelberg New York London

Library of Congress Control Number: 2012950769

© Springer Science+Business Media Dordrecht 2012

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

In 1994, Richard B. Norgaard published *Development Betrayed: The End of Progress and a Coevolutionary Revisioning of the Future*. From an ecological perspective, Norgaard offered an analysis of why development has so frequently failed and the reasons why it is programmed to fail. Dating back to the Western Enlightenment, the modern project has been based on presumptions about universal human values and the idea of progress through control over nature through science, material abundance through technology, and effective government through rational social organization. However, despite resounding achievements, between the promise of modernity and its actual accomplishments, there has been a remarkable gap. Instead of fulfilling its deepest aspirations, Norgaard argues that modernity through science and technology as the main engines of economic growth has led to systematic introductions of risk, environmental degradation, population increase, poverty, social injustice, and cultural destruction on a global scale. The social acceptance of scientific ways of understanding and attempts to act rationally on these understandings has led to the exclusion of other ways of knowing, both scientific and traditional, to the detriment of a coevolutionary path to the future.

In this book, we do not unanimously claim that we share Norgaard's conclusions, but we do share and have been inspired by his co-evolutionary perspective on development and the promise of including other ways of knowing, both scientific, philosophical, and cultural. In particular, the traditional Chinese worldview derived from Confucianism, Taoism, Buddhism, neo-Confucianism, and popular religious practice provides lessons for an ecological worldview based on ideals of harmony, human perfectibility, and systemic fit within natural systems and processes. This remains true even in the presence of the distinctive successes of the Asian Four Tigers (Hong Kong, Singapore, South Korea, and Taiwan) and efforts to draw positive lessons from them by China, India, and others. The traditional Chinese worldview strongly emphasizes the interdependence of all living beings and therefore calls for a delicate balance between human wants and ecological needs. In contrast, the Judeo-Christian worldview contains deeply dualistic and individualistic values that put human beings at the center of the universe. The most extreme version of this anthropocentric paradigm is reflected in the dominant values and beliefs of consumerism. To what

extent distinctive Asian worldviews can alter the Western trajectory remains an open question, one that must be addressed with something other than romantic idealism.

The coevolutionary perspective and the aspiration nevertheless to include other approaches to thought and practice take the form of cross-cultural encounters among American, Chinese, and European scholars who set out to reflect on the cultural contexts and meanings of engineering and development, well aware that development is a complex and nontrivial concept. These cross-cultural encounters can be circumscribed as efforts to grapple with three simply stated but complex questions related to American, Chinese, and European cultural contexts:

- Where do engineers come from?
- What is engineering for?
- What are engineering studies for?

The first question refers to the formation of engineers through educational systems, institutions, degree programs, curricula, courses, disciplines, and more. The latter two questions acknowledge and extend Gary Downey's work on dominant practices and scalable scholarship in *engineering studies*. Here, they more precisely refer to localized meanings and purposes of engineering and cases of critical participation within engineering and sophisticated scholarly reflection on both opportunities and discontents.

What we offer is thus a genuinely cross-cultural, inter-, and meta-disciplinary reflection by engineers, philosophers, humanists, and social scientists. The book is the result of an American-Chinese-European research project launched in Golden, Colorado, at the Colorado School of Mines in May 2010. The original idea for this workshop grew out of previous meetings in 2009 at the Graduate University of the Chinese Academy of Sciences in Beijing and Dalian University of Technology and a previous European-American project titled "Engineering in Context." Regarding the composition of the team, Carl Mitcham was in charge of selecting the American team of scholars, Li Bocong and Carl Mitcham of selecting the Chinese team, and Steen Hyldgaard Christensen of selecting the European team. The structure of the book and the contributions of participants were agreed upon at the 3-day May 2010 workshop in which 21 scholars participated. During the process, Yanming An acted in roles of mediator and translator to bridge potential gaps in understandings between Chinese- and English-speaking participants. Some further coauthors were invited to join the project following the workshop, thus raising the number of contributors to 36.

The working hypothesis and point of departure of the workshop was the shared belief that engineers and engineering are key influences in the new form of the world and experience that we as human beings are creating both locally and globally. Additionally, this creation is most commonly described in terms of development, although the concept of development is usually understood to mean quite different things in American, Chinese, and European cultural contexts. In the extension of this shared belief, some of the questions that we discussed were:

1. What does engineering mean in different contexts?
2. How does international development work challenge the professional identities, practices, designs, and ethics of engineers?

3. How does development at different levels (subnational, national, international, transnational, global) challenge engineers to engage perspectives other than their own (e.g., local communities, engineers from other countries, humanitarians, etc.)?
4. What can we learn from different cultural perspectives?
5. What is the meaning and role of sustainability in relation to engineering and development?
6. In what ways do sustainability support or challenge ideas and practices in engineering?

Inevitably, such questions relate to ongoing discussions among engineering educators regarding engineering epistemology and the proper relationship between theory and practice and interactions between “the technical” and “the social” in an engineering education deemed suitable for engineering practice in an increasingly globalized professional context.

In an extension of Andrew Jamison’s historiographical work on engineering and technology and Anders Buch’s analysis of dominant discourses in the literature on engineering challenges, the workshop identified three different strategies to the integration of what has been called “social,” “contextual,” or “nontechnical” knowledge into engineering education. Each of these strategies is characterized by a distinct set of inherent normativities. Concurrently, these strategies reflect different perspectives on development related to commercial, societal, and cultural contexts, respectively. The three strategies are:

1. A business strategy

Aimed at optimizing local and national competitiveness and profit and securing economic welfare through a focus on the market system, companies’ demand for competencies, employability, management, and technical innovation. Epistemologically speaking, here nontechnical knowledge predominantly takes the form of integrating business knowledge and business disciplines into engineering curricula.

2. A professional strategy

Aimed at improving living conditions and securing social welfare through technological solutions that focus on macro-ethical responsibilities in relation to humankind and nature. Here, the emphasis rests on engineering virtues, professionalism, solutions that work, and “doing service” to humanity by enriching technological solutions. Nontechnical knowledge integration quite often takes the form of an endeavor to restructure undergraduate engineering as an academic discipline, similar to other liberal arts disciplines in the sciences, arts, and humanities. Strong emphasis is put on professional and disciplinary mastery with the goal of preparing students for lifelong learning rather than employment as an engineer immediately after graduation at the bachelor level.

3. A hybrid strategy

The point of departure for this strategy is the disintegration and proliferation of technological knowledge and the emergence of techno-science. The aim is to produce new knowledge and engage with the community. Nontechnical knowledge takes the form of (a) increased context sensitivity and a concern to increase the breadth of problem scoping in engineering and (b) integration of contextual

knowledge and understanding into engineering curricula with an emphasis on social responsibility.

These three strategies and their inherent normativities will either explicitly or implicitly, individually or in combination, make themselves heard as the backdrop of the individual chapters in this book.

We would also like to emphasize the collective character of the volume. This is reflected on two levels. First, in spite of our aim to write a scholarly book allowing participants a certain degree of freedom to pursue their research priorities, it has been a central concern for all of us that the work should present itself as a coherent and integrated whole. Second, the collective character of the book is reflected in the fact that a considerable number of the 23 chapters are coauthored, a few of them even across cultural divides.

Because the book aims to further the dialogue between engineering and philosophy by exploring ways the humanities can contribute to self-development in engineering education through the appreciation of the multiple contexts within which engineers increasingly work, academics are our primary audience. However, the book also addresses a wider audience and may actually function as a means to achieve greater self-understanding for both teachers in engineering disciplines and for practitioners. Additionally, educational policy makers, on both political and institutional levels, may find valuable material for reflection and inspiration here, insofar as different chapters provide insights into what development policy makers should know about engineering. We believe that, not least, the process of globalization compels engineering educators to rethink and to recontextualize engineering education in order to educate a better and more hybrid type of engineer. Finally, we hope the book may inspire students of engineering as well as students of the humanities and social sciences who are interested in the challenges and complexities that a rapidly changing and globalized world pose for higher education in general and for engineering education and practice in particular.

The Structure of the Book

The structure of the book reflects an effort to present the individual chapters in a logical and coherent manner. At the beginning, there is an introduction which serves to frame the contents but can also be read separately. The separate chapters are grouped into three main parts, each presented and framed by its own short introduction. An abstract and a number of keywords at the beginning of each chapter support a reading overview.

In the first part, engineering and development and dialectics of good intentions are reconsidered or questioned from both philosophical and engineering perspectives. The second is focused on engineering education. This part is devoted to a comparative analysis of American, Chinese, and European perspectives on engineering education viewed from both a synchronic and a diachronic perspectives. The third

part consists of a combination of comparative case studies of specific technologies, engineering leadership, and engineering ethics studies starting with a study of Engineers Without Borders, followed by a comparative study of socio-technical integration in research policies, scaling up to a general perspective on the relationship between engineering, nature, and society in the final two contributions.

The diversity of images and identities of the engineer, and the diversity of environments within which they work, is also reflected in the diversity of contributors. Historians, sociologists, and philosophers meet with “hard-core” electrical and mechanical engineers. Backgrounds in literature meet backgrounds in business administration and chemistry. The reader may feel the original backgrounds in the angle and style of the different chapters. The American, Chinese, and European origin of the authors may also be perceptible in the differences in the use of the English language. For the editors and other contributors, this variety of inputs was an enriching experience. It was also one of the starting premises of the project. We hope readers will feel and appreciate something of the experience we had when working together.

Acknowledgements

First, we would like to express our gratitude to the Colorado School of Mines for generously hosting a 3-day kickoff meeting and workshop in May 2010. In particular, we wish to thank the *Hennebach Program in the Humanities* for significant financial support, the *John and Sharon Trefny Institute for Educational Innovation* for associative endorsement, and the International Network for Engineering Studies (INES) for collaborative sponsorship. We further wish to acknowledge the cosponsorship of the Danish alliance, PROCEED (Program of Research on Opportunities and Challenges in Engineering Education in Denmark). Several contributors to this volume are involved in PROCEED, which is a cross-disciplinary research effort, funded by the Danish Strategic Research Council from 2010 to 2013. The aim is to help engineering education more effectively meet the environmental, societal, and technological challenges the profession is facing due to globalization and increasing international competition.

Second, we would like to thank the participating universities and institutions of higher education for their willingness to enter into the project and for giving the financial support for their respective project participants to travel to the workshop in Golden and the freedom to make their contributions to the project and to author their contributions. Particular institutions to be acknowledged include:

Aalborg University, Denmark
Aarhus University, Denmark
Arizona State University, Arizona, USA
Catholic University of Lille, France
Clemson University, South Carolina, USA

Colorado School of Mines, Colorado, USA
 Dalian University of Technology, China
 Dublin City University, Ireland
 Dublin Institute of Technology, Ireland
 Graduate University of the Chinese Academy of Sciences, China
 Katholieke Hogeschool Sint-Lieven, Belgium
 Northeastern University, China
 Pennsylvania State University, Pennsylvania, USA
 Purdue University, Indiana, USA
 Renmin University of China, China
 Technical University of Denmark, Denmark
 Tsinghua University, China
 University of Dublin, Trinity College, Ireland
 University of Wisconsin, Wisconsin, USA
 Virginia Polytechnic Institute and State University (Virginia Tech), Virginia, USA

We are also indebted to The Danish Society of Engineers (IDA), Denmark, for sponsoring editor-in-chief of this book Steen Hyldgaard Christensen's participation in the project and would thus like to convey our warmest appreciation to IDA.

Finally, we would like to thank our publisher, Springer, and in particular the publishing editor, Ties Nijssen, for a very fruitful collaboration. Also deserving of acknowledgement is Pieter Vermaas, editor-in-chief of the Springer book series *Philosophy of Engineering & Technology*, for his early interest in the project and help in establishing the contact with the publisher. It would also be remiss of us not to recognize the contributions of numerous proofreaders and copyeditors who helped finalize the project. Because of the large number of scholars contributing from the United States, China, and Europe as editors, we have accepted as an editorial principle both UK and US styles of language and spelling.

Herning, Denmark
 Golden, Colorado
 Beijing, China
 Clemson, South Carolina
 February, 2012

Steen Hyldgaard Christensen
 Carl Mitcham
 Bocong Li
 Yanming An

Contents

Part I Rethinking Philosophy of Engineering and Development

Introduction	2
Erich W. Schienke and Brent K. Jesiek	
1 Turning Engineering Green: Sustainable Development and Engineering Education	7
Andrew Jamison	
2 From a Micro–Macro Framework to a Micro–Meso–Macro Framework	23
Bocong Li	
3 Traditional Chinese Thinking and Its Influence on Modern Engineering and Social Development	37
Qian Wang and Qin Zhu	
4 Engineering and Development in Modern China: Challenges and Responses	47
Xiaonan Hong and Li Ma	
5 “Ecocity China”: An Ethos Under Development	69
Erich W. Schienke	
6 Negotiated Development: Rediscovering a Global Development Ethic	87
Peter McEvoy, Jane Grimson, and William Grimson	

Part II Rethinking Engineering Education

Introduction	104
Andrew Jamison and Yi Shen	

7 The Challenge of Educating Engineers for a Close, Crowded and Creative World 109
 Ela Krawczyk and Mike Murphy

8 Educating Chinese Engineers: The Case of Shanghai Jiao Tong University During 1896–1949 123
 Brent K. Jesiek and Yi Shen

9 Academic Drift in European Professional Engineering Education: The End of Alternatives to the University? 145
 Steen Hyldgaard Christensen

10 Governing Engineering..... 169
 Anders Buch

11 Historical Tensions in Engineering Education: European Perspectives..... 183
 Andrew Jamison and Matthias Heymann

12 Socio-technical Integration in Engineering Education: A Never-Ending Story..... 197
 Steen Hyldgaard Christensen and Erik Ernø-Kjølhed

13 Tensions in Developing Engineering Design Competencies 215
 Ulrik Jørgensen

14 The Local Engineer: Normative Holism in Engineering Formation 233
 Gary Lee Downey

15 Eyes Wide Shut? Loyalty and Practical Morality in Engineering Education..... 253
 Martine Buser and Christian Koch

Part III Rethinking Perspectives on Engineering, Nature, and Society

Introduction..... 270
 Martin Meganck and Yanming An

16 Ex-students Engaged in “Engineers Without Borders”: What Have They Become? 275
 Christelle Didier

17 Socio-Technical Integration: Research Policies in the United States, European Union, and China 291
 Hannot Rodríguez, Hu Mingyan, and Erik Fisher

18 Inheritance Ethics in Engineering Development: Comparison Between Shenyang and Ruhr on Industrial Heritage Conservation..... 305
Jian Wang and Jia Chen

19 Dam Construction Ethics in China 317
Zhihui Zhang

20 The Development of Railroads in the United States and China 329
Nan Wang

21 Engineering Leadership 341
Mike Murphy and Eugene Coyle

22 Harmonization with Nature: Ancient Chinese Views and Technological Development 357
Guoyu Wang and Yuan Zhu

23 Lynn White Revisited: Religious and Cultural Backgrounds for Technological Development..... 379
Martin Meganck

Author Biographies 397

Index 405

General Introduction

**Steen Hyldgaard Christensen, Carl Mitcham, Bocong Li,
and Yanming An**

Engineering, Cultural Value Systems, and Development

Are there elements in China's cultural tradition which – not only for China but the world at large – can continue to live today and retain their value? Or is the difference in environment so great that, except as museum pieces, they have lost their relevancy?

(Bodde 1957, p. 85)

As indicated by the titles of its three sections, this book has three aims: (1) rethinking philosophy of engineering and development, (2) rethinking engineering education, and (3) rethinking perspectives on engineering, nature, and society. The unifying intention centers on cross-cultural awareness by comparing American, Chinese, and European perspectives. In pursuing these goals, the following three major thematic issues are of primary concern: (a) China's modernization and the challenge of "sustainability" in both developed and developing countries; (b) local, national, and global normativities behind the positioning and repositioning of engineering and engineering education across the three regions and beyond; and (c) the traditional

S.H. Christensen, Ph.D.
Aarhus University, Birk Centerpark 15, DK-7400 Herning, Denmark
e-mail: steenhc@hih.au.dk

C. Mitcham
Department of Liberal Arts and Int'l Studies
Colorado School of Mines, Golden, CO, USA

B. Li, M.A.
Department of Social Sciences, University of the Chinese Academy of Sciences,
19A Yuquan Rd, 100049 Beijing, People's Republic of China
e-mail: libocong@ucas.ac.cn

Y. An, Ph.D.
Department of Languages, Clemson University, Clemson 29634-0535, SC, USA
e-mail: yanming@clemson.edu

Chinese harmony-oriented worldview as a conceptual resource for ecological thinking and its application in specific cases of engineering ethics studies in China and in comparison with other perspectives.

Recombining chapters within and across the three sections of the book brings other themes into view. For example, a separate issue highlights China's modernization and the inadequacy of any view that portrays modern engineering in China as mainly reactive and characterized by an inability to decouple modernization from Westernization. Instead, any appreciation of the role of engineering in China must acknowledge distinctions between four historical periods of codevelopment between engineering and Chinese society:

- 1840–1919: Premodernization
- 1919–1949: Chinese nationalism and modernization
- 1949–1978: Independent development of China under communism
- 1978–2011: Reform and opening up

A dialogue with the past and the legacy of communism has played crucial roles in codeveloping engineering and modernization in the Chinese context. Other contexts with different periodizations of codevelopment between engineering and society have manifested different dialogues that can inform and be informed by the Chinese experience.

Indeed, a second theme calls attention to cultural value systems and their relevance to engineering ethics studies in America, Europe, and China. In each of these regional histories, professional engineering ethics has emerged in dialogue with distinctive cultural traditions. In the United States, the tradition of free market individualism can be found reflected in an emphasis on the responsibilities of individual engineers to avoid conflicts of interest and blow the whistle when necessary. In Europe, traditions of social solidarity have led to greater emphasis on organizational and institutional responsibilities. In the United States, for instance, ethics codes for individual engineers play a more prominent role than in any European country. In Europe, role responsibilities are more often given legal formulations that structure both public service institutions and private corporations.

In China, the problematics of traditionalism, communist nationalism, and opening up have contributed special tensions to discussions of professional ethics. Here, interactions between a traditional harmony-oriented worldview, nationalist development, and incipient globalization provide a background for multiple case study controversies. Of note in the present volume are the infrastructural development of the Chinese railway system (Chap. 20), controversies over dam construction (Chap. 19), and debates about conservation of the Chinese industrial heritage (Chap. 18). In particular, controversies regarding modern dam construction for hydroelectric generation, abundant and inexpensive water, agricultural irrigation, industrial and commercial application, and management of floods and droughts have raised ethical concerns in China such that the prospects of further dam construction are uncertain. Indeed, much is the same in the United States and Europe, which have abandoned their earlier commitments to dam construction. Is China simply repeating a historical

development of the West or is it possible that China will moderate or modify its dam construction work in ways that will better the West?

Still a third theme concerns engineering education. Here, the emphasis shifts to the United States and Europe (as in Chaps. 9, 10, 11, 12, 13, and 14) but with complementary chapters dealing with the formation and leadership roles of engineers in China (Chaps. 4, 8, and 21). Taken together, such discussions disclose multiple trajectories for reform in engineering education across the three regions. They also make it abundantly clear why governing and reforming engineering education by relevant constituencies is so extremely complex.

Finally, the concluding two contributions (Chaps. 22 and 23) may be read as a dyad centered on the cultural origin and nature of, and differences between, the traditional Chinese harmony-oriented versus the Judeo-Christian domination-oriented worldviews. These two discussions are in some sense foundational for framing analyses of environmental degradation, of the historical roots of our present ecological crisis, and of principles of sustainable development. In dealing directly with the classical texts of the respective cultural backgrounds, these reflections present a fuller and more detailed portrait of the ambiguous social role of engineering, science, and technology in Asian and Eurocentric cultures.

Since the 23 chapters of the book and the links between them are presented in some detail in the three section introductions, this general introduction has broader aims. By way of providing deeper background for particular discussions, it considers three issues: neoliberal regimentation of globalization and development, emerging concerns in engineering and engineering ethics studies in China, and post-neoliberal engineering-for-development initiatives that seek to incorporate social justice goals and the often contradictory dialectic of “good” intentions.

Neoliberal Regimentation of Globalization and Development

Neoliberalism seems to be everywhere. This mode of free market economic theory, manufactured in Chicago and vigorously marketed through principal sales offices in Washington DC, New York, and London, has become the dominant ideological rationalization for globalization and contemporary state “reform.”

(Peek and Tickell 2002, p. 380)

Development is predicated on the assumption that some people and places are more developed than others, and therefore, those who are “developed” have the knowledge and expertise to help those who are not (Kothari 2005, p. 427). In terms of a center periphery of power distinction, this assumption ultimately implies that the center of power is identical with the center of truth (Nederveen Pieterse 1991, p. 5). Although problematic, such assumptions continue to prevail in much development thinking related to the ideology of modernization and tend either consciously or unconsciously to be embodied in the ideas, authority, and practices of the development *expert* (for a more detailed discussion of a global development ethic see

Chap. 6, Kothari 2005; Nederveen Pietersee 1991, 2010). According to Franz Schuurman (2000, p. 8), in the wake of World War II, all development thinking shared in at least three beliefs:

1. The essentialization of the third world and its inhabitants as homogeneous entities
2. An unconditional commitment to the concept of progress and the makeability of society
3. The importance of the (nation) state as an analytical frame of reference and a political and scientific confidence in the role of the state to realize progress

Among a number of other contributing factors, globalization has forced the qualification of these beliefs. In itself, globalization was propelled by rapid advances in transport, communication, and information technologies. In the long nineteenth century, globalization took place primarily through European and North American colonization and the economic activities of nation states. In the second half of the twentieth century, nation-state globalization was subsumed into transnational political entities such as the United Nations and NATO with increasing competition from multi- and transnational corporations such as Adidas and Nike (shoes), Siemens A.G. (industrial equipment), Microsoft (software), and Nestlé (foods). The energy and telecommunications sectors of the economy could provide further examples. Thomas Friedman (2007) has characterized these nation-based and corporate-based processes as globalization 1.0 and 2.0, respectively. He has further argued the existence of a new form of globalization 3.0 based in individuals: entrepreneurs, musicians, athletes, and others who themselves become global actors. One might also suggest that scientists and engineers are increasingly representatives of globalization 3.0, which nevertheless remains highly subject to the structures of neoliberal governmentality.

According to Trent Hamann (2009), neoliberal governmentality is rooted in entrepreneurial values such as competitiveness, self-interest, and decentralization. Its central aim is

the strategic production of social conditions conducive to the constitution of *Homo economicus*, a specific form of subjectivity with historical roots in traditional liberalism. However, whereas liberalism posits “economic man” as a “man of exchange,” neoliberalism strives to ensure that individuals are compelled to assume market-based values in *all* of their judgments and practices in order to amass sufficient quantities of “human capital” and thereby become “entrepreneurs of themselves”. Neoliberal *Homo economicus* is a free and autonomous “atom” of self-interest who is fully responsible for navigating the social realm using rational choice and cost-benefit calculation *to the express exclusion of all other values and interests*. Those who fail to thrive under such social conditions have no one and nothing to blame but themselves.

(Hamann 2009, p. 38)

Neoliberal governmentality thus celebrates the empowerment of the individual, the downsizing of government, and the decentralizing of state power to smaller localized units. The neoliberal mode of governance promotes the self-regulating

free market. Citizens who pursue the common good along traditional lines, striving to enhance civil society and social justice, are redefined as customers striving in this capacity to maximize their self-interest vis-à-vis the public (Steger and Roy 2010, p. 12).

According to Erhard Berner and Benedict Philips (2005), the apparent efficiency of this governmentality is the foundation of its influence (the shortcomings of Keynesian style controlled capitalism in the 1970s having led, it is argued, to the creation of self-serving state bureaucracies and economic stagflation). Its underlying goals of cutting subsidies and transfers for public welfare and development made it popular among conservative governments, bilateral and multilateral development agencies, and international financial institutions such as the World Bank and the International Monetary Fund (IMF). However, James Petras and Henry Veltmeyer (2002) have accused “foreign aid” neoliberalism of being a catalyst for regression. They distinguish between two approaches to aid – realist and idealist – and possible hybrid combinations thereof. The predominant realist approach requires the payment of both principal and interest on loans from international financial institutions, with devastating impacts on policy-making and living conditions in developing countries. To obtain such largely short-term loans, recipient countries are required to adhere strictly to the so-called Washington Consensus formulated in the 1980s by the IMF, World Bank, and US Treasury.

The Washington Consensus itself grew out of the postwar international economic order established by a 1944 conference in which representatives from 44 allied nations gathered at the Mount Washington Hotel in Bretton Woods, New Hampshire. Dominated by Harry Dexter White (1892–1948) and John Maynard Keynes (1883–1946), the Bretton Woods agreements created the IMF and the World Bank along with the momentum that led to the General Agreement on Tariffs and Trade (GATT), which eventually was transformed into the World Trade Organization (WTO). The Washington Consensus can be read as a critical reformulation of the Bretton Woods system. In brief, as a policy package, Washington Consensus neoliberalism promotes (as summarized by Williamson 1989):

1. Privatization of public enterprises
2. Deregulation of the economy
3. Liberalization of trade and industry
4. Massive tax cuts
5. “Monetarist” measures to keep inflation in check, even at the risk of increasing unemployment
6. Strict control on organized labor
7. The reduction of public expenditures, particularly social spending
8. The downsizing of government
9. The expansion of international markets
10. The removal of controls on global financial flows

This approach is seen by Petras and Weltmeyer as a catalyst of “reverse aid” designed to benefit the donor countries. In support of Petras’ and Weltmeyer’s position, the 2001 Nobel Prize winner in economics Joseph Stiglitz writes:

The Western countries have pushed poor countries to eliminate trade barriers, but kept up their own barriers, preventing developing countries from exporting their agricultural products and so depriving them of desperately needed export income.... It not only hurt the developing countries; it also cost Americans, both as consumers, in the higher prices they paid, and as taxpayers, to finance huge subsidies, billions of dollars.

(Stiglitz 2002, pp. 6–7)

By contrast, the idealist approach conceives of aid as a disinterested policy unrelated to the interests of financial capital and guided exclusively by humanitarian concerns, democratic values, and economic well-being. However, in many cases, the idealist approach tends to neglect its own embedding in a specific historical-structural context. The idealist approach emphasizes normative values but does not always critically assess the degree to which these values may be influenced by other interests or not complied with in aid-receiving countries.

It is also important to notice the transformative and adaptive capacity of the far-reaching political-economic neoliberal project. Making a distinction between destructive and creative moments of neoliberal reform, Jamie Peck and Adam Tickell (2002, pp. 388–389) argue that neoliberalism does not unfold following a universal scheme but in localized forms with differential combinations of state, cultural context, and market and in terms of “rollback” or “rollout” neoliberalism. As a consequence, neoliberalism has many different trajectories. There are major differences among American, Chinese, Russian, and Danish trajectories of “rollout” neoliberalism.

According to Wendy Larner (2000), besides governmentality and a policy package, the term neoliberalism also denotes an ideology. Manfred Steger and Ravi Roy (2010) argue that the ideological codifiers of neoliberalism are global power elites consisting of managers and executives of large transnational corporations, investment bankers, corporate lobbyists, influential journalists, public relation specialists, intellectuals, economists, celebrities, top entertainers, state bureaucrats, and politicians. As advocates of neoliberalism, they serve its agenda in saturating the public discourse with idealized images of a consumerist, free market world. “Skillfully interacting with the media to sell their preferred version of a single global marketplace to the public, they portray globalizing markets in a positive light as an indispensable tool for the realization of a better world” (Steger and Roy 2010, p. 11).

Since the financial crisis that broke out in 2008 and has continued into 2012, it has become increasingly clear that neoliberalism has not been able to deliver on its promises. Markets were not self-correcting and governed by an Adam Smithian “invisible hand.” Neither did they automatically emerge as the natural order by themselves without strong support from the state. Tax cuts and deregulation of financial markets have instead contributed to the creation of social injustice and inequality of tremendous proportions, both nationally and globally. According to Stiglitz:

The world has not been kind to neo-liberalism, that grab-bag of ideas based on the fundamentalist notion that markets are self-correcting, allocate resources efficiently, and serve the public interest well. It was this market fundamentalism that underlay Thatcherism,

Reaganomics and the so-called “Washington Consensus” in favor of privatization, liberalization, and independent central banks focusing single mindedly on inflation. For a quarter century, there has been a contest among developing countries, and the losers are clear: countries that pursued neo-liberal policies not only lost the growth sweepstakes; when they did grow, the benefits accrued disproportionately to those at the top.

(Stiglitz 2008, p. 1)

The current crisis of development is therefore both a crisis of neoliberal development in the global South and a crisis of neoliberal globalization in the West. In the West, neoliberal globalization is being challenged by new social movements, “Occupy Wall Street” being only among the more recent. In the global South, alternative development strategies now test the limits of the ideology of modernization (Nederveen Pieterse 1991). Ultimately, the current situation may be conceived of as a crisis of financial market capitalism itself. According to Michael Brie (2009, pp. 20–22), the current crisis of financial market capitalism is unfolding in five dimensions, posing a threat to its continued existence in the present form. Brie’s descriptors are abbreviated and summarized below:

1. *A crisis of overaccumulation.* Valorization of capital investment and development necessities are fundamentally different.
2. *A crisis of social reproduction.* There is a tendency in financial market capitalism to shorten capital valorization to 2 years. As a result, there is a general underinvestment in the renewal and development of the most important fields of social reproduction, in particular in education, culture, environment, and health.
3. *A crisis of social integration.* Worldwide, the decay of the state has reached 25% of all countries. There are now over 20 million refugees worldwide. There are three billion humans in need of basic essentials such as sufficient nutrition, fresh water, minimal sanitary conditions, medical help, and education. In many countries, either the social state or the traditional institutions of social integration are being destroyed.
4. *A crisis of democracy.* Never before have there been so many free elections as today, while at the same time, the expectations attached to them of a social and economic development that corresponds to these interests have been followed by disappointment. This means that there are crises in both the rationality and legitimacy of the political system of representative democracy.
5. *A crisis of security.* Water, raw materials, access to the sea, migration, knowledge, capital, and cultural identity – in neoliberalism, anything and everything becomes not only a commodity but also a cause of competition and violent confrontation. With the globalization of capital, violence has also been globalized.

Emerging Engineering Studies in China

In the first years after the 1949 Chinese Revolution, economic and cultural capital were concentrated in the hands of the old elite classes, while political capital was concentrated in the hands of the new Communist elite, made up largely of peasant revolutionaries. The new

regime first redistributed economic capital, dispossessing the old elites and converting the means of production into state and collective property... Having virtually eliminated economic capital, the CCP turned its attention to redistributing cultural capital, with the intention of further undermining the advantages of the old elite, an endeavor that reached its most radical point during the Cultural Revolution... After Mao's death in 1976, the new CCP leadership renounced class leveling and reconciled with the old elite. This facilitated the consolidation of a technocratic class order and the emergence of a New Class [of red engineers].

(Andreas 2009, p. 11)

As the most populous and rapidly developing country in world history, the People's Republic of China (PRC) – which across the twentieth century experienced more wrenching social change than any other state – is home to large-scale engineering achievements and sobering disasters. In the tradition of the Great Wall and Grand Canal are the Three-Gorges Dam (see Chap. 19) and a system of high-speed trains more extensive than the rest of the world combined (see Chap. 20). At the same time, in 1975 the Banqiao Reservoir Dam collapse caused more casualties than any other dam failure in history; in 2009, a whole 12-story apartment building on the outskirts of Shanghai toppled over due to a foundation failure; and in 2011, two high-speed trains collided in Zhejiang Province, causing the second deadliest such accident in the world. Environmental pollution is the worst of any developing country and has impacts far beyond China's borders.

Reflecting the large role of engineering in China today, probably more engineers occupy political leadership positions in the Chinese Communist Party and PRC than is the case in any other government. The closest comparison in United States history is the period when Herbert Hoover was elected the first engineer president (1929–1933). There is also more discourse on the ethics of science and engineering than in any other developing country as well as than in any other country in history at a comparable stage of technological development, including the first third of the twentieth century in the United States. During the 1990s, for instance, the Graduate University of the Chinese Academy of Sciences (GUCAS) established a program on the philosophy of technology and engineering and subsequently founded the Chinese journal *Engineering Studies* (2004–present). Under the leadership of Li Bocong, the program has expanded into a practice-oriented program in the philosophy and sociology of engineering broadly construed. As Li argues (2010, pp. 37 and 39), the “engineering community comprises [not only] engineers [but also] managers, investors, workers, and other stakeholders.” Moreover, since “philosophy is above all about how to lead a better life with wisdom,” in the contemporary world, this calls for reflection on “the wisdom of engaging in engineering activity.” This theme of integrating wisdom into engineering is reflected especially in Chaps. 3, 5, 18, and 22.

Additionally, in 2007, scholars from leading engineering universities established the Chinese Society for Ethics of Science, Technology, and Engineering based at Dalian University of Technology. Engineering ethics discourse in these contexts struggles with tensions inherited from pre-communist China (efforts to overthrow feudalism and colonialism), years of dominance by Mao Zedong (red over expert),

and opening up under engineer Deng Xiaoping (rapid economic development and globalization). As one young scholar has described the situation (Zhu 2010, pp.101 and 104), “engineering and engineering ethics studies in China [are drawing] on resources from China’s long cultural history, reconstructing the Marxist social criticism of technology, and learning from European and North American intellectuals” to ask: How can science, technology, and engineering best contribute to enhancing Chinese ways of life? What is the most ethical way to deal with the social and environmental problems that often arise from technological and engineering change? How can we avoid engineering mistakes while promoting Chinese economic development? Working with such questions, Chinese scholars have a “responsibility to think globally and to rethink locally in order to redefine the significance of ‘made in China’.”

There have been complaints that things are “poorly made in China” (Midler 2009). But this charge fails to appreciate how after more than 200 years of imperialist challenges, China could only have been expected to develop some asymmetric business tactics. To complain that Chinese industrialists often go “out of their way to manipulate product specifications to widen profit margins” (Midler 2009, p. xvii) neglects to acknowledge the heritage of duplicity of European and American behaviors toward China and the rationalized duplicity inherent to productive systems in the West.

What is being made in China today is in fact something more than material products, a point that can be indicated in part by enlarging the understanding of capitalist production. Going beyond classical (non-Marxist and Marxist) analysis, capital in a generalized sense includes any human product that enhances a person’s power to perform other economically useful work. Within this framework, Pierre Bourdieu (1986) has distinguished cultural and social capital. Adapting Bourdieu, Joel Andreas (2009) has described ongoing shifts in economic, cultural, and political capital. For Andreas, since the death of Mao, the peasant cadre political capital has been progressively eclipsed by the cultural capital of engineering expertise. But perhaps more than is commonly recognized, engineering expertise itself is also being remade in China – with global implications.

Post-Neoliberal Engineering-for-Development Initiatives

It is precisely the groundswell of *anti-development* thinking, oppositional discourses that have as their starting point the rejection of development, of rationality, and the Western modernist project, at the moment of purported Washington consensus and free-market triumphalism, that represents one of the striking paradoxes of the 1990s. Ironically, however, both of these discourses – whether the World Bank line or its radical alternative – look to *civil society, participation, and ordinary people* for their development vision for the next millennium.

(Mohan and Stokke 2000, p. 247)

Since the beginning of 1990s, globalization has become the new context for engineering and engineering education in the United States, Europe, and elsewhere. Engineering-for-development initiatives should therefore be seen in the light of competing ideologies of globalization. Among the most important are what may be termed market globalism, social justice globalism, and restorative justice globalism. Market globalism is characteristically promoted by the United States and sees globalization as primarily a process of expanding the free market and lowering international trade barriers, both to some degree preserved by US military power. Social justice globalism is more typically promoted by European countries and stresses the extent to which globalization is a political process that promotes human rights and international law; to the extent that military force plays any role, it must be exercised through the United Nations or some other multilateral mechanism. Restorative justice globalism takes the notion of restorative justice from the domestic sphere, where it refers to a focus on the needs of victims, offenders, and engaged communities instead of attempts to satisfy abstract legal principles, and extends this to international affairs. China, for instance, tends to see globalization as a process in which to reaffirm long-denied sovereignty and to redress historical wrongs.

There are also, of course, various antiglobalization ideologies. Manfred Steger (2009), for instance, uses the term “jihadist globalism” to refer to struggles against both market globalism and social justice globalism in the name of allegedly Islamic values and beliefs perceived by adherents to be under attack by forces of secularism and consumerism. But in fact, any globalism opposes itself to others and thus constitutes at once both an anti- and a pro-perspective on globalization as a whole.

In the present context, the focus is mainly on post-neoliberal engineering-for-development initiatives that seek to incorporate social justice goals. However, as Giles Mohan and Kristian Stokke (2000) have indicated above, it should be noticed that the move toward conceptualizing global engineering-for-development initiatives in terms of “community development,” “participatory development,” and “empowerment” or the other way around can be deceptive, since it has produced high-level agreements between actors and institutions of the new “left” and the new “right,” although for quite different reasons. This is an indication of diversity but also of tensions between commercial, professional, and hybrid approaches to development.

In recent years, there has been an explosion in global-development-engineering initiatives in engineering education in the United States and elsewhere driven by a broad range of goals including addressing basic human needs, working to end poverty, providing students with cross-cultural design experience in preparation for careers in the globalized economy (Riley 2007). Similarly, engineering-for-development initiatives that seek to incorporate social justice goals have emerged in engineering communities around the globe (see, e.g., Riley 2008; Baillie and Catelano 2009; Catelano 2007). According to Donna Riley (2007), a broad array of models has been employed for this purpose, both curricular and cocurricular models. These models have been employed in collaboration with foreign governments, educational institutions, or nongovernmental organizations. Moreover, entrepreneurial, sustainable, appropriate technology, and/or community-based approaches to design have

been applied. These initiatives seek to imagine new models of interactions with indigenous people and local cultures able to counteract adverse effects of development interventions more effectively (Nieuwma and Riley 2010).

Since the beginning of the 1990s, engineering activities dealing with humanitarian engineering, community development, and service learning have surged within engineering communities in the USA and around the world. According to Juan Lucena et al. (2010) and Carl Mitcham and David Muñoz (2010), it was the involvement of other professions in humanitarian relief such as Doctors Without Borders (1971), Reporters Without Borders (1985), and Lawyers Without Borders (2000) that prompted engineers to take up the challenge leading to the establishment of a number of groups in France in the late 1980s (see Chap. 16 in this respect), Spain (1991), Canada (2000), Belgium (2002), Denmark, and others, under some national form of the name “Engineers Without Borders.” Simultaneously, there has been a growing interest among engineers in trying to address the challenges of sustainable development (see Chaps. 1, 5, 10, 11, and 23 for a more comprehensive account of the historical background for the emergence of sustainable development and other challenges to and for engineers).

According to Lucena et al. (2010), the convergence of three historical key events stimulated a growing interest in humanitarian relief and sustainable development in the USA (Lucena et al. 2010, p. 40):

- The globalization of US engineering education
- The transformation of long-term loyalty to engineering employees
- The unparalleled media coverage of humanitarian crises, violent conflict, poverty, and environmental degradation occurring worldwide

Globalization has been recognized within engineering education in the USA and elsewhere both as a new business need and as a professional or social responsibility concern (see, e.g., Downey and Beddoe 2011). Simultaneously, it has been included among the ABET (Accreditation Board of Engineering and Technology) EC2000 criteria. Under criterion 3, the global context is reflected as a requirement for engineers to obtain “the broad education necessary to understand the impact of engineering solutions in a global and societal context.”

One example of a course that seeks to meet this ABET requirement is the “Engineering and Global Development” course offered at Smith College’s Picker Engineering Program. Its objectives and pedagogy are designed to enable engineering students to (Riley 2006, p. 51):

- Design and build technology systems for use in developing countries
- Apply knowledge of appropriate technology and its critique to design
- Critically analyze issues related to the use of technology in developing countries
- Demonstrate understanding of the limitations of technology in addressing problems of development

In this course, specific attention and critique is centered on the “expert” model.

Similar courses or programs may be found in many other places across the USA. The University of Colorado at Boulder, for example, offers a program in

Engineering for Developing Communities with a similar mission: “to educate globally responsible students who can offer sustainable and appropriate technology solutions to the endemic problem faced by developing communities worldwide (including the US).”

The crucial question is whether these initiatives have succeeded. As suggested by the term “voluntourism,” voluntary work among engineering students might sometimes entail incentives for tourism in exotic places, making their projects “hit and run” style development projects without any real value for beneficiaries. Actual contributions to the development process of a country only happen when engineers or prospective engineers are truly alert to the importance of contextual sensitivity and listen to the desires of those they are attempting to serve (Parsons 1996). In arguing in favor of a participatory model of interaction which they term negotiated development, the authors of Chap. 6 offer a more in-depth treatment of some of the complexities of the development process.

References

- Andreas, Joel. 2009. *Rise of the red engineers: The cultural revolution and the origins of China's new class*. Stanford: Stanford University Press.
- Baillie, Caroline, and George D. Catalano. 2009. *Engineering and society: Working towards social justice*. San Rafael: Morgan & Claypool.
- Berger, Mark T., and Mark Beeson. 1998. Lineages of liberalism and miracles of modernization: The World Bank, the East Asian trajectory and the international development debate. *Third World Quarterly* 19(3): 487–504.
- Berner, Erhard, and Benedict Philips. 2005. Left to their own devices? Community self-help between alternative development and neo-liberalism. *Community Development Journal* 40(1): 17–29.
- Bodde, Derk. 1957. *China's cultural Tradition: What and wither?* New York: Rinehart.
- Bourdieu, Pierre. 1986. The forms of capital. In *Handbook of theory and research for the sociology of education*, ed. J.F. Richardson (1086). Westport: Greenwood Press.
- Brie, Michael. 2009. Ways out of the crisis of neoliberalism. In: *Development dialogue*, ed. U. Brand, N. Sekler, No. 51, January 2009. Uddevalla: Mediaprint.
- Catalano, George D. (2007) *Engineering, poverty, and the earth*. San Rafael: Morgan & Claypool.
- Downey, Gary L., and Kacey Beddoe. 2011. *What is global engineering for: The making of international educators*. San Rafael: Morgan & Claypool.
- Friedman, Thomas. 2007. *The world is flat: A brief history of the twenty-first century*. Release 3.0. New York: Farrar, Straus and Giroux.
- Hamann, Trent H. 2009. Neoliberalism, governmentality, and ethics. *Foucault Studies* (6):37–59.
- Jenkins, T.N. 2002. Chinese traditional thought and practice: lessons for an ecological economics worldview. *Ecological Economics* 40:39–52. Elsevier Science B. V.
- Kothari, Uma. 2005. Authority and expertise: The professionalization of international development and the ordering of dissent. In *Antipode*. Oxford; Blackwell.
- Larner, Wendy. 2000. Neo-liberalism: Policy, ideology, governmentality. *Studies in Political Economy* 63(Autumn): 2000.
- Li, Bocong. 2010. The rise of philosophy of engineering in the east and the west. In *Philosophy and engineering: An emerging agenda*, ed. Ibo Van de Poel, and David E Goldberg. Dordrecht: Springer.

- Lucena, Juan, Schneider, Jen, and Jon A, Leydens. 2010. *Engineering and sustainable community development*. San Rafael: Morgan & Claypool.
- Midler, Paul. 2009. *Poorly made in China: An insider's account of the China production game*. Hoboken: Wiley.
- Mitcham, Carl, and David, Munöz. 2010. *Humanitarian engineering*. San Rafael: Morgan & Claypool.
- Mitter, Rana. 2008. *Modern China. A very short introduction*. Oxford: Oxford University Press.
- Mohan, Giles, and Kristian, Stokke. 2000. Participatory development and empowerment: The dangers of localism. *Third World Quarterly* 21(2):247–268.
- Nederveen Pieterse, Jan. 1991. Dilemmas of development discourse. The crisis of developmentalism and the comparative method. *Development and Change*, vol. 22, 5–29. London: Sage.
- Nederveen Pieterse, Jan. 2010. After post-development. *Third World Quarterly* 21(2): 175–191.
- Nieusma, Dean, and Donna, Riley. 2010. Designs on development: Engineering, globalization, and social justice. *Engineering Studies* 2(1):29–59.
- Parsons, Laura B. 1996. Engineering in context: Engineering in developing countries. *Journal of professional Issues in Engineering Education and Practice* 122(4). October 1996, ASCE.
- Peck, Jamie, and Adam, Tickell 2002. Neoliberalizing space. *Antipode* 34(3):380–404. Oxford: Blackwell.
- Petras, James, and Henry Weltmeyer. 2002. Age of reverse aid: Neo-liberalism as catalyst of regression. *Development and Change* 33(2):281–293. Oxford: Blackwell.
- Riley, Donna, and Alan H. Bloomgarden. 2006. Learning and service in engineering and global development. *International Journal for Service Learning in Engineering* 2(1, Fall 2006):48–59.
- Riley, Donna. 2007. Resisting neoliberalism in global development engineering. *American Society for Engineering Education*.
- Riley, Donna. 2008. *Engineering and social justice*. San Rafael: Morgan & Claypool.
- Schuurman, Frans J. 2000. Paradigms regained? Development studies in the twenty-first century. *Third World Quarterly* 21(1):7–20.
- Steger, Manfred B. 2009. *Globalization. A very short introduction*. Oxford: Oxford University Press.
- Steger, Manfred B., and Ravi K Roy. 2010. *Neoliberalism. A very short introduction*. Oxford: Oxford University Press.
- Stiglitz, Joseph. 2002. *Globalization and its discontents*. London: Penguin Books.
- Stiglitz, Joseph. 2008. The end of neo-liberalism. Project Syndicate. www.project-syndicate.org
- Williamson, John. 1989. What Washington means by policy reform. In *Latin American readjustment: How much has happened*, ed. John Williamson. Washington D.C.: Institute for International Economics.
- Zhu, Qin. 2010. Engineering ethics studies in China: Dialogue between traditionalism and modernism. *Engineering Studies* 2(2): 85–107.

Part I
Rethinking Philosophy of Engineering
and Development

Introduction

Erich W. Schienke and Brent K. Jesiek

Whether serving directly or indirectly; whether aligned with local, national, or global interests; whether mobilized in support of defense, infrastructure building, technological innovation, or technocratic planning, engineers have long served as agents of development. As a result, their work frequently occurs at the intersection of numerous, competing normativities, or different views of how the world ought to be, what is judged good or bad, how things are valued and why. These normative claims necessarily ebb and flow over time; they proliferate and contract, forcing engineers to periodically reposition themselves and their work in relation to larger social, economic, political, and cultural forces. Engineers are at once instigators and reactants in a variety of developmental milieus.

Among contemporary development discourses challenging engineers, sustainability stands out as particularly ascendant and influential, especially as it makes its way into engineering courses and curricula, transforms engineering design practices, and begins to refashion entire industries. Yet the very notion of sustainable development is paradoxical in light of at least three tensions. The first tension rests on the paradox that continuing current national and global development practices will simply not suffice in addressing the projected growth in demand, nor adequately reduce impacts on the environment and human populations. A second key tension is that economic development itself does not imply a leveling off, in that a well-reasoned articulation of the ends is elusive and difficult to imagine, let alone capable of being signified by objective means. A third tension comes in thinking that development is somehow singular, that is, one pattern we will eventually fall into if only we can develop our ability to manage the complexity of “the system.”

E.W. Schienke, Ph.D. (✉)

Rock Ethics Institute, Pennsylvania State University, University Park, PA, USA

e-mail: erich@psu.edu

B.K. Jesiek, Ph.D.

School of Engineering Education and School of Electrical and Computer Engineering,

Purdue University, West Lafayette, IN, USA

e-mail: bjesiek@purdue.edu