UNIVERSITY
KAISERSLAUTERN

Inaugural Meeting of the
International Society for Industrial Ecology (ISIE)
The Science and Culture of Industrial Ecology
ISIE 2001, 12-14 November 2001, Leiden (The Netherlands)

Industrial Ecology's Hidden Philosophy of Nature: Fundamental Underpinning to Use Nature as Model

Ralf Isenmann

Forschungsschwerpunkt Umweltschutz und Energietechnik (FUE)
[http://www.uni-kl.de/FB-ARUBI/Forschungsschwerpunkte]
FB Sozial- und Wirtschaftswissenschaften
Heft 13, November 2001

University Kaiserslautern
Ralf Isenmann, Dipl.-Wirtsch.-Ing. (Master of Business and Engineering)
Department of Business Information System and Operations Research (BiOR)
Chair: Prof. Dr. Heiner Müller-Merbach
Gottlieb-Daimler-Straße
67653 Kaiserslautern
Germay
Phone: +49 631 205 2936
Fax: +49 631-205 3381
Email: isenmann@bior.de
Internet: http://www.bior.de

Overview

1 Author and Correspondence Address 3

2 Keywords 3

3 Summary 4

4 Goal and Scope 8

5 Content 9

6 Methods 11

7 Results and Conclusions 11

8 References 12

9 Transparencies 16

10 Further Studies 25

1 Author and Correspondence Address

Ralf Isenmann, Master of Industrial Engineering and Management (Dipl.-Wirtsch.-Ing.), University Kaiserslautern, Research Fellow at the Department of Business Information Systems and Operations Research (BiOR), and member involved in several environmental management studies within the broad interdisciplinary and specialized research division "Environmental Protection and Energy Technology", carried out at the University Kaiserslautern, in particular within the research field "what can economists learn from nature seen as model"; former occupation: Research Fellow at the Department of Philosophy in particular Philosophy of Sciences, Technology and Economics, University Kaiserslautern.

University Kaiserslautern
Ralf Isenmann, Dipl.-Wirtsch.-Ing.
Department of Business Information Systems and Operations Research (BiOR)
Chair: Prof. Dr. Heiner Müller-Merbach
P.O. Box 3049
67653 Kaiserslautern
Germany
Phone: +49-631-205-2936
Fax: +49-631-205-3381
Email: isenmann@bior.de
Internet: http://www.bior.de

2 Keywords

Analogy; Ecological Economics; Industrial Ecology; Learning from Nature; Metaphor; Nature as Model; Paradigm; Philosophy of Nature; Philosophy of Science

3 Summary

In its scientific sense, industrial ecology represents an emerging **transdisciplinary field** of studying **industrial systems** and their fundamental **linkage with natural ecosystems**. As a short form, industrial ecology is called the “science of sustainability”.

At the bottom of industrial ecology there is a **refreshingly different perspective of understanding nature as model** in comparison with other scientific disciplines and concepts of understanding nature e.g. in terms of “sack of resources”, “biophysical limit”, “something outside”, “surrounding”, or just “environment” as opposed to industrial systems. The keynote of industrial ecology’s specific perspective of understanding nature is to balance the development of industrial systems with the constraints of natural ecosystems, analogous to an “industrial symbiosis”. This perspective does not merely spring from a persistent craving for balancing natural ecosystems and industrial systems but is based on a persuasive analogy between nature - seen as matured cyclical economy on the one hand - and industry taken as a whole - interpreted according to a living systems approach on the other.

Indeed, **metaphorical application** of nature and natural ecosystems are intuitively appealing and smartly sounding. Surely, metaphorical usage and **analogy** provide valuable insights as an **eye-opener**. Certainly, metaphorical usage and analogy also lead to new facets of interpreting nature, perhaps for learning from nature in order to contribute for solving our environmental problems.

However, the currency of metaphors and analogies themselves does not imply automatically general acceptance and proper usage. More detailed, according to common scientific standards of philosophical awareness, metaphorical usage and analogy are assigned to the **context of discovery**. Metaphor and analogy are actually fundamental to our way of thinking, and indeed, they may deliver unexpected insights and they may prove to be a window for surprising and refreshing vistas. However, even if metaphor and analogy are interpreted indispensable to science, it does not follow that all metaphors and analogies are indispensable.

Moreover, they are by no means appreciated as appropriate methods or or legitimate instruments for the **context of justification**. To be a little more precise, according to common epistemological standard, usage of metaphor and analogy become more or less **provocative and** - probably - **misleading** without being made clearly and transparent. In the famous words of Alfred Marshall (1966, 314): “It is well to know when to introduce them, it is even better to know when to stop them off”. Moreover, from an philosophical point of view, they need **substantial underpinning** by convincing arguments. Further, in avoiding the danger to comprise a “Trojan Horse” within industrial ecology science, its non-mainstream perspective of understanding nature as model requires solid foundation.

At first glance, it is this unusual and non-mainstream perspective of understanding nature as model, its frequently metaphorical use, based on a proclaimed compelling analogy that industrial ecology may cause surprise within the scientific community. Thus, as an emerging scientific discipline, **industrial ecologists** as its proponents **are** probably **often challenged by critics, sceptics, hard-liners and other mainstream-scientists to conceptualise and underpin their characteristic understanding of nature**: Some of them may argue that industrial ecology is just loosely based on natural ecosystems. Resulting from this, they may trouble that industrial ecology seems vague and mired in its own ambiguity and weakness. Some others may state that from an philosophical point of view industrial ecology seems to be in its infancy, only at the beginning of a voyage of epistemological exploration. In addition to such criticism, there are some industrial ecologists who sense that a consolidated theory-building is only emerging.

Due to this challenge, industrial ecologists made few **initial efforts** to strengthen and elucidate their background assumptions concerning nature and to underline their apparently problematic employment of nature as model. Based on these initial industrial ecology efforts and **in pursuing to gain greater conceptual clarity**, an approach of nature as model is presented. This approach aims to contribute for laying a general solid underpinning of industrial ecology's hidden philosophy of nature.

Although such a voyage of philosophical exploration obviously does not take place in a broader sense, **elucidation** about "meta industrial ecology implications" seems to be still significant because it represents an essential element of **scientific task and duty**. There are at least three main reasons that industrial ecologists should pay attention to matured insights of philosophy of science and philosophy of nature:

! Firstly, reasoning on philosophical questions is nothing exclusively for professional academic philosophers but to every scientist, engineer, ecologist, economist etc. who does research and takes responsibility contributing to shape towards sustainability at large. Thus, it is up to **industrial ecologists themselves** being philosophically aware. Primarily it is their turn and they are able to reason on philosophical aspects.

! Secondly, clarifying **meta industrial ecology implications** is nothing really "outside" industrial ecology. Undeniably, there is no need to import these implications from outward into industrial ecology science because they are already internal, always implicit, and usually inherent.

! Thirdly, **background assumptions** and essentials of industrial ecology are defined or - as a minimum - influenced by philosophical aspects. Thus, it is a serious question of basic categories and actually of industrial ecology's reputation as emerging scientific discipline to take care of philosophical awareness.

Of course, scientists and economists have frequently drawn heavily from biological analogies and metaphors as linguistic equivalent - in particular from organism-analogy, evolution-analogy, fractal-firm-analogy, brain-analogy, and bionics-analogy - in order to illustrate and point out the understanding e.g. of economic phenomena. However, nature as model regularly causes more than surprise. Hence, with regard to industrial ecology, it seems necessary to provide a fundamental underpinning for this unusual perspective focusing on four main reasons:

! The first reason is that **to protect** nature as model **against** inflationary use of biological analogies and poetic metaphors as **merely rhetoric or picturesque** note in economic literature.

! The second reason is that **to prevent cosmetic reference** to nature only as fruitful metaphor, for example, as it is often done by management consultant companies.

! The third reason is that **to critically examine** references to nature and reasoning based on nature. It is **not going to romanticise** nature or to equate nature just with a “holy world of harmony”, “biological community”, or “familiar cooperation”.

! As a larger goal, the fourth reason is that **to emphasize** the vital **relevance of nature** for industrial ecology in order to contribute towards sustainability at large.

Summed up, we surely will progress in our thinking by basing our ideas of an area in the unknown on using metaphors and analogies drawn from an area of the known. However, we should be aware that in reasoning by metaphors and analogies there are **pitfalls and shortcomings to be avoided,** i.e. usage of metaphors and analogies are proper and legitimate and - probably - highly helpful, as long as what is involved is primarily the elucidation of the sense of a given proposition. If we try to use them for proving a proposition or even to establish a presumption in its favour, we will be lead into more or less grave errors.

4 Goal and Scope

The goal is to contribute for laying a fundamental underpinning for industrial ecology in its scientific sense, in this case especially for its use of nature as model. Therefore an **impressive battery of philosophical arguments** is provided bringing to bear against the sort of probably raised fallacies and facile or hasty proclaimed critics by sceptics, hard-liners, and mainstream-scientists who often overlook industrial ecology's stimulating role towards sustainability.

In industrial ecology nature is usually interpreted as model explicitly or at last implicitly. However, despite the fact that there are already some initial contributions dealing with the role of the natural ecosystem metaphor and analogy in industrial ecology, industrial ecology obviously seems to require further efforts in order to underpin and conceptualise its non-mainstream interpretation of nature. As a result, there is urgent **need for research** on industrial ecology's underlying philosophical assumptions.

The tangible objective is twofold:

! firstly, as a larger goal, to **make philosophical thinking quite accessible** to industrial ecologists while its content is of interest to professional philosophers;

! secondly, more precisely, the contribution aims (i) to **protect "nature as model" against** inflationary use of biological analogies as **merely rhetoric**, (ii) to **shield industrial ecology** from sceptics, and (iii) to **avoid** it **against** obvious **shortcomings**.

5 Content

The contribution is divided into two sections: In the **first introductory section**, the relevance of nature for industrial ecology is outlined by a comprehensive classification framework (typology) that proves useful to survey the substantial differences of understanding nature within the field of different scientific fields, in particular within different environmental economic schools.

The **major second section** deals with basics of philosophy of science and philosophy of nature in industrial ecology:

! At first, industrial ecology is outlined by a framework of basic characteristics in order to highlight the substantial differences in comparison to traditional perspectives of understanding nature as object or limit.

! Then, industrial ecology's hidden philosophy of nature is uncovered to demonstrate the seemingly unproblematic use of nature as model. Based on this, the dialectic principle of thesis, antithesis and synthesis is applied in order to settle the dispute between sceptics' and protagonists' viewpoints concerning nature as model. It is emphasised to be aware of its **hypothetical status,** i.e. nature provides a minimum representing a perhaps useful heuristic of smart solutions, evolutionary strategies, and ecological principles. However, nature by no means represents an all-inclusive checklist that could guarantee sustainability or ethical fairness itself. This sophisticated perspective of understanding nature as **hypothetical model** correlates with a groundbreaking study "Environmental Report 1994. For Environmentally Sound, Sustainable Development" of the German Council of Environmental Advisors (Rat der Sachverständigen für Umweltfragen, SRU 1994) who stated very clearly that every effort of **hyper-interpreting nature is quite problematic**: Indeed, such efforts of understanding nature e.g. as "partner", "stakeholder", "master", "teacher" etc. probably offer valuable insights. However, they still remain rhetoric or private beliefs of noble-minded ecologists but they could not serve a general acceptable perspective towards sustainability at large. Consequently, these efforts should be treated carefully, or when evidently deficient, just rejected.

! Next, it is outlined that nature as model can serve as a paradigm for industrial ecology. More detailed, an elementary architecture of industrial ecology science is presented, the term “paradigm” is illustrated, and major impacts on industrial ecology are outlined. Following the Kantian understanding, nature as model looks like a regulative idea providing a helpful heuristic that can be employed for guiding industrial ecology’s research program.

! The **conclusion** may support a final pleading to use nature as model in industrial ecology:

– On the one hand, understanding nature as model is not only pointing to the limits of nature as scarce source, finite sink, and fragile self-organised cycle. Limits usually imply reduction, restriction, avoidance, diminution, and minimisation. Limits imply respect tending to be understood in a negative sense just containing negative connotations. However, nature as model contains **positive connotations**. It may serve as a paradigm in order to guide industrial ecology’s research program.

– On the other hand, understanding nature as model provides **substantial enhancement** of traditional perspectives of understanding nature as object and limit. With this in mind, perhaps the industrial ecology specific perspective of understanding nature as (hypothetical) model **may transcend classical perspectives** of traditional scientific fields e.g. of environmental economic schools which are still highly influenced by neoclassical environmental and resource economics and its one-sided mechanistic understanding of nature as “sack of resources”.

In all, the appeal of nature as model not merely springs from a persistent craving for balancing nature's ecosystems and industrial systems. Profoundly considering that nature as model is **more than fashionable rhetoric and smart theoretical idea**, industrial ecology research should be advanced and turned into practice.

6 Methods

According to the above-mentioned goal and scope, industrial ecology's implicit philosophical aspects are situated in the centre. Four major philosophical methods are applied: (i) **classification-framework** (typology) to specify the interpretation of nature; (ii) **dialectic principle** of thesis, antithesis, and synthesis to settle the dispute between sceptics' and protagonists' viewpoints concerning nature as model; (iii) **basics of anthropology** to explain how it is even possible to understand nature by science in general, in particular by industrial ecology, and to look to nature for a model by reflexive manner; (iv) **epistemologically based architecture of industrial ecology science** to demonstrate that the reflexive interpretation of nature as model represents a paradigm serving as helpful heuristic and influencing industrial ecology's research and practice.

7 Results and Conclusions

It is possible to elucidate industrial ecology's hidden philosophy of nature by reflexive manner. An impressive battery of philosophical arguments is presented to underpin industrial ecology's perspective of understanding nature as model. Consequently, it seems plausible and useful to **learn from nature,** i.e. industrial ecologists can **selectively apply** nature's smart solutions, evolutionary strategies, and ecological principles for balancing natural ecosystems and industrial systems.

The keynote is **to be aware of nature's hypothetical status**. Thus, nature as model provides a **minimum** that can be considered when we already know what we are looking for, i.e. we need something like a regulative idea that constitutes nature and natural ecosystems' phenomena as relevant objects for solving our environmental problems. Even then, we could look on nature for a model searching for smart solutions, evolutionary strategies, and ecological principles which might seem appropriate for us in order to solve our environmental problems. Nature does not provide unequivacal orientation. Hence, nature as model can not provide an all-inclusive checklist that guarantees sustainability or ethical fairness itself.

Metaphorically, nature as model provides valuable insights as an **eye-opener**. From this rhetoric sense we can learn by gaining inspiration and encouraging creativity to derive ecological innovations. However, additionally to linguistic aspects, nature as model can also serve as paradigm. This **paradigmatic sense** includes rhetoric use as metaphor but broadens the interpretation as smart biological analogy and exceeds the connotation as picturesque note by far. Nature as model is seen as regulative idea that offers a helpful heuristic guiding industrial ecology's research program. Such a regulative idea plays a dominating role that is (i) to arrange our way of thinking, (ii) to organise our imagination of phenomena, and (iii) to govern our decision-making.

8 References

Allenby, B.R. (1999a): Earth Systems Engineering. In: Journal of Industrial Ecology 2 (3), 73-93.

Allenby, B.R. (1999b): Industrial Ecology: Policy Framework and Implementation. Englewood Cliffs (NJ): Prentice Hall.

Allenby, B.R.; Cooper, W.E. (1994): Understanding Industrial Ecology from a Biological Systems Perspective. In: Total Quality Environmental Management, Spring, 343-354.

Andrews, C.; Berkhout, F.; Thomas, V. (1994): The Industrial Ecology Agenda. In: R. Socolow; C. Andrews; F. Berkhout; V. Thomas (Eds.): Industrial Ecology and Global Change. Cambridge: Cambridge University Press 1994, 469-477.

Ausubel, J.H. (1998): Industrial Ecology: A Coming of Age Story. In: <http://phe.rockefeller.edu.RFF_IE>, © 1998, access 17.10.01.

Ayres, R.U.; Simonis, U.E. (Eds.) (1994): Industrial Metabolism. Tokyo et al.: UN University Press.

Bey, C. (2001): Quo vadis Industrial Ecology? Realigning the Discipline with its Roots. In: Greener Management International (accepted manuscript, to appear).

Boulding, K.E. (1971): The Image. Ann Arbor: University Michigan Press.

Bourg, D. (2000): Industrial Ecology: Philosophical and Political Meanings. In: D. Bourg; S. Erkman (Eds.): Proceedings Industrial Ecology and Sustainability. UTT and ICAST, CD-ROM.

Cleveland, C.J. (1999): Biophysical Economics. In: K. Mayyumi; J.M. Gowdy (Eds.): Bioeconomics and Sustainability. Cheltenham (UK): Edward Elgar, 125-154.

Commoner, B. (1971): The Closing Circle – Nature, Man, and Technology. New York: 1st ed. Knopf.

Daly, H.E. (1991): Elements of Environmental Macroeconomics. In: R. Costanza (Ed.): Ecological Economics. New York: 2nd printing, Columbia University Press, 32-46.

Daly, H.E. (1993): On Economics as a Life Science. In: H.E. Daly; K.N. Townsend (Eds.): Valuing the Earth. Economics, Ecology, Ethics. Cambridge (Mass): MIT Press, 249-265.

Ehrenfeld, J.R. (1998): Industrial Ecology and Interdisciplinarity. In: Industrial Ecology and Curriculum. Trondheim, <http://www.indecol.ntnu.no/conferences>, © 1998, access 30.01.01.

Erkman, S. (1997): Industrial Ecology: An Historical View. In: Journal of Cleaner Production 5 (1/2), 1-10.

Frosch, R.A. (1992): Industrial Ecology: A Philosophical Introduction. Proceedings of the National Academy of Science USA 89 (2), 800-803.

Frosch, R.A., Gallopoulos, N.E. (1989): Strategies for Manufacturing. In: Scientific American 261 (9), 94-102.

Fuchs, D.A.; Mazmanian, D.A. (1998): The Greening of Industry. In: Business and the Environment 7 (4), 193-203.

German Council of Environmental Advisors (Rat der Sachverständigen für Umweltfragen, SRU) (1994): Environmental Report 1994. For Environmentally Sound, Sustainable Development [German: Umweltgutachten 1994. Stuttgart: Metzler-Poeschel.

Graedel, T. (1994): Industrial Ecology: Definition and Implementation. In: R. Socolow; C. Andrews; F. Berkhout; V. Thomas (Eds.): Industrial Ecology and Global Change. Cambridge: Cambridge University Press 1994, 23-41.

Graedel, T.E.; Allenby, B.R. (1995): Industrial Ecology. Englewood Cliffs (NJ): Prentice Hall.

Honnefelder, L. (1993): What Nature has to be protected? In: GAIA 2, 253-264.

Isenmann, R. (1998): Natur als Vorbild. In: W. Nachtigall; A. Wisser (Eds.). BIONA-report 12, IV. Internationaler Kongreß München. Stuttgart et al.: Fischer, 129-147.

Isenmann, R. (2000): Nature as a Paragon. In: D. Bourg; S. Erkman (Eds.): Proceedings Industrial Ecology and Sustainability. UTT and ICAST, CD-ROM.

Isenmann, R. (2001): Innovationsquelle Natur. In: A. Wisser; W. Nachtigall (Eds.). Technische Biologie und Bionik. BIONA-report 15, 5. Bionik-Kongreß Dessau 2000. Mainz: Akademie der Wissenschaften und der Literatur, 224-242.

Isenmann, R. (2001): The Use of Nature as Model: Epistemologically-based Foundation for Industrial Ecology. In: ERP Environment (Eds.): The 2001 Eco-Management and Auditing Conference. Conference Proceedings. 21-22 June 2001. Nijmegen School of Management. Shipley (UK) 148-155.

Journal of Industrial Ecology (Ed.). (2000): What is industrial ecology? <http://mitpress.mit.edu/journals/JIEC/jie-call.html#whatis>, © 2000, access 24.11.00.

Kant, I. (1787/1910 ff.): Kritik der reinen Vernunft. In: Königlich Preußische [later on: Deutsche] Akademie der Wissenschaften (Eds.): Kants gesammelte Schriften. Band 3. Berlin: de Gruyter.

Keitsch, M.; Erkman, S. (1998): Philosophical Reflections on Industrial Ecology and Appropriate Methods in Research and Curriculum. In: Industrial Ecology and Curriculum. Trondheim, <http://www.indecol.ntnu.no/conferences>, © 1998, access 30.01.01.

Korhonen, J. (2000): Completing the Industrial Ecology Cascade chain in the Case of a Paper Industry. In: Eco-Management and Auditing 7 (1), 11-20.

Korhonen, J. (2001): Some Suggestions for Regional Industrial Ecosystems – Extended Industrial Ecology. In: Eco-Management and Auditing 8 (1), 57-69.

Kuhn, T.S. (1970): The structure of scientific revolutions. Chicago: 2nd printing, University Chicago Press.

Lakatos, I. (1978): The Methodology of Scientific Research Programmes. Cambridge: Cambridge University Press.

Manahan, S.E. (1999): Industrial Ecology. Environmental Chemistry and Hazardous Waste. London et al.: Lewis Publishers.

Mirowski, P. (Ed.) (1991). Natural Images in Economic Thought. Cambridge: Cambridge University Press.

Norwegian University of Science and Technology (NTNU) (2000): NTNUs Industrial Ecology Programme. Trondheim: NTNU.

Pigou A.C. (Ed.) (1966): Memorials of Alfred Marshall. Reprints of Economic Classics. New York: Kelley Publishers [1st Ed. London: Macmillan 1925].

Raha, S. (1999): Industrial Ecology - Analogy, or the Technical Core of Sustainability? In: Green Business Opportunities 5 (2), 5.

Reichenbach, H. (1961): Experience and Prediction. Chicago: University of Chicago Press.

Richards, D.J.; Allenby, B.R.; Frosch, R.A. (1994): The Greening of Industrial Ecosystems. In: B.R. Allenby; D.J. Richards (Eds.): The Greening of Industrial Ecosystems. Washington (DC): National Academy Press, 1-19.

Ring, I. (1994): Marktwirtschaftliche Umweltpolitik aus ökologischer Sicht. Möglichkeiten und Grenzen. Stuttgart, Leipzig: Teubner.

Ring, I. (1997): Evolutionary strategies in environmental policy. In: Ecological Economics, 23, 237-249.

Schumpeter, J.A. (1954): History of Economic Analysis. New York: Oxford University Press.

Simonis, U.E. (1993): Von der Natur lernen? Über drei Bedingungen zukunftsfähiger Wirtschaftsentwicklung. In: Zwierlein, E. (Ed.): Natur als Vorbild. Idstein: Schluz-Kirchner.

Smith, A. (1975): Power of the Mind. New York: Ballantine Books.

Socolow, R. (1994): Preface. In: R. Socolow; C. Andrews; F. Berkhout; V. Thomas (Eds.): Industrial Ecology and Global Change. Cambridge: Cambridge University Press 1994, xv-xx.

Socolow, R. (1994): Six Perspectives from Industrial Ecology. In: R. Socolow; C. Andrews; F. Berkhout; V. Thomas (Eds.): Industrial Ecology and Global Change. Cambridge: Cambridge University Press 1994, 3-21.

Tibbs, H.B.C. (1992): Industrial Ecology: An Environmental Agenda for Industry. In: Centre of Excellence for Sustainable Development, <http://www.sustainable.doe.gov/articles/indecol.shtml>, © 1992, access 01.09.00.

Wernick, I.K.; Ausubel, J.H. (1997): Industrial Ecology: Some Directions for Research. In: http://phe.rockefeller.edu.ie_agenda, © 1997, access 17.10.2001.

Zwierlein, E. (1994): The Paradigm of Self-Organization and its Philosophical Foundations. In: R.K. Mishra et al. (Eds.): On Self-Organization. Heidelberg et al.: Springer, 288-298.

Zwierlein, E. (1997): Natur denken. In: Ethik und Sozialwissenschaften, 8, 60-62.

Zwierlein, E.; Isenmann, R. (1995): Ökologischer Strukturwandel und Kreislaufökonomie. Idstein: Schulz-Kirchner.

Zwierlein, E.; Isenmann, R. (1996): Umweltphilosophie. In: P. Eichhorn (Ed.): Umweltorientierte Marktwirtschaft. Wiesbaden: Gabler, 133-151.

9 Transparencies

Industrial Ecology's Hidden Philosophy of Nature

Fundamental Underpinning to Use Nature as Model

Ralf Isenmann
University Kaiserslautern
Department of Business Information Systems and Operations Research (BiOR), Chair: Prof. Dr. Heiner Müller-Merbach
E-Mail: isenmann@bior.de
Internet: http://www.bior.de

International Society for Industrial Ecology (ISIE)
The Science & Culture of Industrial Ecology, Leiden (Netherlands), November 12-14, 2001: Tuesday, November 13, 2001

University of Kaiserslautern
Department of Business Information Systems and Operations Research
Chair: Prof. Dr. Heiner Müller-Merbach

Ralf Isenmann, 13.11.2001

1

1 Hidden philosphy of nature
2 Philo-sophical pre-requisites
3 Con-clusion

Industrial Ecology's Hidden Philosophy of Nature

Fundamental Underpinning to Use Nature as Model

Contents

1 Industrial Ecology: Hidden philosophy of nature

2 Philosophical prerequisites to understand nature by industrial ecology

3 Conclusion: Implications for industrial ecology

1 Hidden philosphy of nature
2 Philo-sophical pre-requisites
3 Con-clusion

1 Industrial Ecology: Hidden Philosophy of Nature (I)

Author	Reference to **nature understood as model** explicitly or at least implicitely
Frosch/Gallopoulos (1989, 94)	IE "would function as an analogue of biological system"
Tibbs (1992, 2 and passim)	IE "takes the pattern of the natural environment as a model"
Simonis (1993, 131)	"Learning from nature by taking private lessons in ecology"
Graedel (1994, 24)	"The ideal anthropogenic use of ... materials ... would be one ... similiar to the biological model"
Socolow (1994, 4)	"Nature is the measure of man"; nature "as the principal shaper of global human activity"
Andrews/Berkhout/Thomas (1994, 471)	Nature "is instructive to explore in some detail what an industrial ecosystem could involve"
Richards/Allenby/Frosch (1994, 3, 8)	"Natural ecosystems as no waste ecology"
Allenby/Cooper (1994, 343)	"Sustainable economic strcuture will resemble a mature biological community"
Graedel/Allenby (1995, 10)	Nature understood as master of recycling
Ring (1994 passim; 1997, 243)	"Orient economic activities towards ecological principles"
Wernick/Ausubel (1997, 7)	IE "implies that models of non-human biological systems ... are instructive for industrial systems"
Ausubel (1998, 1)	IE "asks whether nature can teach industry ways ... in minimazing waste"
Manahan (1999, preface and 93)	Nature as cyclical economy without waste
Cleveland (1999, 148)	It is characteristic for IE "to look to the natural world for models of ... efficient use of resources"
Allenby (1999, 43)	"The concept of industrial ecology ... [is] based here on the biological analogy"
Ehrenfeld (2000, 237)	"Natural ecosystems ... offer the only ... example ... of long-lived, robust, resilient living systems"
Journal of IE (2000, 1)	IE "looks to the natural world for models"
Korhonen (2001, 57)	"Ecosytems are masters of recycling ... ecosystem metaphor provides a sustainable model"
NTNU (2001)	"Nature as a teacher" and "learning from nature"

1 Industrial Ecology: Hidden Philosophy of Nature (II)

1 Hidden philosophy of nature
2 Philo-sophical pre-requisites
3 Con-clusion

Internal industrial ecology topic

- Manahan (1999, 2) concedes that industrial ecology ”is **loosely based**” on natural ecosystems.
- Korhonen (2000, 11) says that industrial ecology’s ”theory is **only emerging**”.
- Fuchs/Mazmanian (1998, 193) emphasise a **premature stage**: ”Progress in our understanding of greening has been hampered by a lack of theoretical and methodological rigour”.

1 Industrial Ecology: Hidden Philosophy of Nature (III)

1 Hidden philosophy of nature
2 Philo-sophical pre-requisites
3 Con-clusion

Provisional result (1)

- In industrial ecology **nature** is employed and used **as model** explicitly or at least implicitly,
- often phrased in terms of a **metaphor** and frequently based on a proclaimed compelling **analogy** between natural ecosystems and industrial systems.
- This perspective is refreshingly **different from** traditional ones, e.g. in terms of ”**sack of resources**”, ”biophysical **limit**”, ”something outside”, or just ”environment”.

1 Hidden philosphy of nature

2 Philo-sophical pre-requisites

3 Con-clusion

2 Philosophical Prerequisites to Understand Nature by Industrial Ecology (I)

Why dealing with philosophical prerequisites?

! Epistemological awareness is an element of industrial ecology's **scientific task and duty**

! Meta-industrial-ecology-implications are already **internal**, always **implicit** and usually **inherent**

! Clarifying background assumptions becomes **relevant and essential** for industrial ecology's **reputation** as emerging scientific discipline

1 Hidden philosphy of nature

2 Philo-sophical pre-requisites

3 Con-clusion

2 Philosophical Prerequisites to Understand Nature by Industrial Ecology (II)

Meaning of Philosophy

Typical philosophical questions	Main realms of philosophy
What can we know?	Epistemology
What shall we do?	Ethics
What may we hope?	Philosophy of religion
What (who) is man?	Anthropology

University of Kaiserslautern
Department of Business Information Systems and Operations Research
Chair: Prof. Dr. Heiner Müller-Merbach

Ralf Isenmann, 13.11.2001

1 Hidden philosphy of nature

2 Philo-sophical pre-requisites

3 Con-clusion

2 Philosophical Prerequisites to Understand Nature by Industrial Ecology (III)

Authors dealing with philosophical prerequisites

! Bourg (2000): Industrial ecology and its philosophical and political meanings

! Ehrenberg (2000): Industrial ecology as paradigm shift or normal science

! Keitsch/Erkman (1998): Philosophical reflections on industrial ecology and appropriate methods in research and curriculum

! Isenmann (1998; 2000, 2001): Philosophical facets of industrial ecology e.g. (i) understanding nature, (ii) paradigmatic shift, (iii) architecture of industrial ecology science, (iv) learning from nature

1 Hidden philosphy of nature

2 Philo-sophical pre-requisites

3 Con-clusion

2 Philosophical Prerequisites to Understand Nature by Industrial Ecology (IV)

Authors dealing with the role of metaphor and analogy

! Allenby/Cooper (1994): Understanding Industrial Ecology from a Biological Systems Perspective

! Sagar/Frosch (1997): A Perspective on Industrial Ecology and Its Application to a Metals-industry Ecosystem

! Commoner (1997): The Relation between Industrial and Ecological Systems

2 Philosophical Prerequisites to Understand Nature by Industrial Ecology (V)

1 Hidden philosphy of nature

2 Philo-sophical pre-requisites

3 Con-clusion

Epistemological role of metaphor and analogy

! Intuitively appealing and smartly sounding (e.g. for didactic and educational purposes)

! Providing valuable insights as "eye-opener" (e.g. for encouraging creativity and gaining inspiration)

! Leading to new facets of understanding nature (e.g. for learning)

! Common epistemological standard (Reichenbach 1891-1953):
- appropriate for the **context of discovery**, **but**
- **by no means for the context of justification**
- because: "**genetic fallacy**", i.e. mixing genesis with validity, danger of a "**Trojan Horse**"

University of Kaiserslautern
Department of Business Information Systems and Operations Research
Chair: Prof. Dr. Heiner Müller-Merbach

Ralf Isenmann, 13.11.2001

10

2 Philosophical Prerequisites to Understand Nature by Industrial Ecology (VI)

1 Hidden philosphy of nature

2 Philo-sophical pre-requisites

3 Con-clusion

Nature as construction and interpretation

! "Nature" does not automatically or clearly speak to us. Nature appears to us in several ways of mediation.

! **Epistemology**: According to Kant (1781, KrV, 198): Every effort of understanding nature implies a **construction** and an **interpretation** by humans.

! **Anthropology**: In line with Löw (1990) and Zwierlein (1997): The pivot for understanding nature is a "**logical anthropomorphism**".

University of Kaiserslautern
Department of Business Information Systems and Operations Research
Chair: Prof. Dr. Heiner Müller-Merbach

Ralf Isenmann, 13.11.2001

11

2 Philosophical Prerequisites to Understand Nature by Industrial Ecology (VII)

Industrial ecology as means for interpretation

! **Application**: Conceptual framework containing three layers

	Industrial Ecology characteristic perspective
Meta-Theory: Epistemological interest in nature	Orientation by nature
Theory: Comprehension of nature	Nature as model
Practice: Dealing with nature	Learning from nature

2 Philosophical Prerequisites to Understand Nature by Industrial Ecology (VIII)

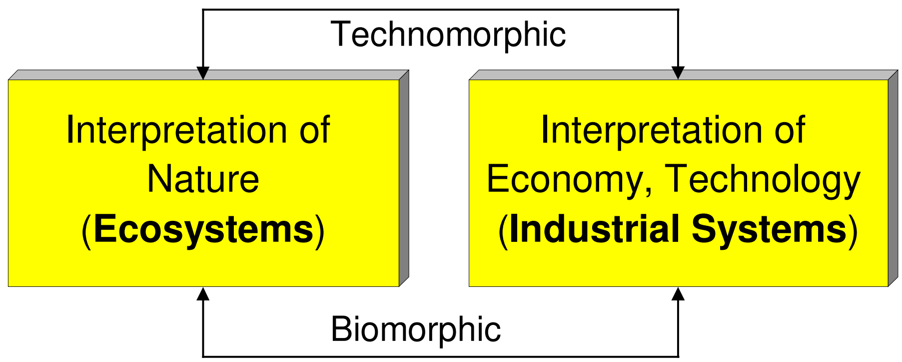
Industrial ecology as means for interpretation

! **Application**: Conceptual framework containing three layers

	Perspective 1		Perspective 2	**Perspective 3 (Industrial Ecology)**	Perspective 4
Comprehension of nature (theory)	Nature as object		Nature as limit	Natur as model	Nature as partner, teacher, master etc.
Dealing with nature (practice)	Use of nature	Care of nature	Avoiding to use nature	Learning from nature	Coevolution with nature
Epistemological interest in nature (meta theory)	Inter-ference into nature	Conservation of nature	Respect for nature	Orientation by nature	Incorporated efficiency of nature

2 Philosophical Prerequisites to Understand Nature by Industrial Ecology (XI)

Analogy “ecosystems - industrial systems”



2 Philosophical Prerequisites to Understand Nature by Industrial Ecology (X)

Provisional result (2)

! Based on matured insights of philosophy of science and philosophy of nature,

! industrial ecology can be seen as (probably) **appropriate scientific means** to interpret nature by and into our language.

! It’s perspective on nature is guided by three characteristics:
- **epistemological interest** in nature (**orientation** by nature)
- **comprehension** of nature (nature as **model)**
- **way of dealing** with nature (**learning** from nature)

3 Conclusion: Implications for Industrial Ecology (I)

1 Hidden philosophy of nature
2 Philo-sophical pre-requisites
3 Con-clusion

Five major insights

" IE: Nature as **model**, used metaphorically, based on analogy

IE: Lack of effort (i) to uncover its hidden philosophy of nature and (ii) to underpin its metaphorical understanding
$ **philosophical elucidation**

% IE: Appropriate **scientific means** to interpret nature by and into our language

& Philosophical prerequisite: Awareness of the **hypothetical status** of nature as model

' IE: Substantial **enhancement** for understanding nature

3 Conclusion: Implications for Industrial Ecology (II)

1 Hidden philosophy of nature
2 Philo-sophical pre-requisites
3 Con-clusion

My larger goal

$ to **provide** an impressive battery of **philosophical arguments** bringing to bear **against** the sort of probably raised fallacies and facile proclaimed critics by **sceptics**.

! **not rejecting** industrial ecology's hidden philosophy of nature **at all**, **but**:

$ to **elucidate** still hidden background assumptions

$ to **encourage awareness** (i) that "nature as model" is always **hypothetical** and (ii) its use needs **conceptual underpinning**

10 Further Studies

Issue 1/1999: Ralf Isenmann: „Natur als Vorbild“ - Vom Wandel im Naturverständnis zum Wertewandel im Unternehmen. Lehrstuhl Betriebsinformatik und Operations Research. FUE-BIOR Issue 1. Universität Kaiserslautern 1999.

Issue 2/1999: Ralf Isenmann: Umweltorientierte Unternehmensführung mit der „Natur als Vorbild“ – Eine empirische Studie zur Verwendung der „Natur als Vorbild“ in deutschen Großunternehmen. Lehrstuhl Betriebsinformatik und Operations Research. FUE-BIOR Issue 2. Universität Kaiserslautern 1999.

Issue 3/1999: Ralf Isenmann: Nature as a Paragon. Paradigm for Industrial Ecology and Guideline for a Sustainable Company [= Proceedings Industrial Ecology and Sustainability. Conferences and Workshops. Troyes, September the 22nd - 25th 1999 (France). Edited by Dominique Bourg and Suren Erkman. Published by Universite de Technologie Troyes (UTT) and Institut pour la Communication et l'Analyse des Sciences et des Technologies (ICAST) 2000 on CD-ROM]. Department of Business Information Systems and Operations Research. FUE-BIOR Issue 3. University Kaiserslautern 1999.

Issue 4/2000: Ralf Isenmann und Nicolas Warkotsch: Internet-based Environmental Reports by Companies – Towards an Efficient and Customised Corporate Environmental Reporting. Department of Business Information Systems and Operations Research. FUE-BIOR Issue 4. University Kaiserslautern 2000.

Issue 5/2000: Ralf Isenmann und Heiner Müller-Merbach: Internetbasierte Umweltberichterstattung von Unternehmen: Grundlagen - Unterstützungspotentiale - IKT-Architektur. [= Proceedings zum Symposium 2000. Abwasser - Altlasten - Recycling. Universität Kaiserslautern 2000, S. 80-91] FUE-BIOR Issue 5. Universität Kaiserslautern 2000.

Issue 6/2000: Heiner Müller-Merbach: Ökologische Belastungen durch moderne Informations- und Komunikationstechnologien. [= Proceedings zum Symposium 2000. Abwasser - Altlasten - Recycling. Universität Kaiserslautern 2000] FUE-BIOR Issue 6. Universität Kaiserslautern 2000.

Issue 7/2000: Ralf Isenmann, Christian Lenz und Heiner Müller-Merbach: Umweltberichte von Unternehmen im Internet: Der aktuelle Stand für Deutschland. Lehrstuhl Betriebsinformatik und Operations Research. FUE-BIOR Issue 7. Universität Kaiserslautern 2000.

Issue 8/2000: Ralf Isenmann, Alexandro Kleine und Heiner Müller-Merbach: Umweltberichterstattung im Internet von KMU. Praxiserfahrungen, Klassifizierung, Tendenzen. Lehrstuhl Betriebsinformatik und Operations Research. FUE-BIOR Issue 8. Universität Kaiserslautern 2000.

Issue 9/2000: Ralf Isenmann: From Nature as an Object and a Limit to Nature as a Paragon – Paradigm for Industrial Ecology. Department of Business Information Systems and Operations Research. FUE-BIOR Issue 9. University Kaiserslautern 2000.

Issue 10/2000: Ralf Isenmann, Ramin Ghafari und Heiner Müller-Merbach: Umweltberichterstattung im Internet: Empirische Befunde, Klassifizierung, Praxiserfahrungen, Tendenzen. Lehrstuhl Betriebsinformatik und Operations Research. FUE-BIOR Issue 10. Universität Kaiserslautern 2000.

Issue 11/2001: Ralf Isenmann, Christoph Schweren und Heiner Müller-Merbach: Einsatz des Internet zur Umweltberichterstattung von Unternehmen: Empirische Analyse zur Nutzung von zweck- und prozeßbezogenen Unterstützungspotentialen. Lehrstuhl Betriebsinformatik und Operations Research. FUE-BIOR Issue 11. Universität Kaiserslautern 2001.

Issue 12/2001: Ralf Isenmann: The Use of Nature as Model: Epistemologically-based Foundation for Industrial Ecology. [= The 2001 Eco-Management and Auditing Conference. Conference Proceedings. 21-22 June 2001. Nijmegen School of Management, The Netherlands, ed. by ERP Environment. Shipley (UK): ERP 2001, S. 148-155] Department of Business Information Systems and Operations Research. FUE-BIOR Issue 12. University Kaiserslautern 2001.

The issues are available at the Department of Business Information Systems and Operations Research (BiOR) and can be ordered either as (i) conventional reports by print media or as (ii) electronic versions by PDFs.

Address for orders: University Kaiserslautern, Department of Business Information Systems and Operations Research (BIOR), z.Hd. Herrn Ralf Isenmann, Gottlieb-Daimler-Straße, 67653 Kaiserslautern, Germany, **Tel.**: +49 631 205 2936, **Fax**: +49 631-205 3381, **E-Mail**: isenmann@bior.de; **Internet**: http://www.bior.de