

Industrial Ecology in China, Part II

Education

Han Shi, Yuichi Moriguchi, and Jianxin Yang

Teaching Industrial Ecology in China

The earliest industrial ecology-related teaching in Chinese universities can be traced to the course “Pollution-Free Industrial Processes,” which was first delivered at the Department of Chemical Engineering of Tsinghua University in 1988. The course then evolved into the first course on cleaner production delivered at the Department of Environmental Engineering of Tsinghua University in 1993.

Since then, an increasing number of Chinese universities have started to offer courses such as frontiers of the environmental sciences, cleaner production, industrial environmental management, eco-materials, and green chemistry. Within these courses, industrial ecology theory and practice have been introduced. No university in mainland China, however, had delivered, until 2001, any particular course on the subjects of life-cycle assessment (LCA), materials flow analysis (MFA), industrial symbiosis, or industrial ecology more generally. Much headway was made in the year 2002, however. During the spring semester of 2002, Tsinghua University offered the first course on industrial ecology to undergraduate students. Advocated by Zhongwu Lu, a member of the Chinese Academy of Engi-

neering (CAE), the School of Materials and Metallurgy of Northeastern University in Liaoning Province has placed a high priority on industrial ecology research on the metallurgical industry and has begun offering industrial ecology courses to both undergraduate and graduate students.

The first book on industrial ecology in Chinese was published in 1999 (Erkman 1999); it was a translation of Suren Erkman’s *Vers Une Ecologie Industrielle*. The book has played an instrumental role in raising primary awareness of

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industrial ecology in academic and policy-making circles. Although effective in documenting the intellectual history and basic concepts of industrial ecology, the book is not suitable as a textbook for higher education in science and engineering or as a technical guideline for industrial practice. In 2002, Nansheng Deng and Feng Wu of Wuhan University published the first university textbook in industrial ecology (Deng and

Wu 2002). It includes chapters such as the **theoretical framework for industrial ecology, materials and energy flow, dematerialization, LCA, design for environment (DfE), extended producer responsibility, product-oriented environmental policy, eco-efficiency, eco-industrial parks, and education on industrial ecology.** On the basis of the textbook, the Department of Environmental Sciences of Wuhan University also began offering an industrial ecology course to undergraduate students in the fall semester of 2002. The Research Center for Eco-Environmental Sciences and the Institute of Process Engineering of the

Chinese Academy of Sciences have very recently also begun offering education in and granting master's and doctoral degrees in the field of industrial ecology.

Qingshi Zhu, president of the Science and Technology University of China, and a few other members of the Chinese Academy of Sciences jointly advocated the introduction of the emerging field of green chemistry from the United States to China in the mid-1990s. Since then, more and more Chinese universities have started to carry out research and offer courses on green chemistry, a concept strongly linked to industrial ecology. Among them, the Science and Technology University of China remains a leader. To date, Chinese universities have organized five international symposia on green chemistry.

An important ongoing initiative is the Collaborative Industrial Ecology in Asia project at the Yale University School of Forestry and Environmental Studies (F&ES) funded by the Luce Foundation, a U.S.-based private philanthropy organization. Within this project, the Yale F&ES has been collaborating with Tsinghua University (Beijing), the Center for Environmentally Sound Technology Transfer (Beijing), Shanghai Jiao Tong University (Shanghai), and the National University of Singapore (Singapore) to develop both the capacity of Asian institutions and a cohort of environmental leaders and professionals within the field of industrial ecology. With the support of this project, the Chinese translation of *Industrial Ecology*, the well-known textbook by T. E. Graedel and B. R. Allenby, is being published by Tsinghua University Press. Along with efforts being made to translate industrial ecology terms in a manner that is technically correct and culturally relevant, both Yale University scholars and visiting scholars from the Chinese partners are developing Asian cases on industrial ecology to make the book more relevant to Chinese readers. Upon its publication, it will be the first Chinese textbook on industrial ecology that is not only for university education but also to be used as a technical guide for industrial practitioners. Subsidized subscriptions for the *Journal of Industrial Ecology* are also being offered to Asian universities and environmental institutions.

The Outlook for Diffusing Industrial Ecology in China

Because the industrialization process in China is progressing rapidly, there are tremendous opportunities for the application of industrial ecology concepts and tools as well as new subjects for industrial ecology to explore. Compared to current environmental tools, the wide application of industrial ecology may have the following particular merits for China's environmental policy and management practice:

- Expansion of the focus of industrial environmental management from manufacturing processes and activities to cover both product-related environmental impacts and interenterprise and regional economic implications caused by broad industrial activities.
- Linkage of environment and energy directly. Traditionally, the energy dimension is, to a large extent, missing in China's environmental policy framework. In recent years, there has been growing consensus that environmental and energy policies should be linked from the start, but practical approaches to doing so are largely underdeveloped. Industrial ecology may well serve to formulate environmental and energy policies in a more integrated, mutually supportive manner.
- Directing the attention of industrial environmental management from solving existing problems to preventing future environmental pollution. This will help mitigate the ironic situation in which China has been facing the challenge of fixing long-standing environmental headaches while creating further problems arising from new investments.
- Provision of a practical framework for integrating economic growth and environmental protection. Notions such as the closed-loop economy, eco-industrial parks, and eco-industrial development are more likely to be accepted by Chinese economic decision makers because of the proindustrial elements of these concepts. In contrast, pollution abatement and even

cleaner production are commonly seen as environmentally focused and counterproductive by the Chinese industrial community.

Just over the past two years, the concepts of eco-industrial parks and the closed-loop economy have started to flourish in China. Although government officials and industrial estate managers talk more and more often about these matters, what is apparently lacking is the theoretical framework, practical tools, and experts who can effectively apply them. Chinese universities and research institutions have started to respond to the need to fill this gap. Tsinghua University created an eco-industrial research center within its Department of Chemical Engineering. SEPA (State Environmental Protection Administration) approved the establishment of a national key lab on eco-industrial development in Northeastern University, CRAES (Chinese Research Academy of Environmental Sciences), and Tsinghua University. With the support from the National 863 Program and other sources, the Chinese Center for Materials Life-Cycle Assessment is being established within Beijing Polytechnic University. The formation of the Chinese Eco-materials Research Society is also underway. This surge of institutional development presents an unprecedented opportunity for introducing industrial ecology by advancing basic and applied research and educating China's future industrial ecologists.

For industrial ecology to prosper in such a rapidly industrializing nation, it must not become the patent of the environmental community; its acceptance and application by economic policy makers, urban planners, and industrial managers will be the decisive factor. One important lesson learned from Chinese experience in introducing cleaner production is how much more effort is needed if the industry does not buy into the concept.

Currently, Chinese industry has not been widely aware of or convinced of the value of industrial ecology and has not been prepared to fund research and practice on the development of industrial ecology tools. On the other hand, government agencies have not been sensitized to the public goods effects and urgent demands of

industrial development in China and have other funding priorities rather than industrial-ecology-related research. Thus, Chinese universities and research institutions face a great challenge in obtaining funding to conduct industrial-ecology-related research and enhance institutional networking. Given the fact that many leading advocates are members of the CAE with their incomparable policy influences, joining hands by some of them could be extremely effective in raising the government's attention and support. Strong leadership is essential to securing the synergy among some of these influential scholars, who have different disciplinary backgrounds and are affiliated with different institutions. A promising sign is that Kuangdi Xu, president of the CAE, has been actively promoting the reduction, reuse, and recycling of resources and development of closed-loop economies (Xu 2002). Another important activity is the ongoing study on strategy and mechanisms for the promotion of circular economies and cleaner production in China. Yi Qian, a member of the CAE and professor at Tsinghua University, is leading an international team of experts, including Zhongwu Lu, a member of the CAE and former president of Northeastern University. This study has just been launched within the framework of the Task Force on Circular Economies and Cleaner Production under the China Council on International Cooperation on Environment and Development. The initiative is designed to develop useful policy suggestions on how to effectively promote circular economies and cleaner production in China to the Chinese government on the basis of local case studies on Liaoning Province, the Shanghai municipality, and the city of Guiyang.

Collaborations between Chinese academic institutions and their European, North American, and Japanese counterparts have played an indispensable role in catalyzing pilot research and nurturing China's initial expertise in industrial ecology. The cooperation with and support from foreign universities and organizations will continue to be of vital significance for Chinese universities and other institutions. Such cooperation and support should better focus on demonstrating the value and relevance of industrial ecology to Chinese government and industry and

helping initiate a challenging but vital process of nurturing a core pool of educators and professionals in China in the longer term. A new generation of industrial ecology researchers and practitioners will be essential to tap the potential contribution of industrial ecology toward a more sustainable industrialization process in China.

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About the Authors

Han Shi is the director of the Center for Environmentally Sound Technology Transfer, Beijing, China. **Yuichi Moriguchi** is the head of a research section and **Yianxin Yang** is a JSPS Fellow at the National Institute for Environmental Studies in Tsukuba, Japan.

Address correspondence to:

Han Shi
Center for Environmentally Sound Technology Transfer
109 Wanquanhe Road
Haidian District, Beijing 100089
P. R. China
shihan@acca21.org.cn
<www.cestt.org.cn>