A QUESTION OF CONTEXT

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INTRODUCTION

Industrial ecology can provide a viable platform for inquiry into industrial operations, economic processes, and even the human proclivities for irrational relations to their contexts filled with systems of living order. Impediments confront any who take this avenue of inquiry. One important one is the counterintuitive nature of the complexity encountered therein. Industrial ecology, as complexity stimulated by concepts without context, can easily stimulate the same pattern of behavior as that which keeps us from seeing the long-term harm of our short-term behaviors. In this way industrial ecology would simply join the other phenomena that are part of the problem we repeatedly set out to study. There are signs that this may already be occurring.

Industrial ecology problems seem to lie at the junction between two worlds. This is the location where humanly motivated actions, to achieve results, encounter the longer-term consequences of their behavior returning to meet them; i.e., we meet our actions from the past in the contexts of our future. To illustrate this we make a distinction between results and consequences. Results are what we purposefully hope to achieve, and organize directed actions to do so. Consequences are the unintended results, or second-order results, that emerge after our intentions are realized. We propose that environmental problems are mostly from the world of consequences, or second order results, and that we lack means to identify and manage consequences. Unless industrial ecology develops sufficiently innovative methods so that they can manage consequences it is doomed to be more of the problem than with the solution.

The strengths, and weaknesses, of industrial ecology begin with it being a conceptual contradiction. Its major attraction point, and perhaps its strength, is the dynamism that the joint packaging of industrial and ecological traditions allows. This demands and hopefully enhances a search for a third way out from the obvious contradiction between the artificial and the natural. The discouragement, and perhaps major weakness, comes from the fact that the two worlds have learned how to be natural enemies. As such efforts to relate them fail. To date there is no scientific approach to inquiry in this joint domain that illustrates any worthy success. The activities to date have been based more on belief than knowledge.

The contradictory nature of industrial and ecological traditions may in fact not be as much of an impediment as it seems. Past contradictions have often provided the energy source for truly great science. Contradictions have long been a great motivator to the great scientists. If so, the adjacency of these opposites and the omnipresent concern to do something to improve things may well be sufficient to encourage a coherent study of linkages between technology-based, human activities and the natural systems that provide them with context.

Industrial ecology thus could provide a very promising doorway through which we can see alternative processes of economic development. At a minimum, by looking through the doorway we come to appreciation the need for alternatives to current policy and science. Another weakness, which may be more profound, is that the area of study is seen as depressing. It tends to attract depressed people with less than innovative ideas. Perhaps something can be done to attract people that are more fun with more stimulating ideas.

These problems and potentials can be seen in some of the current concepts being advanced in industrial ecology. Some of these may in fact be obstacles to genuine improvement, just as many of the past concepts in the area clearly impeded development. Two of current candidates are recycling and sustainability. Even conceptually recycling is not possible, and probably not desirable. Recent evidence from its practice shows how the truth of its physical impossibility is seeping into public consciousness. We will not go very deeply into this evidence in this paper, since the general news media are covering it rather well (Warren, 1999). We will point to the human weaknesses that encouraged concepts like recycling and continue to hope it will work. Herein, we will instead look more closely at the dream of achieving sustainability. This, we project, is an even more serious indicator of the human tendency to resolve human-nature relationship problems by creating problems at an ever-deeper level. More simply put, we can argue that while recycling is a clear example of a Catch-22 of perpetualism, sustainability is close to a Faustian Tragedy of trashing the stage to save the play. Perpetualism relates to the technology development passion of humans, that gained great momentum via the industrial revolution, to develop a machine that runs infinitely with no needed inputs of materials or energy. The Faustian problem, to trade off the future for short-term gain, seems to be an intrinsic part of the human condition.

It is unclear whether current interpretation of industrial ecology can achieve or even approach its implicit objectives on the back of sustainability. The unwarranted optimism of sustainability clouds the more exciting potentials of industrial ecology to find innovative and beneficial ways. While it parades as a new model, sustainability ends up obscuring the urgent need to seek genuinely innovative approaches to economic motivation and management.

INDUSTRIAL EOCLOGY AS A FIELD OF SCIENCE

Several additional questions are arising as to what industrial ecology is, and isn’t. Clearly it needs to be and is a multidisciplinary field. In addition, it is substantial enough to warrant the attention it now gets. Its adherents have recently become more concerned about its boundaries and appearance. To become a field of science yet inclusive enough to allow inquiry that is outside the limits of scientific disciplines, it might be helpful to compare current development of industrial ecology to that of earlier multidisciplinary efforts, such as the early General Systems Theory group. GST formally emerged in 1953 within and from the American Association for the Advancement of Science (AAAS). The group that formed it were researchers known to be leaders in their respective disciplines, yet they were also known to be unhappy with the limitations of their home disciplines. It is worthwhile to note that some of these people later became the early leaders of environmental concern with industrialization. Foremost in this group was Kenneth Boulding, past president of AAAS and GST.

Industrial ecology and systems theory attracted people from diverse disciplines. While their fields of work and approaches to problem solving were very diverse they were held together by a belief in science and a desire to find more inclusive methods of science and beyond science. They were concerned about the approach to science where clarity was gained by establishing ever more narrow disciplines with ever-tighter rule bases and method sets. This was against the tradition where encouragement went to those who would specialize to the extreme, and where methods and problems become ever more tightly circumscribed. Systems theorists, and now industrial ecologists, saw the solutions to what bothered them beyond the disciplines they were trained in. Their home disciplines were unable to solve these problems. They sought approaches that were more prosaic, inclusive, and contextual. Yet, when it comes to articulating a clear definition of what they do, and don't do, both face essentially an unsolvable dilemma.

Both groups were looking through a new perspective on science. The traditional had been specialization and reductionism in order to better capture living forces. The new perspective was to form networks of former specialties and work to clarify by expanding to include context. The dilemma is that neither group did a very good job of defining who they were and what they were after. The systems group, while being older, has died and been reincarnated a number of times. Through this process it seems to have developed a sense of wisdom and humor about definitional problems. The more successful members of that group, which include three Nobel Prize winners, illustrate how ambiguity can tend to stimulate, not discourage, a researcher.

The major breakthroughs in contemporary science have come from interdisciplinary work, but generally from disciplines working adjacent to one another. We simply argue that industrial ecology can learn from this, as well as the experiences of systems theorists, to continue the search for a new relationship to context in the problems it chooses to solve and how it chooses to solve them. The enemy of this approach appears to be the reductionistic and anti-contextual approaches of traditional science. In fact, the same approaches and their attitude they engender may be at the root of many current environmental problems (Hawk, 1977).

SUSTAINABILITY

Sustainable development is not per se a wrong idea, but it easily leads to sloppy thinking and scientific impossibilities. Since it has recently emerged as the central hope of most environmental discussion we will address it in this section. There is widespread agreement that the mission of sustainability includes a threefold mission, which any political action towards achieving it must fulfil (Huber, 1998):

1. to promote further economic development

2. to ensure ecological sustainability by not exceeding the earth's carrying capacities, and

3. to bring about social equity by creating a better balanced distribution of opportunities to use natural resources and sinks, and giving access to a fair share of the wealth produced.

While there is little clarity as to what sustainability means in achieving these missions, and little agreement as to how to measure its achievement in their regard, this approach is worrying for other reasons. Sustainability can easily point to two well-travelled pathways. First is the dream of creating an negative-entropy machine, probably industrial, that links to the deeply seated notion of humans upon the environment without cost. The economist, Nicholas Georgescu-Roegen presents this human tendency, and its seemingly eternal sponsoring agents, in great detail (Georgescu-Rogen, 1971). The logic of this theory is that the 2nd Law of Thermodynamics, the so-called "entropy law," disallows human realization of sustainability, although not the dreams of it. As he might say, "Its simply not on, perhaps economizing is possible, but not sustainability."

Sustainability is quite similar to its earlier conceptual cousin, "stability." The mission of achieving a "stable relationship between humans and their environment" was proposed about fifteen years ago, as initiated by one Georgescu-Roegen's most famous student, Herman E. Daly. He proposed a way to resolve environmental problems via working to attain "a stable state." Daly became known as an important environmental economist and eventually attained much stature at the World Bank, although his ideas made little difference to World Bank environmental policies and practices. Georgescu-Roegen was not so encouraged by his student's work. He pointed out how the Daly stable-state fame work was closely akin to the historic dream of creating a perpetual motion machine. He also pointed out that Daly wasn't such a good student, with a bit of laughter added to the comment.

Something more significant is needed. Research needs to be conducted into more interesting alternatives to current forms of sustainability, recycling and environmental protection. These maladaptive responses consume too much of the limited energy available to negotiate a new treaty between the artificial and the natural.

Some clues as to what this might mean are provided in parts of the recent book on "Bioeconomics and Sustainability," by Kozo Mayumi and John Gowdy. They in essence argue that more is needed than refinement of an industrial machine that is limping. While they argue that aspects of the industrial machine can be saved/improved we would argue that most of it is no longer essential to human well-being. Well-being is being redefined around a very different sense of context of the human condition than that offered by industrialization.

THE CONTEXTUAL ALTERNATIVE

One suggestion has been to focus the research in industrial ecology on the importance of context. According to Allenby:

> *"…the point is not that we shouldn't continue with the LCA, DfE, and industrial metabolism studies. They are all valuable and worthwile, as long as the implications and limitations imposed by the implicit boundary conditions are understood; and we certainly need the practice and data that result…Rather it indicates that at some level of the system, the technocratic approach, which most industrial ecologists are inherently comfortable with- and which most LCA, DfE, and industrial metabolism work to date exemplify- must be augmented by other forms of analysis. Because in the real world context matters, we must study context.*
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> *Only by reaching out to other disciplines…will we be able to discern and understand*

the truly difficult barriers to change and technological and cultural evolution. Such barriers are particularly difficult to study, because they require multidisciplinary approach…and because they are often an unconscious part of ourselves and our culture. Yet they are frequently the most important roadblocks to discontinuous progress, and only if we can identify and understand them will industrial ecology fulfill its true promise."

The most advanced areas of science appear to have arrived at a related area of concern and now call for inclusion of context as part of synthesis. More research needs to be done on the two worlds of environmental concern and scientific development, and how they can be mutually developed at a higher level of understanding of both.

This might be something like an environmental version of the early socio-technical systems developments of Fred Emery and Eric Trist. Their research into the importance of including context discovered that in most machine design the underlying principles were derived from engineers using a technological imperative. They argued that design should include social and perhaps natural imperatives in the decision process as well.

Late industrialization, which is removing industrial entities and replacing them with Information and Communication Technologies (ICT) comes from ideas that are very similar to those advanced by Emery and Trist in the late 1950s. During the sixties they argued how context was becoming a dominant actor in economic interactions (Emery and Trist, 1965). This would allow the advantages of a new perception towards a post-industrial context and ultimately a new attitude towards and design of context. This would need to be very different from the tradition continued in a 1999 book on "Neo-Industrial Organising," by E. Ekstedt, et.al.

Within industrial societies it has been common to separate business (private) and societal (public) activities and the values implied by each. If context is important then this separation becomes almost impossible. While the division was thought to be important to industrial development, it may be harmful to ecological development. Making a distinction between values that are societal and those that are private seems unusually American and increasingly counterproductive. Once again, Emery and Trist are helpful here. They proposed a set of future human values that they thought would heal this traditional industrial split and allow for further development of human beings in a renewed context.

Domain	Existing	Future
Cultural Values	Achievement Self-control Independence Endurance for distress	Self-actualization Self-expression Interdependence Capacity for joy
Organizational Philosophies	Mechanistic forms Competitive relations Separate objectives Own resources regarded as owned absolutely	Organic forms Collaborative relations Linked objectives Own resources regarded as also belonging to society
Ecological Strategies	Responsive to crises Specific measures Requiring consent Damping conflict Short planning horizon Detailed central control Small local government units Standardized administration Separate services	Anticipative of crises Comprehensive measures Requiring participation Confronting conflict Long planning horizon General central control Enlarged local government units Innovative administration Coordinated services

Their future values would provide for a very different kind of context for economic activities.

STUDYING CONTEXT

To be more specific, we are proposing a way to include context while allowing it to becom a more integrated basis for human value-making and decision-taking. Two research projects that focus on energy management are used as examples. The first is about describing an regional energy system as an example of implementation of the ideas of industrial ecology and calculating the resulting greenhouse gas emission reductions with the second being experimentation with methods to improve efficiency of end energy use.

Environmental benefits of co-operation in regional energy system

The most critical innovation of the industrial ecology model is the level of inter-enterprise co-operation. It is suggested that industrial ecology will contribute to sustainable development as co-operation between various actors produces ”system innovations” that go beyond special process improvements or single product innovations (Wallner 1999, Huber 1998).

A regional energy system consists of energy consumption and energy supply. The system varies substantially between different countries and regions, according to the available natural resources, economic factors, and the stage of historical and technological development, governmental factors, climate, and so forth.

Consumption sectors are various industries, transportation, heating/cooling, households and services (Lehtilä, Tuhkanen 1999). The consumed amount and type of energy in a certain region depends on many parameters, which are presented in the following table.

Consumption sector	Parameter
Industry	– Type of industry – Product(s) – Demand of product – Specific consumption of electricity, heat and/or direct fuel use
Transportation	– Transport modes and their shares – Transport technology – Specific consumption of fuel or electricity – Land use / zoning practices
Heating and cooling	– Climate – Population – Building volume / person – Technology used for heating and cooling – Specific consumption of electricity, heat and/or direct fuel use
Households and services	– Population – Lightning and appliances technology (cooking, cold storage, washing and cleansing, miscellaneous) in use – Specific consumption of electricity, heat and/or direct fuel use

The energy supply consists of primary energy supply and the conversion of primary energy into electricity or heat. Primary energy supply can be divided into fossil/renewable fuels and imported/local/exported fuels. The conversion into electricity and heat can be divided into industrial self-production, combustible fuel-based power and/or heat generation technologies and wind and solar power (Lehtilä, Tuhkanen 1999).

Some Finnish regional energy systems have been described as examples of implementation of the ideas of industrial ecology. Environmental benefits of co-operation have been estimated to find out the feasibility of industrial ecology model in practise. In the following the potential for the greenhouse gas emission reduction in one of the cases is discussed.

In city of Jyväskylä located in Central Finland about 3300 GWh of primary energy is consumed per year. Most of the energy consumed in Jyväskylä is used for heating purposes. Heating of the buildings stands for nearly half of all energy consumption. Industrial processes account for 30 % and road traffic about 10 % of energy consumption. Industry is the biggest user of electricity in Jyväskylä consuming about 40 % of all electricity consumed. More than half of all electricity consumed in Jyväskylä is also generated in town by the Rauhalahti Power plant. The fuels used for all energy purposes (i.e. heating purposes, industrial processes, road traffic and others) consist mainly of domestic, local fuels, which account for 60 % of all primary energy fuels used. The most used fuel is milled peat, which stands for about 45 % of all fuels. Rest of the local fuels are wood residuals from the industrial plants from the region. Under 30 % of the fuels used are foreign, fossil fuels. (Keski-Suomen Energiatoimisto 1999)

The CO_2 emission reduction that have resulted from current energy supply system has been estimated to be 10-50 % depending on the chosen comparison system. Some estimations have also been made about the significance of parameters like building volume per person and specific energy consumption per heated volume. Between 1960 and 2000, greenhouse gas emissions have increased in the region under study because of increased population and standard of living. However, due to improved heating technology and decreased specific heat consumption of houses, the energy consumption per person have decreased. Assuming the best possible development of technology both in heating energy consumption and energy production side and no increase in living standard (i.e. building volume per person) the CO_2 emission resulting from consumption of heat in the residential sector would be 60 % lower than today.

In order to include and rethink the context following questions should be answered:

- Why has the energy system developed as it has?
- Are similar systems feasible in other regions?
- If yes, why haven't they been implemented?
- If not, what kind of system would be feasible and what determines the feasibility?
- What are the options for further CO_2 emission reductions ?
- Which actors and how are involved in causing the emissions/should be involved in reducing the emissions?

Experimentation with methods to improve the efficiency of end-energy use

Home heating, cooling and appliance usage are major users of energy in the US and thus major contributors to global CO_2 emissions. Estimates are that they account for about 30% of the problem. A three-year program (1995-1998) was run for the USEPA, titled ENERGY STAR®Homes. It was set up to encourage innovation in the production and operations of houses so as to reduce the problems associated with energy consumption.

The ENERGY STAR®Homes program was designed to be a base-camp for experimentation and innovation with non-regulatory alternatives. It was a voluntary program that identified incentives for industry change and set up processes to facilitate their realization. Many innovations were initiated but impediments seemed to always be encountered. Impediments seemed to arise equally from government, industry and environmental groups. The impediments were much more significant than those encountered previously in other ENERGY STAR® programs that dealt with non-home buildings and office equipment.

Some conclusions can now be drawn since several hundred builders are now building several thousand houses across the US that meet the standards required of these "more efficient" homes. From this standpoint the work was a success. At a more general level it was not successful and pointed out the potential hopelessness of current efforts to make gains within involving context. Change was strongly resisted by the context that included traditional attitudes, methods and values. The building industry was found to be extremely resistive of change, even though a great deal of new technology had been developed to achieve energy savings. The problem was a lack of innovations in the social systems that would implement the technical innovations. Issues of costs, profit and related economic dimensions were found to be relatively trivial. The need to control power relations was a dominate impediment. One means available to provide for social innovation, i.e., shake up the power relations, is to eliminate the $100 billion plus that the industry receives each year to maintain the status quo. Such a shaking up of current relations would allow for development of a very different context, and a very different way to deal with the consequences of the results of the industry that produces houses.

In addition, it was found that the home, or the idea of the home was the contextual basis for societal values. These values were quite conservative, and thus allowed the industry that produced houses to be much more conservative than other industries. As such it was not especially interested in improving cost/performance relations of its products, let alone working to arrive at a new relationship between its products and their natural context. This became an excellent way to seing and understanding of the overall environmental deterioration issue. Homes were found to be the key symbols of cultural ideas associated with families and the role of individuals. The home offered a way to research the human values at the base-camp of societal existence. What we found did not make us very optimistic, at least in the US context. Individual and societal aspirations, and most of the consumption habits that surrounded these aspirations in US society will not change easily.

During the time of the study, due to an expanding economy, consumers were willing to buy almost anything, thus producers avoiding any worry about making products more desirable, or environmentally sensitive. Consumers tended to encourage this tendency by pointing out that they might live in the house for only a few years and so its characteristics didn't really matter so much. In the fight versus flight option flight was clearly more critical.

Beyond this were even more serious problems in the value systems of the end consumers that made significant improvement essentially impossible. This is demonstrated in the following section.

RECYCLING, SUSTAINABILITY AND TRADE-OFFS

The essence of resource use in the US is widely accepted, at least by observers standing outside the US, as simple gluttony. With about 3% of the world's population the US accounts for about 25% of the energy and materials consumed in product making and using. The leading edge of this gluttony is most easily illustrated by the continuing expansion of four wheel drive sports utility vehicles. These are affectionately known, in the US, as the SUV. A top of the line SUV, like a Range Rover, gets about 13 miles per gallon, is driven about 14,000 miles per year, and thus uses about 1,075 gallons of fuel each year. Since each gallon generates about 20 pounds of pollution (including the pollution associated with refining the fuel), each SUV generates about 21,500 pounds of carbon dioxide.

The above may be interesting but even more so are the recent rationalizations raised under the banner of sustainability. It is now being argued that using an SUV is not as bad as it seems if Americans will make use of innovative ways to offset the 21,500 pounds of carbon dioxide production with ways to make their homes more efficient. The means and numbers are as follows:

a) Change Washing Machines – Switching to a front loading clothes washing machine will save up toe 1,000 pounds of carbon dioxide per year.
b) Windows – Installing new (plastic) windows with multiply glazing will save up to 4,300 pounds of carbon dioxide per year.
c) Lighting – Replacing incandescent lighting with compact fluorescent bulbs will save up to 1,250 pounds of carbon dioxide per year.
d) Oil Furnace – Replacing an existing furnace with a more efficient one will save up to 8,900 pounds of carbon dioxide per year.
e) Refrigerator – Replacing an old refrigerator with a more efficient one can save up to 1,500 pounds of carbon dioxide per year.

Somehow this doesn't add up. It seems more like a means to allow Americans to continue to feel good about sustaining their life style. More is needed. Examination of context illustrates this, as well as provides some clues as to what changes might help.

CONCLUSIONS

The strength, and weakness, of industrial ecology begins in it essentially containing a conceptual contradiction. Its major strength, and attraction, is the dynamism allowed by packaging industrial and ecological traditions together and expecting them to find a third way out from their intrinsic contradictions. This is also a major weakness and efforts must be made to allow the two sides to be seen simultaneously – i.e., in context.

Several questions are arising as to what industrial ecology is, but these discussions make little sense unless it is against a context, and little gain can be made unless it's the right context. We argued that the context of industrial ecology must contain interdisciplinary activities, people and attitudes. In this way a new sense of context can be found or created. This can also change the problems which we decide to solve and how we choose to solve them. An significant challenge in this regard is to shift problem solving efforts in industrial ecology from how to achieve results to how to manage consequences of achieving short-sighted results.

Research needs to be conducted into radical alternatives to the various forms of sustainability, recycling and environmental protection that now consume many of the limited resources available to humans.

Energy systems, in their broader sense, which include energy production and consumption activities, provide an interesting avenue into the subject of context. The need for reducing greenhouse gas emissions in significant ways is clear. Energy analysis projects could help define significant. Pursuing the two pathways to research identified herein provides additional ways to identify the barriers and opportunities to change and their context-dependence.

> *"Solutions are temporary events, specific to a context, developed through the relationships of persons and circumstances. Reality changes shape and meaning because of our activity. And it is constantly new. We are required to be there, as active participants. It can't happen without us and nobody can do it for us."*
>
> Margaret Wheatley

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