Editorial: cooperation within sustainability networks and its implications for research and teaching

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Abstract: *Sustainability networks are understood as local/regional systems of voluntary but organised cooperation among different stakeholders exhibiting a common vision of sustainable development.* On the basis of a more detailed description of the concept in the editorial article of the first part of this double special issue of *Progress in Industrial Ecology* on 'Sustainability Networks', this paper emphasises the possible outcome of interorganisational collaboration in such networks in practice. These practical measures may include: recycling materials and cascading energy, joint-developing of sustainable products, improving and integrating processes, encouraging common acceptance of social responsibility, and promoting inter-company learning and knowledge generation. Moreover, the implications for research and teaching on sustainability networks are also discussed. Here, the importance of inter- and transdisciplinarity are highlighted, and the approach of transdisciplinary case studies for sustainable development is introduced. Some thoughts for future research and development of the ideas and approaches presented in the 14 articles published in this double special issue are also given.

Keywords: sustainable development; interorganisational collaboration; sustainability networks; inter- and transdisciplinarity research.

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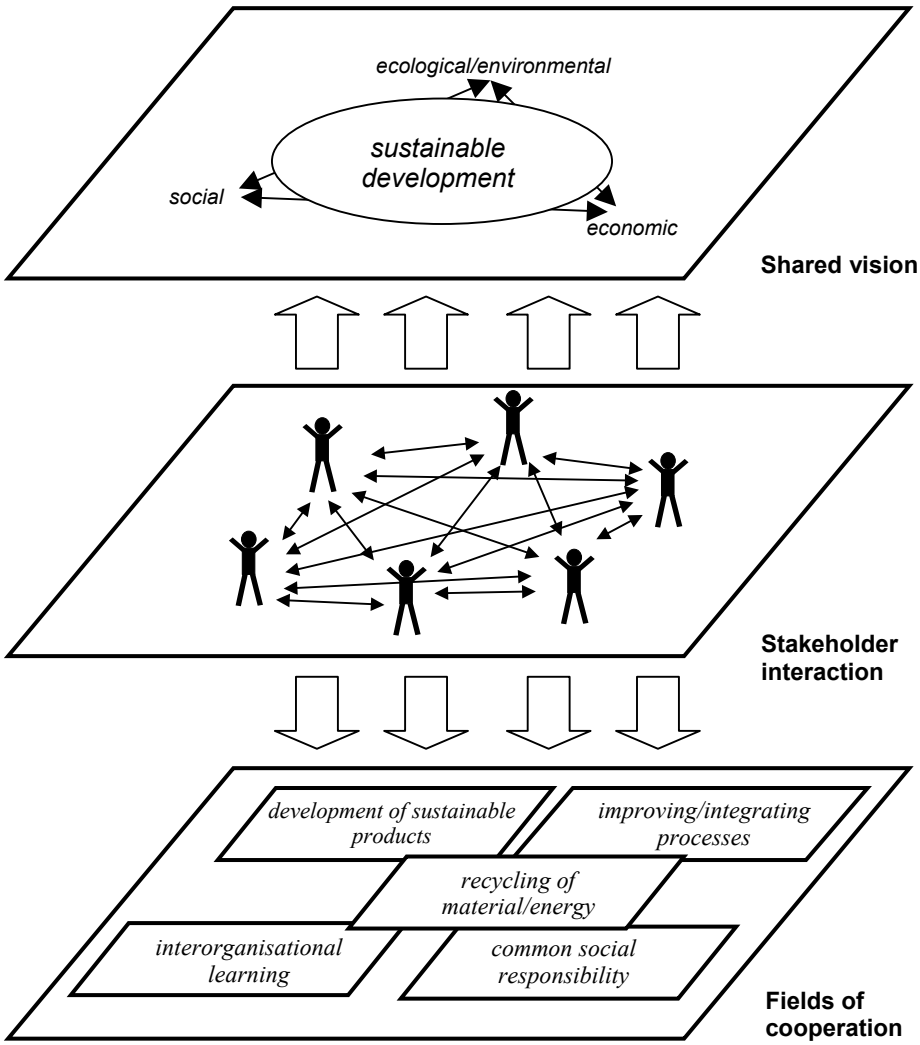
1 Introduction

This paper is based on the introduction to the concept of *sustainability networks* in the Editorial Article of Part I of this double special issue of *Progress in Industrial Ecology (PIE)*. Sustainability networks were defined as *local/regional systems of voluntary but organised cooperation among different stakeholders exhibiting a common vision of sustainable development.* In order to gain a better understanding of the concept of sustainability networks, a distinction between three layers was suggested: the vision layer, the stakeholder layer, and the cooperation layer (see Figure 1). The most essential layer is the stakeholder layer, which symbolises the integration of and interaction between stakeholders. On the basis of this stakeholder interaction, a common vision of sustainable development, symbolised by the upper layer, can be established. Furthermore, the integrated stakeholders need to interact in order to transform the common vision for sustainable development into concrete action.

Figure 1 Three levels in the concept of sustainability networks



I also argued that recycling or waste utilisation, the common theme in industrial ecology at present, should only be understood as one potential outcome of practical cooperation within sustainability networks, and not as an overall vision, nor as the most important layer (layer of stakeholders, *i.e.*, the human actors). This is because the physical flows of matter and energy, and the flow characteristics themselves, are merely a result of human preferences, visions, decisions, and actions, not the driver of these preferences and visions.[1] It is not the flows that constitute the system of the actors involved or the vision of these actors; rather, it is the actors who decide to be involved and are the ones who decide upon the vision (for a more detailed description of the concept of sustainability networks, see Posch, 2004a).

This is why there is a strong emphasis on stakeholder interaction and cooperation within the concept of sustainability networks. Concrete outcomes of this interaction, like interorganisational recycling activities or industrial symbiosis between network companies, are no longer the main issue of analysis. Instead, attention is drawn away from waste and material flows and is focused on the actual interaction and cooperation of the network actors.[2] Any material flow within the sustainability network is thus merely the result of decisions made by the network actors (Posch, 2004b,p.113).

While the focus of the description of the concept in the above-mentioned article was placed on stakeholder interaction and the creation of a shared vision of sustainable development between these stakeholders, possible areas for practical interorganisational cooperation within sustainability networks are outlined (lower layer in the model) in Section 2 of the present article. It is necessary to mention here that these fields of collaborative action may go far beyond mere recycling of material, and may include a wide variety of other measures for environmental and social sustainability. The description of the areas for cooperation is carried out only for the purpose of characterising the possible outcomes of sustainability networks, and not in order to designate exact areas for cooperation. The objective of this special issue of *Progress in Industrial Ecology* is to encourage future works by researchers in the field of industrial ecology, cleaner production, Natural Step, and others. The Journal wants to encourage work that considers what other forms of cooperation and practical outcomes of such cooperation can be studied and suggested in order to achieve progress in sustainable development research and practice.

In Section 3 of this paper, the implications for research and teaching on sustainability networks are then described. Here, the claim for interdisciplinary approaches that has already been repeatedly asserted in the literature, but has not yet really been thoroughly considered and implemented in terms of the scientific field of industrial ecology, plays an important role. The overview of the papers of this special issue of *PIE* provides a first impression of the wide variety of points of view from which the topic can be looked at. Besides interdisciplinarity, it is also necessary to go further into the question of transdisciplinarity and its relevance for research on sustainability networks. Finally, the concept of transdisciplinary case studies for sustainable development is briefly described. Such case studies allow the integration of research, teaching, and practical application, which might also be a very promising approach in the field of industrial ecology in general, and for research and higher education on sustainability networks in particular.

2 Possible areas for cooperation within sustainability networks in practice

While on company level sustainable development means continuous improvements in terms of ecological and social impacts of the business activities, it is still necessary to identify those fields of activities where interorganisational cooperation within networks can be beneficial for sustainability. Here, the attention needs to be turned to the question, "Where the advantages of interorganisational cooperation in comparison to mere intraorganisational problem solving lie?" It cannot be assumed a priori that all companies are interested in cooperation in the field of environmental and social management. Rather, there must be an obvious benefit recognisable from participating in a sustainability network in order to justify the transaction costs of interorganisational cooperation.[3]

Research reveals that the following factors are influential in the emergence of cooperation (Brockhaus, 1996):

- The ecological and social effects of the specific business activities need to be considered as a serious problem or as being in a state of crisis by as many companies as possible.
- The higher the complexity of a problem, the more the necessity of a cooperative solution is perceived.
- Cooperation is enhanced when prior attempts to solve the problem through a controversial dispute have failed.
- The perception of increasing turbulence in the political, social, and economic environment of the actors can induce cooperation.

Moreover, the balance between the economic interests of the company and the external ecological and social interests of various groups of stakeholders is clearly becoming more and more important (Schaltegger, 2003). This implies the need for explicit strategic planning and design of all relevant stakeholder relationships, where interorganisational cooperation can play a major role.

Besides these more general reasons for cooperation within a sustainability network, there are a number of factors directly related to the specific interorganisational activity. Some of these factors are briefly described in the following pages. They are:

- Recycling materials and cascading energy.
- Cooperating in improving and integrating production processes.
- Cooperating in the development of sustainable products.
- Common acceptance of social responsibility.
- Promotion of inter-company learning and knowledge generation.

2.1 Recycling materials and cascading energy

In terms of ecological sustainability, the quantitative and qualitative preservation of natural resources is essential. Renewable and nonrenewable resources may be used only so far as the possibilities of future generations to meet their needs is not compromised. At the same time, resource protection also implies maintaining the quality of the environmental media, *i.e.*, limiting the emission of pollutants to a level where the natural self-purification of the environment is still possible. In this context, Müller-Christ and Hülsmann talk of a "dual definition of success" when they state that future companies need not report only their monetary profit but also their achievements in protecting their natural resource base (Müller-Christ and Hülsmann, 2003). The authors further emphasise that the protection of the natural resource base is a long-term prerequisite for survival of the company, and hence, should always be considered in fundamental management decisions. This view requires that sustainable management employ a rationality that does not stop abruptly at company borders, but one that also embraces the company's external resource base. Consequently, resource management is always an interorganisational matter. The physical flows of matter and energy cross the boundaries and borders of processes, organisations, and regions, and cannot be dealt with and managed by means of intraorganisational approaches alone (Korhonen and Strachan, 2004).

One central instrument of industrial resource management is recycling, since the reintegration of production and/or consumption of wastes in production processes simultaneously lead to a substitution of natural virgin resources and to a reduction of waste release (Strebel, 2003). As Lifset states, "closing the loop, that is, diverting products and materials that would otherwise be destined for disposal into productive uses, is indeed a pivotal tenet of industrial ecology" (Lifset, 2002,p.1). In those cases where internal reuse of by-products is not possible, interorganisational recycling activities can be a good solution. The different production technologies in various industries usually enlarge the potential for recycling activities significantly. Of course, the spatial proximity of the partner firms is a main criterion for interorganisational recycling.

2.2 Cooperating in improving and integrating production processes

The industrial production of goods is based on division of labour, not only intra- but also cross-plant. Along a supply-chain, or within a supply-network, many companies are involved in the production of a certain good. The totality of companies, from extraction of raw materials to the transfer of goods to end consumers, works to form a supply-network.

The issue of whether or not cooperation on improving and integrating production processes takes place in such networks strongly depends on the existence of network awareness. Suppliers of standardised components or raw materials, perhaps operating in various countries, often only know their direct buyer, and hence, are not aware within which supply networks they participate in. In this case, cooperation on improving and integrating processes can take place only on a bilateral basis, if at all. Only if the contact between the companies is closer, as in so-called industrial clusters[4] (characterised by the spatial proximity of the cluster firms) can integration of the production processes take place. Within such networks, common R&D activities for process improvements and efficiency gains can also take place. Moreover, administrative facilities and technical

equipment may also be shared by the network companies. This not only leads to lower costs but also to a reduction of resource and energy use, and of pollutant output at different stages of production. A number of additional technical possibilities for closing system loops or for substituting renewable resources for nonrenewable resources often arise from the interorganisational cooperation of several companies.

2.3 Cooperating in the development of sustainable products

In terms of the ecological impact of a specific product during its life cycle, the main impact usually occurs in the production and/or consumption phase. Such impact is determined to a high degree in the product's development phase where the shape and the composition of the product are fixed. Hence, the process of product development, which is industrial design, is essential in sustainability.[5] Products that meet consumer requirements while having a minimum negative ecological and social impact along the whole supply chain need to be developed. According to the German waste legislation, producers bear the responsibility for the ecological impact as well as for the disposal of their products (KrW-/AbfG, 2004,Sec. 22).[6]

The same responsibility could be assigned to the producers concerning the social impacts of the products. For example, such aspects as workplace design, avoidance of dangers in production and consumption, and the abandonment of any production involving exploitation of deprived groups (*e.g.*, child labour in developing countries) could all be made more important.[7]

In order to cope with such comprehensive product responsibility, interorganisational cooperation is usually indispensable. Of course, in terms of describing cooperation in the development of sustainable products, supply-networks are of main interest, but NGOs also play an important role. Here, some international examples of good practice, such as the Green-cloth campaign, already exist (Kirschten, 2003,p.177).

2.4 Common acceptance of social responsibility

In recent years, various factors such as the globalisation of the economy, radical innovations in information technologies, financial frauds, and market crashes, especially in the New Economy, have led to the idea that industry should develop greater social responsibility. The main issues of Corporate Social Responsibility (CSR),[8] defined in terms of the responsiveness of businesses to stakeholders' legal, ethical, social, and environmental expectations, differ from industry to industry. In the beginning, CSR concepts focused very much on industries with high health and/or environmental risks. Now, the concept has become much broader and encompasses the following main issues:

- Social responsibility throughout the life cycle of products: Here, the compliance with human rights as a fundamental principle allowing the individual freedom to lead a dignified life, freedom from abuse and violations, and freedom to express independent beliefs at all stages of the supply chain is aspired to. Aside from this, further key challenges are involved, such as labour rights (including the rights of the child), land rights, and indigenous peoples' rights.[9]
- Human resources management: Employees and their tacit knowledge are one of the most valuable resources of any company. A highly motivated staff is more productive, and hence, also economically beneficial. Key aspects are the

treatment of elderly employees, women, employees from various cultures, disabled employees, *etc.*

- Corporate citizenship: The regional social responsibility of companies is not limited to the creation of employment, but could also include activities to strengthen community links, to cooperate with local schools, to sponsor cultural events, or to increase local procurement, *etc.*

Cooperation for common acceptance of social responsibility provides a powerful mechanism for enhancing the ability of industry to cooperate on a broader basis with civil society. In this way, ties to the various groups of stakeholders can be fostered (see the stakeholder model by Madson and Ulhøi, 2001) and innovative ground for significantly improving business environments can be broken.

2.5 Promotion of inter-company learning and knowledge generation

Promotion of inter-company learning and knowledge generation for sustainability is very closely related to the other issues briefly described above. The issue of interorganisational learning in sustainability networks highlights the high potential for commonly gaining a better understanding of many sustainability-related issues and possibly finding solutions to the environmental and social challenges facing the network members. As noted above, because the material and energy flows cross product, process, and firm boundaries and borders, it is impossible to learn about measures to control them without interorganisational and network cooperation. Malone and Yohe even state:

> "That distributing expanding knowledge and shared ethical values through emerging communications technologies could be the key to unlocking the sort of environmentally sustainable, economically prosperous and equitable future that is likely to be socially and politically stable." (Malone and Yohe, 2002,p.377)

Hence, in a sustainability network, all relevant stakeholders should be integrated in order to enhance the network's knowledge base and thus, the capability for innovation in all sub-systems of the network.

A system of common knowledge management could be established within the sustainability network that would allow the network actors to set up and exchange further knowledge about new technologies, legal and other constraints, or potential developments in various fields of interest. For example, the available waste flows with potential economic value could be communicated through such a platform.[10] Moreover, interorganisational learning in sustainability networks can create a learning experience where decision makers of the network members are able to develop a conceptual framework they need to make a shift in thinking necessary for reorientation towards sustainability. This includes the creation of knowledge and competences for technological innovations, but also goes far beyond it by addressing cultural and ethical issues.

Here, stakeholder influence is no longer viewed as an extra burden and limitation on corporate or network management, but rather as a possibility for mutual learning (Madson and Ulhøi, 2001,p.78). In fact, interorganisational learning depends on interaction between organisations and stakeholders (Halme, 2001,p.101). In the optimal case, this leads to a double loop learning by all network participants, which, in contrast to

single loop learning, includes a questioning of the status quo and of the underlying values and beliefs, thus enabling a fundamental reorientation of actors towards sustainability (Boons and Berends, 2001,p.118).

3 Implications for research and teaching on sustainability networks

As described above, sustainability networks are highly complex systems, integrating many various stakeholders with different interests, values, and beliefs. The core element of a sustainability network is the stakeholder cooperation and the emergence of a common vision of sustainable development, which then can be broken down to concrete actions in different fields. Now, the question arises as to what contribution research and higher education can make in establishing the concept of sustainability networks in practice, and how research and teaching on sustainability networks need to be shaped.

3.1 The need for interdisciplinarity

Considering the high complexity of sustainability networks and the variety of aspects on perspectives involved, it becomes quite obvious that no single discipline can address all the above-mentioned topics. As already claimed for the field of industrial ecology (*e.g.* Korhonen *et al.*, 2004), interdisciplinary research will also be required in order to promote a holistic view of the phenomenon of sustainability networks in all their varying forms:

> "The impetus for developing IE stems from the need to incorporate a multidisciplinary, holistic approach, which considers sustainable development and multiple objectives spanning several levels of system organisation, into the strategic and operational decision making processes of industry." (Tilley, 2003,p.15)

Researchers need to gain cross-functional competences and insights in more than one field of science (Brattebø, 2002,p.1). This approach facilitates real cross-disciplinary thinking, translating, reconciling, and integrating disparate discourses, traditions, and methodologies. "Our objective must be to combine knowledge from different fields and traditions in such a way as to increase their power of expression and interpretation." (Kleiber, 2001,p.55)

This also corresponds with the vision of *Progress in Industrial Ecology*, which calls for the need:

> "To bridge the material and energy flow analysis and studies of industrial ecology to business, management and organisational studies, including the now established discipline of corporate environmental management." (Korhonen and Strachan, 2004,p.5)

In fact, when reading the contributions to this second part of this special issue of *PIE* on sustainability networks, one gains a good impression of the different perspectives from which the question of interorganisational cooperation can be approached.

Desrochers[11] started from a historical perspective and discovered some highly interesting roots of industrial recycling networks or industrial symbiosis networks that stretch back as far as the 19th Century. In his valuable paper in this issue of *PIE*, he presents some evidence regarding the propensity of past managers, technicians, and

entrepreneurs to spontaneously create recycling networks. Furthermore, he argues that this widespread but seemingly forgotten behaviour led some writers, beginning with the most prominent paper of Frosch and Gallopoulos (1989), to construct an analogy between recycling processes in natural ecosystems and in industry. As a conclusion, he emphasises that with some creative thinking and much effort, profitable recycling possibilities might be found for many things in many circumstances. Here, the question arises as to how these recycling activities can be used as a starting point for sustainability networks. Desrochers states that spontaneous market coordination should be given more consideration in recycling networks than it is currently receiving, and he supports his argument with unique historical material.

In his contribution, *Korhonen* takes a closer look at the theory of industrial ecology by focusing on the concept of diversity, which is an important concept in ecology and biology and recently is also often cited in sustainable development research. Hence, this paper convincingly demonstrates the goal of interdisciplinarity by bringing together knowledge from various fields of science. Korhonen analyses whether or not the concept of diversity can be important and useful for developing industrial ecosystems – if yes, how; and if not, why not? For this, he fulfils the most essential task of bringing light to the different possible ways of defining diversity. Here, he is not content with describing the basic aspects of diversity, *i.e.*, diversity in various industries involved in the network, or in various kinds of waste/by products that are exchanged. He rather includes other very interesting aspects like diversity of organisational culture of the firms/plants, or of the workforce and employees. Then, he focuses on the interrelation between diversity and other very important and often cited properties or characteristics of industrial ecosystems, which are roundput, locality, and connectance. Here, roundput is understood as a qualitative model for how or in what direction certain flows move in a system. Locality is defined in terms of how much of the product life cycle, from 'cradle to grave', is possible to maintain within the local system boundaries. Finally, he measures system connectance by dividing the number of direct roundput links, *i.e.*, links between the actors in waste material or waste energy utilisation, with the number of all possible links. These highly interesting theoretical questions are illustrated with the case of the Uimaharju Industrial Ecosystem, located in the region/province of North Karelia in Eastern Finland, and its evolution from Type I to Type III ecosystem. Finally, Korhonen discusses and evaluates seven arguments presented in the literature arguing for the importance of the concept of diversity. He arrives at the conclusion that some of the arguments hold while some do not.

In their paper, *Fichtner et al.* focus on management issues regarding interorganisational cooperation. By analysing two case studies – one from the energy sector, the other from the waste disposal sector – they come to the conclusion that inter-company concepts can contribute to improved environmental management by producing considerable cost savings and environmental benefits, as compared to 'optimal' strategies implemented by the individual companies. For example, the energy case study points out that the installation of a custom-designed cycle power plant would be the most promising solution to meet the energy demand necessary to maintain the production in the firms involved. Whereas, the disposal case study shows that a waste storage in spatial proximity to the waste emitter as well as a more effective combination of different waste flows can lead to considerable reduction of transport-related emissions and costs. Moreover, by analysing the literature and interviewing decision-makers in industry, they identified several barriers to interorganisational environmental

management. They categorised these barriers into barriers at the level of individual actors, barriers at the level of individual firms, and barriers at interorganisational level. In fact, not only the clear evidence of the advantages of interorganisational cooperation that they provide, but also the measures that they describe for overcoming barriers to inter-company cooperation (*e.g.*, installing adequate information systems or building trust between the network actors) are of high interest with regards to sustainability networks, industrial symbiosis, industrial ecosystems, or eco-industrial park work.

Konrad concentrates in his paper on information systems that are necessary for holistic life-cycle management. As mentioned earlier, interorganisational cooperation for the development of more sustainable products can be a very important field of activity within sustainability networks and exchange of information, and sharing of knowledge can greatly contribute to these networks. Hence, Konrad's analysis of the determining factors, effects, and types of company using product-oriented information systems is of high value for sustainability networks. His findings concerning the limitations of product-oriented information systems are also very interesting. For example, he documented a whole series of cases where the use of such tools for product design remained only marginal or where marketing decisions based on them very soon afterwards were cancelled. The most important conclusion is that the collection and storage of life-cycle data must not develop into a self-purposive, symbolic activity with little connection to what goes on within or between organisations. Rather, it is crucial to tune the information systems to the specific needs and circumstances of each company and/or of each network.[12]

Günther and *Scheibe* place individual-related innovation barriers at the centre of their analysis. The focus on the barriers, and in particular, on analysis methodologies that can be used to identify and evaluate such barriers, complements the contributions of Fichtner *et al.* and Konrad discussed above. *Günther* and *Scheibe* identified and evaluated barriers to the development of more environmental-oriented procurement processes in industry. In the so-called 'hurdles analysis' method introduced in their paper, the identification of key persons in the procurement processes in organisations is a crucial step in overcoming the different kinds of barriers, *i.e.*, barriers related to lack of *knowledge*, *ability, will*, or *allowance.* It is of high relevance for sustainability networks to surmount such barriers, since green procurement can also contribute to interorganisational environmental management approaches, for example, by helping to reduce or replace inputs and undesired outputs, to reuse materials and hence, to close material cycles, (*i.e.*, procurement and use of waste of other companies in industrial symbiosis and eco-industrial parks), to produce environmentally friendlier products and services by not using certain substances (due to legal requirements or stakeholder pressure), *etc.*

Kirschten approaches the topic of interorganisational cooperation for sustainable development from an organisational point of view. She states that innovation networks are a necessary institutional prerequisite for sustainability-oriented innovations. She substantiates this hypothesis with results from empirical research on so-called 'sustainable innovation networks', which she defines as interorganisational cooperation between more than two actors aligned with innovation processes covering technical-economical, ecological, and social innovations. Interestingly, she also argues that only interdisciplinary and/or transdisciplinary cooperation ensures an adequate consideration of the whole situation of the problem and of the possibilities with regards to the attainment of common sustainable innovation goals. Here, she emphasises the high

importance of mutual learning processes, which on the one hand are presented above as an own field of cooperation within sustainability networks, and on the other hand are important for the interaction between academics and network actors in practice, as argued in the following section.

3.2 The need for transdisciplinarity

As described above, and illustrated with the contributions of this special issue of *PIE*, interdisciplinarity allows for the crossing of borders between different fields of science in order for a common goal to be attained (Scholz and Marks, 2001,pp.242–243; Tress *et al.*, 2003,pp.8–10). However, the complexity of the concept of sustainable development, to which sustainability networks refer to by definition, requires an even more fundamental paradigm shift in research: it becomes obvious that sustainability networks can never be set up by experts alone. Rather, the creation of a network and the definition of a sustainability-oriented vision need to be performed by the local/regional stakeholders. Although universities and other research institutions might be able to provide valuable support for this process, academics need to understand that scientists alone are no longer in a position to identify a single correct way of living, or the best form of sustainability (Wals and Jickling, 2002,pp.221–226). They rather need to understand how to move from societal needs and preferences towards the provision of generally acceptable solutions and technologies.

As a consequence, research on sustainability networks needs to be transdisciplinary, in the sense that transdisciplinarity involves intense interaction between academics and practitioners in order to promote a mutual learning process between them.[13] This can be seen as a move from science on/about society towards science for/with society (Scholz and Marks, 2001,p.236). Development strategies for the network must not be based on top-down approaches removed from first-hand involvement of those stakeholders concerned in the process of developing future strategies. Such approaches reduce the probability of actual implementation of development strategies and of single projects within the social system. Successful strategies for sustainable development have to be transdisciplinary in order for projects to gain acceptance among the stakeholders and to raise the probability of successful implementation. Without acceptance by the stakeholders, the many sustainability projects, such as a publicly funded case study of a local/regional industrial recycling network/industrial symbiosis, may continue only as long as the project funding is secured. Furthermore, after the money has run out, the actual actors responsible for implementing the results of the research project and promoting continuous improvement, in practice, may abandon the idea.

In the interaction between academics and stakeholders, it is very important that no single area of competence be regarded as better or more valuable than any other. Academic expertise needs to be viewed as being on the same level as more practical experience and the values of non-scientists. In fact, decisions on strategies for sustainable development need to be taken together with stakeholders. The latter can help to identify the relevant problems, to define sustainable development scenarios, and to contribute by expressing their expectations and ideals (Tobias, 2003,p.61). By combining analytical knowledge and systems understanding with practical observation and experience, and linking these to society's risk perception and demands, a joint problem solving process amongst science, technology, and society can be achieved (Lenz, 2003,p.64). Hence, not only does transdisciplinarity comes close to Nicolini's definition of participation as an

instrument in a common inquiry and search for answers (Kollmann *et al.*, 2003,p.19), but it also goes beyond that by including the aspect of mutual learning. The result of such an integrated process of knowledge production amongst scientists and practitioners is knowledge that is socially more robust (Gibbons and Novotny, 2001,pp.77–79).

For example, in our research on recycling potentials within the recycling network in Styria, Steiner found remarkable quantities of waste lacquer powder that used to be dumped by industry (Steiner, 1998). This waste lacquer powder was not defective; it merely lacked homogeneity of colour. In this case, a highly academic approach for solving only technical and logistical problems would not have been enough to initiate recycling of this very valuable material. There was rather a need for a transdisciplinary process that enabled academics and practitioners to jointly develop solutions for reusing the waste lacquer powder for products or product parts that did not need to have absolutely constant colours. Scientists provided the necessary technological expertise and practitioners supplied the requisite market knowledge.

3.3 Mutual learning in transdisciplinary case studies for sustainable development

A very promising approach for integrating teaching, research, and practical application is provided by the concept of *transdisciplinary case studies for sustainable development*, established by Scholz at the Swiss Federal Institute of Technology (ETH) in Zurich. Such case studies allow existing conventional structures and processes to be broken down by establishing close cooperation between academics and practitioners. In other words, the main characteristics of this concept are its inter- and transdisciplinarity, which lead to a mutual learning process among the various actors involved (Scholz and Tietje, 2002). Here, it is argued that this approach of transdisciplinary case studies for sustainable development is also a powerful framework for the interaction of academics and practitioners within sustainability networks.

Transdisciplinary case studies for sustainable development are not only mere research projects, but they are rather a combination of academic research, teaching activities, and factual application in practice, where researchers also act as instructors and tutors of students. Students, researchers, and practitioners work closely together in order to find an appropriate orientation with regards to the leading question of a case study, *i.e.*, sustainable development of society within a certain system. Hence, mutual learning within the case study takes place between all actors involved – practitioners from the sustainability network as well as university teachers/researchers and students.

The integrated nonacademic persons from the sustainability network supply their knowledge and experience to the university in order to gain new insights through interaction with students and researchers. This helps them develop new orientations towards sustainable development and better understand the options available. Regional stakeholders receive input from the interdisciplinary academic case study team. This may initiate further action, and therefore lead to further demand for competences. The role of academics within the case study is to outline and help visualise problems of which the stakeholders may not be aware of, in order to jointly find solutions.

In the other direction, academics also benefit from the practical and tacit knowledge and experience of the regional case agents. Jucker (2002,p.16) states that education for sustainability implies promoting learning for all participants, including experts. The latter need to be continuously open for self-reflection on what they are doing and what they are

claiming. Here, transdisciplinary case studies play an extremely important role in initiating and supporting the reorientation of scientific research embedded in a complex social system. More and more within the currently emerging network-society, scientists are expected to help stakeholders define common ground for action and for the sharing of individual problem solving capacities as well as to contribute to the steering of innovation processes based on scientific knowledge (Glasbergen and Smits, 2003,p.57).

Moreover, it needs to be considered that sustainable development has its beginning with sustainable education, especially at universities. Hence, transdisciplinary case studies on sustainable development include also teaching activities. Here, the university teachers are responsible for setting up the organisational framework of learning within the case study, while student learning remains largely self-regulated. Supported by teachers, the students learn by themselves to integrate knowledge from various sources and to distinguish between important and less relevant data for coping with highly complex problems in the real world system. The emphasis on higher-order learning, focusing on thinking that involves the whole spectrum of activity – from analysis and synthesis to arriving at conclusions – encourages the use of a broad range of knowledge, skills, and abilities as well as the development of critical thinking (Gayford, 2001,pp.320–321). Learners find themselves in a position where they are forced to recognise the consequences of their own actions, and may no longer attribute success or failure to forces beyond their control. In this way, they can see themselves as owners of their behaviour (McCombs, 2001,p.106). This concept of self-regulated learning can itself be viewed as socially sustainable in the sense that it empowers learners to take their learning into their own hands (Jucker, 2002,p.14).

At the University of Graz, initial experience in teaching transdisciplinary case studies was gained with the Erzherzog-Johann case study, where university teachers and researchers as well as students of different disciplines (especially 'Environmental System Sciences', an interdisciplinary course unique in Central Europe), worked together with practitioners for two terms. The guiding question of the case study was how the Eisenerz region, a declining mining region consisting of four municipalities with major structural problems, could achieve ecological, economic, and socially sustainable development in the future. Since intense interaction with stakeholders is essential in the concept of transdisciplinary case studies, the classes within the Erzherzog-Johann case study were partly held in the region of Eisenerz. This facilitated the integration of and communication with regional actors, such as mayors and other politicians of the municipalities, managers of regional industries, and representatives of schools, associations, interest groups, *etc.* In addition, thematic workshops on sustainable regional development and ethics, for instance, and recreational activities (*e.g.*, a common visit to a movie on regionally relevant themes) were organised to foster collaboration. Furthermore, each working group had specific contact persons who supported the group in their given field of work. In this way, students, teachers/researchers, and practitioners worked together to identify paths to sustainable development for the Eisenerz region. Various scenarios were developed and evaluated based on the expertise and preferences of academics as well as those of regional stakeholder groups. This not only provided an improved basis for decision making in the region as a final outcome, but also led to a continuous process of mutual learning for all actors involved, Thus, it also became a potential starting point for a regional sustainability network.

4 Concluding remarks

This special issue of *Progress in Industrial Ecology* on sustainability networks, Parts I and II, contains very interesting 14 refereed papers focusing on various aspects of interorganisational cooperation for sustainable development from different points of view. It is hoped that the issue contributes to scientific discourse in the field of industrial ecology. The concept of sustainability networks marks the high potential of interorganisational collaboration for sustainable development and goes far beyond the exchange of waste and materials for recycling purposes. The special issue also shows the necessity of new forms of research for industrial ecology, including inter- and transdisciplinarity. In order to solve the challenging problems of sustainable development, contributions from various disciplines will be needed. The international journal *Progress in Industrial Ecology* will continue to provide an adequate framework for this exciting dialogue.

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Notes from the Editor-in-Chief

1 This argument is in line with the often-cited Natural Step Framework and the model of Strategic Sustainable Development developed by Professor Karl Henrik Robèrt (see Robèrt *et al.*, 2002; Korhonen, 2004). The argument in the work of Robèrt states that in strategic planning and management in any complex system, and in strategic planning and management toward sustainability, a distinction should be made between different levels while understanding the interdependencies between these levels. Korhonen (2004) argued that the dominant way to use industrial ecology is to focus on the physical flows of matter and energy, and in particular, on recycling the flows or substituting certain flows with others (*e.g.*, renewables for non-renewables to produce energy). This shows that the focus of industrial ecology has mainly been on practical actions and concrete measures, instead of on the level of the overall vision and goal, which must be sustainability. Note that recycling as a practical action can also lead to suboptimal solutions and problem displacement in terms of the vision of sustainability, because recycling consumes energy, requires transportation, and produces wastes of its own. Furthermore, one of the intermediate levels centres on defining the strategy needed to attain the targeted vision. Strategic principles are principles according to which human actors, organisations, firms, and individuals plan their actions. The mere analysis of material and energy flows says nothing about the human decisions and actors driving the flows, and is thus not enough to develop strategic guidelines. Also, for developing strategies, organisational and management aspects as well as stakeholder aspects need to be considered, and these cannot only be studied by using methodologies derived from natural science and engineering (*i.e.*, methods that study material and energy flows, not human actors and their strategic behaviour). Without the strategic approach to planning and management, the actions suggested (*e.g.* recycling or substitution) may not lead to the intended outcomes in terms of the overall goal and vision, which must be sustainability.

2 It is also very important to understand the importance of the more intangible information flows when the focus of systems analysis of industrial ecology is on human industrial and economic systems. This point was emphasised in a recent special issue of *Business Strategy and the Environment* on 'Business and Industrial Ecology' (Vol. 13, No. 5), which argued that networks of human actors and organisations are a very important focus when bridging industrial ecology to business, management and organisational studies as well as policy studies.

3 The two special projects of publishing the triple special issue of *Journal of Cleaner Production* on 'Applications of Industrial Ecology' (Vol. 12, Nos. 8–10, including 26 articles) and the *Business Strategy and the Environment* special issue on 'Business and Industrial Ecology' (Vol. 13, No. 5, including 5 articles) presented many difficulties and limitations when industrial ecology-type cooperation is applied in practical policy and management in the everyday of decision-makers, organisations, or individual consumers. We invite the readers of the Journal to help us find solutions to overcome these difficulties and limitations and to submit to us their papers and thoughts on these possible solutions.

4 The influential work of Michael Porter on economic clusters (an article published in the respected *Harvard Business Review*, see Porter, 1998) provides a fruitful path to begin in addressing the challenge of linking industrial ecology (up to now, mainly an engineering and natural science dominated field) to social sciences, economics, business economics and management, and organisational and policy studies.

5 Design for the Environment (DFE) is among the key approaches in industrial ecology.

6 NoThis principle is among the key principles of extended producer responsibility and has evolved to become part of industrial ecology research (see the topics covered in the aims and scope of *PIE* and *JIE*).

7 In fact, some authors (see Welford, 1998; Korhonen, 2003) have argued that such common tools of industrial ecology and industrial metabolism as Life-Cycle Assessment (LCA) should also be used to consider social issues along the life cycle (*e.g.*, what happens in the part of the supply chain located in developing countries). The authors argued that, currently, LCA is not

used to its fullest potential as the sustainability dimension of equity, for instance, is not addressed in the descriptive, technical, and quantitative calculations of the inputs and outputs of the physical flows of matter and energy along the life cycle of a product.

8 *Progress in Industrial Ecology* wants to invite authors in Corporate Social Responsibility (CSR) to submit their work to the Journal. We have three reasons for this. First, industrial ecology is a form of systems and network analysis. CSR can contribute to such approaches because its focus is on all stakeholders of a firm, and not only shareholders. This means that CSR has to be interorganisational (Korhonen, 2002). Second, we feel that the mainstream industrial ecology literature to date has only superficially addressed the social dimension of sustainable development while mainly focusing on the environmental dimension, in particular, on the physical flows of matter and energy. If industrial ecology claims to become the 'science of sustainability' as the IE literature has argued, it cannot ignore the social dimension. Third, the corporate social responsibility paradigm has been offered as a new paradigm for business, which is radically different from the dominant neoclassical economics paradigm that is very influential in business economics (Korhonen, 2002). Also, the influential work of Ehrenfeld (2000) has argued that industrial ecology should not only be adopted as a form of incremental change, but rather as a radical paradigm shift in modern culture in order to achieve sustainability.

9 Welford (2002) used the declarations on human rights as a source of developing the theory of corporate social responsibility.

10 Sterr and Ott (2004) discussed similar ideas in the *Journal of Cleaner Production* triple special issue, 'Applications of Industrial Ecology' (Vol. 12, Nos. 8–10).

11 Dr. Desrochers has found historical literature materials that are unique. These materials have created a lot of debate within the field of industrial ecology, since the materials undermine the commonly held view that industrial ecology is only a very recent phenomenon (see Desrochers, 2004).

12 This is the critical distinction that must be made between life-cycle assessment and life-cycle management (Korhonen *et al.*, 2004).

13 It is obvious that transdisciplinarity is impossible to achieve only with the research methodologies found in engineering and natural sciences. The year 2004 saw a very rapid increase in the call for industrial ecology to address not only the physical flows of materials and energy, but also the business, management, organisational, policy, and social science aspects in general needed to learn to control and reduce the physical flows of materials and energy. Forty-eight refereed international scientific journal articles were published in three projects designed to respond to this challenge and in this way, expand and improve the work in industrial ecology. *Journal of Cleaner Production* published a triple special issue 'Applications of Industrial Ecology' including 26 articles (Vol. 12, Nos. 8–10). *Business Strategy and the Environment* published a special issue 'Business and Industrial Ecology' including five articles (Vol. 13, No. 5) while *Progress in Industrial Ecology* published a triple issue including 17 articles (Vol. 1, Nos. 1–3). *Progress in Industrial Ecology* invites authors to critically examine the work in these special projects and submit their articles into the review process of the Journal to enhance the debate and thus contribute toward progress in industrial ecology for sustainable development.