Industrial Ecology and Industry Symbiosis for Environmental Sustainability

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Definitions, Frameworks and Applications

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Preface

Why would I like to introduce and explore Industrial Ecology (IE) and Industrial Symbiosis (IS) from an operations management (OM) perspective?

IE considers developing and transforming industrial systems to industrial ecosystems, which have high levels of nearly closed-loop material exchanges and efficiency of energy cascading. IS, as one area within IE, explores ways of developing knowledge webs to facilitate the establishment of novel material exchanges and energy cascading within and across companies and industries. Applying IE and IS effectively dramatically improve environmental sustainability.

OM aims to continuously improve the efficiency and effectiveness of processes for producing goods and providing services to customers. However, a process in OM is considered as a linear transformation. Where raw materials come from and where industrial waste and after-use products go have not been considered purposefully. Linear transformation thinking needs to be replaced by closed-loop thinking in OM in order to successfully transform industrial systems to industrial ecosystems and be sustainable in the long run.

Industrial waste, by-products or residues generate environmental benefits, economic values and reduce the burden to societies if they can be reused, remanufactured or recycled as feedstock to another process. Reduction of disposals along all stages of a product life cycle, including the product after-use stage, contributes to environmental sustainability as well as economic and social sustainability. After-use products should also be considered for their re-entry to industrial systems through the application of reuse, remanufacturing and recycling options, with the assistance of design for environment (DfE). This allows after-use products to re-enter circulations in our industrial systems as resources instead of being disposed of into our natural environment. This can dramatically reduce the intake of virgin materials and pollutant and waste emissions to our natural environment.

This idea is not new and was proposed by Frosch and Gallopoulos in 1989. However, why are OM transformation processes still being considered and taught in a linear transformation representation of inputs and outputs? Shouldn't all processes and systems work towards nearly closed-loop industrial ecosystems in an extended system view?

It has not been an easy journey for me to fully understand the principles and purposes of IE and IS through exploring their definitions and applications in the literature, as the literature offers different and in some cases conflicting views. Writing this book has given me an opportunity to explore IE and IS in great depth and has clarified a number of queries I have had over the last few years. I hope this book can also help readers reappraise and elucidate their own thinking regarding IE and IS and their roles in achieving environmental sustainability. If that is the case, I have achieved my purpose.

Sheffield, UK, Xiaohong Li
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Finally, I wish to thank my readers in advance who are interested in making this world a better place by taking Industrial Ecology and Industrial Symbiosis into their learning and practice. It is you who will make the difference!

Contents

Abbreviations

BCSD-UK	Business Council for Sustainability Development-United Kingdom
C2C	Cradle to cradle
C2G	Cradle to grave
Defra	Department for Environment, Food and Rural Affairs
DETDZ	Dalian Economic and Technological Development Zone (Dalian, China)
DfE	Design for environment
DfRec	Design for recycling
DfRem	Design for remanufacture
DSP	Dominant Social Paradigm
EIC	Eco-industrial cluster
EIP	Eco-industrial park
EPA	Environmental Protection Agency (USA)
EPR	Extended producer responsibility
IE	Industrial Ecology
IM	Industrial metabolism
IP	Industrial park
IS	Industrial Symbiosis
JIT	Just-in-time
LCA	Life cycle assessment

LCC/LCCA	Life cycle cost analysis
LCEcA	Life cycle economic analysis
LCEnA	Life cycle environmental analysis
LCI	Life cycle inventory
LCIA	Life cycle impact assessment
LCRA	Life cycle risk analysis
LCSA	Life cycle sustainability analysis
LCSoA	Life cycle social analysis
MEP	Ministry of Environmental Protection (MEP)
NISP	National Industrial Symbiosis programme (UK)
OEM	Original equipment manufacturer
OM	Operations management
SEPA	State Environmental Protection Agency (SEPA) (China)
SLCA	Social life cycle analysis
TEDA	Tianjin Economic-Technological Development Area (Tianjin, China)
TQM	Total Quality Management
WEEE	Waste Electrical and Electronic Equipment

List of Figures

List of Tables