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### Editorial

## Robert Ayres, Ecological Economics and Industrial Ecology

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#### ABSTRACT

This editorial motivates the special issue containing articles in honour of professor Robert U. Ayres. A concise history of Robert Ayres' research is presented, which identifies relevant publications and ideas. In addition, the eight contributions to this special issue are briefly summarized. They provide connections to relevant insights in related fields, namely Ecological Economics and Industrial Ecology, which allows enriching the research on environmental innovation and societal transitions. Most contributions end with clear suggestions for transitions policy.

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### 1. Motivation

This special issue of EIST serves as homage to Professor Robert U. Ayres. He has an impressive research record and influenced many researchers in environmental science and economics. His pre-occupation has since the 1960s been what we now would formulate as “how to realize a sustainability transition”. He was one of the early contributors to the emerging field of *Environmental Economics* in the USA, working with pioneers like Allan Kneese and Ralph d'Arge.<sup>1</sup> In addition, Ayres is one of the intellectual forerunners of *Ecological Economics*, along with Kenneth Boulding, Herman Daly, Nicholas Georgescu-Roegen, Buzz Holling and Howard Odum. In addition, through his tireless work on the implications of thermodynamics for environmental science and his many detailed studies on material flows for particular environmentally damaging substances (fuels, heavy metals, organic and inorganic chemicals) he is widely regarded to be the intellectual founder of the research field of *Industrial Ecology* (and the associated notion of *Industrial Metabolism*). It is clear that these fields are strongly connected to the emerging research area *Environmental Innovation and Societal Transitions*, the focus of this journal. Unfortunately, many (young) researchers seem to be unaware of these connections. They can hardly be blamed, given the exponentially growing number of publications in environmental science broadly.

<sup>1</sup> Witness the classic publication Ayres and Kneese (1969).

This special issue provides an excellent opportunity to be updated on relevant insights in related fields, which allows enriching the research on environmental innovation and societal transitions.

The papers in this issue contain viewpoints presented by the authors during a symposium at INSEAD on April 10, 2013, to honour the lifetime research by Robert Ayres. Although the authors come from very different backgrounds, they seem to agree on many aspects of three issues discussed: (1) imperfections that pertain to markets and public regulation of energy; (2) how these affect economic growth and stability, unemployment and financial markets; and (3) which policies and strategies are needed in response to guarantee welfare, work and sustainability. Some of the papers (notably the one by Horne) continue the connection between the sustainability transition challenge and the financial-economic crisis, a topic that was extensively addressed in a special issue (Volume 6, 2013) of this journal.

## 2. A concise history of Robert Ayres' research

Robert Ayres (Bob for friends) is a unique researcher. A walking encyclopaedia, an environmental scientist who moves easily between physics, chemistry, biology, economics and engineering, a technological expert and optimist, and an environmental as well as ecological economist. Born in 1932, he has passed the respectable age of eighty, but still looks young and is working as hard as ever. He is famous for his very clear explanations – to various generations of researchers – of the meaning of thermodynamics (the physics of energy) for economics and environmental science. On these matters, he is widely considered to be the most influential writer together with Nicholas Georgescu-Roegen, whose work is – arguably – more philosophical and less pragmatic. Ayres (1999) provides useful comments on Georgescu's contributions.

In addition, he has written extensively about technological evolution and environmental innovation (making him a logical editorial board member of this journal), economic growth and energy, and the current financial crisis. He has thought about so many topics that it is impossible to do credit to his work in such a short space. I thought I knew his publications rather well (partly because I worked with him on two articles) but when checking his curriculum I discovered that he even wrote about robotics, and was one of the first to address (with J. Walter) the economic costs and benefits of climate change – already in 1991, that is, in the same year in which Cline and Nordhaus produced their pioneering economic studies of climate change.

Robert Ayres was trained as a physicist at the University of Chicago, University of Maryland, and King's College London, where he also did his Ph.D. in Mathematical Physics. Over time, Ayres' work was supported by appointments in several reputable institutes. In the sixties he was associated with the think tanks the Hudson Institute (conservative) and Resources for the Future (progressive). Then he co-founded the consultancy International Research and Technology Corp with T.B. Taylor. From 1979 to 1992 he was Professor of Engineering and Public Policy at Carnegie-Mellon University. He was also a visiting researcher at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg (Austria) from 1986 to 1990. In 1992 he became Sandoz (later Novartis) Professor of Environment and Management at the prestigious business school INSEAD in Fontainebleau, France. He retired in the millennium year 2000 but continued working, among others, at IIASA (2006–2010) and as Jubilee Visiting Professor (2000–2001) and King Karl Gustav XVII professor of environmental science (2004–2005) at Chalmers Institute of Technology Gothenburg (Sweden). Clearly, his work moved him around the globe.

To illustrate the breadth of his work, I would like to single out the following books (from a complete list about twice as long):

- Kneese, Allen V. Robert U. Ayres and Ralph C. D'Arge (1970). *Economics and the Environment: A Materials Balance Approach*. Johns Hopkins Press. This elaborates the classic journal article Ayres and Kneese (1969).
- Ayres, Robert U. (1978). *Resources, Environment, and Economics: Applications of the Materials/Energy Balance Principle*. John Wiley and Sons. See my evaluation of this book below.
- Ayres, Robert U. (1994). *Information, Entropy and Progress: A New Evolutionary Paradigm*. American Institute of Physics, New York. See comments below.

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