

## **SESSION 4:**

# **INDUSTRIAL SYMBIOSIS**

## **IN THEORY AND PRACTICE**

In this session, speakers and participants were tasked with rather ambitiously connecting IS to some very big ideas: exploring the IS relationship with or role within sustainability, social science, and business.

IS has been termed ‘sustainability in action’ and ‘a tool for achieving sustainability’ without dissent, so there is implicit consensus that our goal is indeed sustainability. What is the evidence that IS is a useful tool for sustainability? In the first presentation, Professor Roland Clift was asked to address the connection between IS and sustainability; a mandate, he pointed out, that was either too broad or too obvious. Professor Clift reminded us of the role IS plays in resource efficiency – critical to sustainability; he then went on to explore the non-typical IS situation of post-consumer waste goods. Focusing on the economic and environmental impacts along the supply chain, he asked whether understanding the supply chain could translate to a tool for aligning business competitiveness and economic imperatives with environmental performance.

If the first speaker addressed the ‘Are We’ as in ‘Are we advancing sustainability?’, the second set of speakers were given the equally daunting task of providing the social science context for approaching the normative ‘Should We, and if so, How Do We.’ Professors Boons and Baas presented a framework for accessing the scope of the social science contribution to IS and its linkage to other fields. Academic analysis of IS often takes on a technological orientation: what material flows should be addressed, and which match with which. But the practitioners’ primary concern, as evidenced at this Symposium, is more often: communication (the 3 enablers of IS: communication, communication, communication), networks, and company engagement. The concept of embeddedness as a tool to access the social science perspective led to much lively discussion and debate.

Finally, as discussed throughout this Symposium, the business case for IS can be central to companies’ engagement with it. Two practitioners and one academic led the discussion with their perceptions of what drives businesses to participate in IS. The economic case is by no means sufficient as companies do not tend to act as

purely rational economic actors. As with any other business endeavour, many other dimensions are relevant to business, such as the potential for innovation and new business opportunities. And as with any other supplier/buyer relationship, the distribution of costs and benefits is settled through negotiation.

# Industrial Symbiosis and Its Relationship to Sustainability

*Professor Roland Clift, University of Surrey, England*

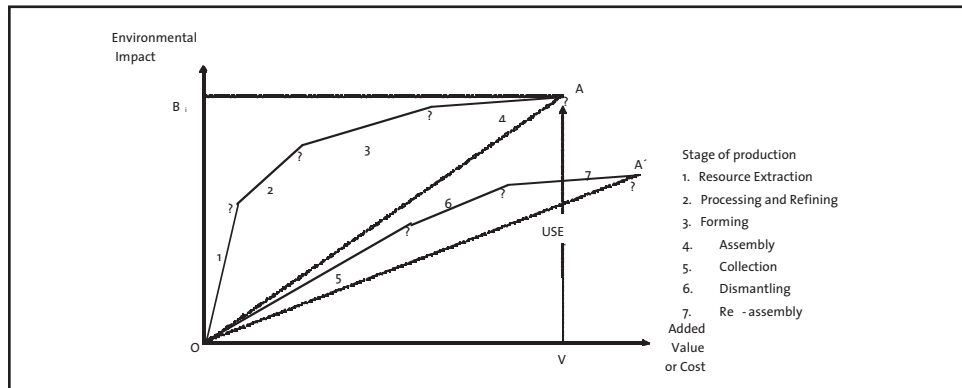
In this presentation, Professor Clift examines the environmental burden and economic value along the supply chain, and what this relationship indicates about when recycling appears attractive and when not. While this analysis is for post-consumer recovery, the characteristics of the supply chain may be indicative of where industrial symbiosis is inhibited, and take-back legislation is necessary.

Traditionally, industrial symbiosis focuses on industrial process or product waste from industry; the overarching goal of sustainability is to organize the economy into closed loops and IS is a useful tool for achieving this goal as it addresses resources efficiency. The cases discussed by Professor Clift took a non-traditional IS approach to examine the incentive for post-consumer recovery of products, i.e. closing loops for waste from used goods. How can understanding the supply chain translate to tools for aligning business competitiveness and economic imperatives with environmental performance? Under what conditions are take-back directives necessary? Specifically, work with Nokia sought to address why it is uneconomic to recycle used telephones: a mobile phone passes out of use usually because of fashion; why is it seen as waste and not a valuable resource to be used? Drawing on an early eco-metrics analysis developed with Unilever, the environmental burden for the manufacturing supply chain for mobile phones was plotted versus economic value captured. As one might anticipate, the parts of the supply chain associated with larger environmental burden (mining and extraction, making components) were not matched by a comparable gain in economic value. The extractive industries do not capture substantial value from mining and extractive activities; most economic value is captured closer to the end product in assembly, where there is considerably less environmental burden.

The manufacturing supply chain was then compared to the curve for recovery and remanufacturing. Both reverse logistics and dismantling entailed quite high costs. Put together, the remanufactured phone had lower environmental impacts in all categories but cost many times more – part of the reason economic drivers alone don't work, and why take-back is sometimes necessary. If there were a more proportional relationship between the economic value and the environmental

burden at the early stages of the manufacturing chain, economic and environmental imperatives might align. A sustainable supply chain would be less convex and preferably straight; recovery and reuse would then be more attractive.

**Figure 1 Environmental Impact versus Added Value (or Cost) for the manufacture of a mobile phone (top) versus its later remanufacture (lower curve).**



Source: Clift and Wright 2000

Is there a system where the curve is linear? Legal cannabis in Canada has a tightly controlled supply chain, line of sight between the primary producer and user, thus a much more sustainable supply chain. [Clift 2001] Marks & Spencer's, a large UK retailer has been interested in developing food supply chain management techniques. The analysis entailed plotting the environmental burden (CO<sub>2</sub>-equivalents) versus economic benefit for 3 distinct suppliers of watercress. The watercress grown in Hampshire, UK, (Marks and Spencer's preferred supplier) had a concave plot. The plot for that grown in Portugal and transported by road to the UK was still concave although with higher environmental burden from transport. The third choice supplier, primarily used during winter months, was Florida, USA; the impact of the air freight produced a convex plot.

Value chain analysis looks at the influence of material flows along the supplier chain. One normally expects a large retailer to dominate its supply chain, but the case for watercress at M&S shows stronger but fairly equal relationships between supplier and buyer; the watercress suppliers do not supply only M&S. This balanced relationship has competitive advantages for both. In the case of mobile phones, the retailer dominates the supply chain. (This is also true in some cases of food retailing, e.g. grapes in South Africa.) Although this is a small number of examples on which to base conclusions, it seems that the economic and environmental imperatives have a chance of going in the same direction when the supply chain is balanced, i.e., when externalities of environmental burden are internalized, or through (rather unlikely) international agreements such as OPEC where suppliers cooperate to increase value capture for primary materials.

Where the price of primary goods is higher, there is more economic incentive for recovery, and thus the potential to reduce the demand for the primary goods. In the

buyer-driven supply chain, the buyer forces down the price of the primary goods, thus making recovery of used goods for recycling uneconomic; unlike IS situations, the demand for the primary material is maintained. Such convex supply chains characterize situations where take-back policy such as the Waste Electronic and Electrical Equipment (WEEE) Directive in the EU is needed to encourage companies to take back used goods at the end of their life. Unfortunately, the existing WEEE systems have no material loops going back to the producers, as would be desired to reduce demands for primary goods.

## REFERENCES

- Clift, R. 2001. Think Global; Shop Local; Roll Your Own. *Journal of Industrial Ecology* 5(1): 7-9.
- Clift, R. 2003. Metrics for Supply Chain Sustainability. *Clean Technology and Environmental Policy* 5: 240-247.
- Clift, R. and L. Wright. 2000. Relationships between Environmental Impacts and Added Value along the Supply Chain. *Technological Forecasting and Social Change* 65 (3): 281-295.

## DISCUSSION AND RESEARCH QUESTIONS

What does a sustainable supply chain look like? Is flat the ideal, or as concave as possible? For steel and aluminium, both situations with large environmental burden from extraction, the economics of post-consumer recovery has led the market to institute the closed loops itself. What does this analysis yield for the supply chains for steel and aluminium?

The example of a branded good such as mobile phones is one where there is a large increase in the economic value at the end of the supply chain. The materials that IS addresses are, by and large, not final products and thus do not have the large economic value-add (for expired batteries, for example). Is this large increase in economic value at the buyer end of the supply chain a barrier to post-consumer recovery? What lessons can be transferred to the IS system?



# Industrial Symbiosis in a Social Science Perspective

*Professor Leo Baas and Professor Frank Boons, Erasmus University, the Netherlands*

Professors Baas and Boons took this opportunity to discuss current and potential contributions of social science research to the field of Industrial Ecology/Symbiosis. It is acknowledged that this field consists of scientists from beta (natural and technical) as well as gamma sciences, and includes academic researchers as well as practitioners, consultants, and engineers. For this reason, the authors proposed to explore: (1) the scope of the social science contribution, and (2) the linkage of this contribution to other parts of the field.

## THE SCOPE OF SOCIAL SCIENCE CONTRIBUTION

The field of social sciences includes a diversity of disciplines including: history, sociology, psychology and geography. In order to discuss the contribution of these disciplines, each with their own focus and theoretical strands, we suggest the concept of embeddedness to survey the social science perspective. Industrial ecology/symbiosis addresses, from a systemic perspective, material and energy streams as they result from human activities. These activities do not occur in a vacuum; they are embedded, that is, they are shaped by the context in which they occur. Building on Zukin and DiMaggio (1991) we propose the following five dimensions:

**Cognitive embeddedness** refers to the way in which individuals and organisations collect and use information, the cognitive maps they employ in making sense of their environment, and the mental disposition of individuals. Themes that can be derived from this are:

- *Bounded rationality.* Following economic approaches, we often assume individuals and organisations to behave according to a rational actor model. A more realistic view is that action is that rationality is bounded, in the sense that individuals and organisations have limited capacities for information processing and decision-making. It has consequences for our ability to deal with complex, multi value problems such as sustainable development.

- *Systems thinking.* Individuals have different strategies for problem solving. Some of these are more suited to systemic problems than others (Sweet et al., 2003). To what extent can such strategies be identified in the activities of participants in Industrial Ecology initiatives?
- *Characteristics of 'change agents'.* Industrial Ecology deals with social change processes. Individuals that act as change agents within or between organisations have special backgrounds and capabilities. We know little about the ways in which these characteristics emerge, and how they can be successfully employed within IE-networks.

**Cultural embeddedness** addresses the influence of collective norms and values in guiding economic behaviour, such as the shaping of preferences, and the influence of ideologies in shaping future visions. We believe that within the field there is a tendency to externalize normative issues, or to take normative positions for granted, both in our scientific activities and in our subject matter. Referring to the latter, some interesting topics are:

- *Collective cognitive maps.* Actors within organizational fields (industrial sectors, regions, national societies, product chains) tend to develop a collective view on the world and ways in which problems should be addressed (IE itself is such a map). This narrows the search for innovations and solutions for social and ecological problems. How do such maps develop, and how do they restrain or enhance the development of IE initiatives?
- *Development of consumer preferences.* Industrial systems fulfil and help define consumer preferences. These preferences are to a great extent culturally determined. How have preferences developed over time, and in what ways has industry influenced them to increase material consumption?
- *Defining what is legitimate.* The definition of what is acceptable industrial behaviour is a social construction, as is the definition of what constitutes acceptable government intervention in industrial activities. This helps to explain why legitimate behaviour differs from country to country. Consequently, it is difficult to copy successful practices of IE from one country (or even region) to another.
- *Defining what is sustainable.* Cultural embeddedness directly implies that sustainability cannot be defined objectively. The major consequence of this is that it needs to be defined in local contexts. What are processes to do so, and what mechanisms make existing definitions difficult to change?

**Structural embeddedness** emphasizes the way in which relationships between actors influence their actions. This dimension has received most attention as a social science contribution to the field of Industrial Ecology. Industrial networks have been analysed (see Session 3A), and coordination mechanisms have been discussed. However, linking these structural features to other dimensions of embeddedness remains a relatively unexplored territory.

**Political embeddedness** acknowledges the fact that processes of power influence economic actions. This includes the role of the state in the economic process. The role of power is rarely discussed systematically in our field. This may have to do with the fact that it is one of the more difficult concepts of sociology in terms of empirical analysis. Nevertheless, actors are not equally able to influence each other's actions and system outcomes, and this central fact of social life must be taken into account.

- *State promotion of IE.* Although research indicates the importance of spontaneity and emergence in successful examples of IE, many governmental actors have sought to promote IE. Can the traditional power base of the state be used to initiate such developments?
- *Market power.* Relationships between firms are asymmetrical. This has effects in terms of their abilities to start or raise barriers to changes in product chains.
- *Exit, voice and loyalty.* How can employees, citizens and consumers participate in IE efforts, given their disadvantage in terms of power in relation to governments and firms? Are stakeholder dialogues the answer, or do these serve mainly to capture these interests?

**Spatial and temporal embeddedness** focuses on the way in which geographical proximity and time influence economic action. The dimensions of space and time are implicit in many accounts of Industrial Ecology, yet we believe they deserve explicit treatment. Physical proximity has been identified as a crucial catalyzing factor in, for instance, the occurrence of complex forms of learning and the building of trust. Time is important as the evolution of industrial systems typically involves long time periods. Some interesting themes are:

- What is the relationship between regional and other forms of industrial ecology? Should regional systems be a focus because of the consequences of physical proximity?
- How can effects of physical proximity be capitalized in global production and consumption chains? Can these be viewed as interconnected regional systems?
- What are the consequences of considering life cycles of industries, regions and product chains?
- Industrial systems develop over time, displaying inherent dynamics of institutionalisation. One perspective of intended change is to counteract such inherent developments of social systems.

## POINTS FOR DISCUSSION

Above, we have listed dimensions that for us capture the social science contribution to the field of industrial ecology, and listed themes that we feel are worthy of exploration.

- **Question 1:** Do these dimensions cover the scope of the social science perspective?
- **Question 2:** Which of these dimensions/themes have up till now been addressed in our field?
- **Question 3:** What are further possibilities (themes) for research?

### **LINKING SOCIAL SCIENCE CONTRIBUTION TO MANAGEMENT APPROACHES AND BETA SCIENCES**

We feel that there is an urgent need to link the social science contribution to other parts of the IE-field. We see two challenges:

1. Linking social science to beta-science approaches. This is a major promise of the field, yet up till now we fail to provide this linkage in research efforts. It requires research projects in which there is true collaboration between researchers from both sub-fields, with the time to establish a common framework of understanding for making a synergetic contribution.
2. Making a thoughtful step from social science research to management and policy contributions. The majority of social science informed contributions to the field are in fact management-oriented. While valuable, these need to take into account more explicitly the consequences of embeddedness as discussed below. This implies:
  - Change of social practices is successful only if context is taken into account
  - Lasting changes are only possible if context changes as well
  - Leverages: look for local changes that change the system

We feel that there is an urgent need to link the social science contribution to other parts of the IE-field. How can these links be established, fortified, and synergized? We see two challenges.

### **REFERENCES**

- Sweet, S., N. Roome and P. Sweet. 2003. Corporate Environmental Management and Sustainable Enterprise: the Influence of Information Processing and Decision Styles. *Business Strategy and the Environment* 12(4): 265-277
- Zukin, S. and P. DiMaggio (Eds.). 1990. Structures of Capital: The Social Organization of the Economy. Cambridge University Press.

## DISCUSSION AND RESEARCH QUESTIONS

Discussion linked each dimension of embeddedness to work presented at the symposium or in the field:

**Cognitive embeddedness:** NISP hiring is a selection process for individuals to perform a brokerage function – a particular way of processing information. NISP workshops also address cognitive embeddedness, getting individuals thinking in a new way. Mr. Grant’s work (see Session 2) also relates to how individuals process information via an IT function.

**Cultural embeddedness:** this context reminds us that one cannot assume a common language or understanding of terms such as waste. These cultural norms may explain why something technically possible is not practicable culturally. The normative aspects of industrial ecology and sustainability are still the unnamed elephant in the field: as a community, we value neutrality, objectivity, and universal truths – but do we largely ignore the normative aspects of what we’re doing? Is it a normative judgment to think ‘more exchanges are necessarily better’?

**Structural embeddedness:** Professor Howard-Grenville’s work (Session 3A) on social network analysis provides a better understanding of the patterns of existing NISP networks, with important implications for the robustness of networks and how they can be strengthened.

**Political embeddedness:** The state promotion of IS was discussed for Korea and China in Session 2, emphasizing the role of IS in environmental protection and resource efficiency over economic benefits. Professor Clift’s work (Session 4) explores the influence of the power relationships within a supply chain on its sustainability. Power relationships are central to information gathering: in a top-down situation, practitioners can demand information; in the networking paradigm, the practitioner has to elicit information, requiring a different skill base (linking back to cognitive embeddedness). Understanding power relationships are relevant when examining how to influence government policy.

**Spatial and temporal dimensions** run throughout the other 5 dimensions. Mr. Laybourn raised the issue of temporal evolution in Sessions 1 and 4. The distinction was made between an inherent dynamic (things naturally changing with time) and an intended dynamic (dynamics introduced on purpose), and the timescale: norms change over decades, not years. The need to make explicit the spatial dimension was also discussed – as one participant pointed out, there are regions in the Netherlands that are smaller than some cities – and this spatial scale is also relevant for development of social networks.

After linking each dimension to other work, the question was raised: which was most important for future research? Discussion was lively. The validity of disaggregating the five was questioned, highlighting the complex interrelationships between them (cause and effect, e.g., are prices determining behaviour or the resultant of said behaviour). The usefulness of the construct in disaggregating social impacts was also highlighted; for example, giving a structure or framework for practitioners to approach the issue of why a technically feasible trade has not gone

ahead. A few practitioners united in the opinion that structural embeddedness was the most important to advance their work. Returning to the lack of clarity around 'what is IS,' it was suggested that further research into understanding what's unique about IS, and common across contexts, will point us to the right dimension. The group agreed it was useful for organizing what social scientists can contribute to IS.

Further reading on integrating social sciences with industrial ecology was suggested by the session moderator, Reid Lifset:

Cote, R. Tansey, J. and A. Dale. 2006. *Linking Industry and Ecology: A Question of Design*. UBC Press.

Green, K. and S. Randles (Eds). 2006. *Industrial Ecology and Spaces of Innovation*. Edward Elgar Publishing.

## The Business Management Case for Industrial Symbiosis

Session 4 closed with a panel discussion on the business case for IS. Panelists were: Mr. Peter Laybourn, NISP, UK; Mr. Jørgen Christensen, The Symbiosis Institute, Denmark; Professor Marian Chertow, Yale University, USA.

### **Mr. Laybourn:**

To engage companies, one must recognize their culture and context. Companies are accustomed to being regulated by government, and berated by non-governmental organizations. Where government programmes try to support them, they are often single issue (be it energy or waste, etc.) and directive, dictating what solution should be applied and how it should be implemented. Externally generated solutions often lack company buy-in and ownership – most companies do not appreciate having some outsider come in and imply they're not running their business correctly. It doesn't match their management culture of self-sufficiency, solving one's own problems.

What changes with NISP? We engage with companies, listen to them, and aim to get to the right solution; if we can't help them, we usually know someone who can. Our interaction is to find out problems, and offer solutions – there is no 'should' associated with the interaction. And I find it very interesting that we usually engage based on something completely different than what they contacted us about in the first place.

### **Mr. Christensen:**

Mr. Christensen reminded us that the story of Kalundborg has been told many times. The exchanges initially developed spontaneously, and later on purpose, but always on a voluntary basis. All bilateral relationships were initiated and carried out by the actors themselves. Forty-six years in, it is a non-project done by a non-organization; there is no supreme chief. Most of the projects are still active and making money every day. The low hanging fruits have been picked; the current aspiration is to have a bio-ethanol plant as a good idea in principle, and Kalundborg is well suited in having appropriate users (Statoil, agriculture). Such a large project takes time and effort from every actor. One lesson he's learned over the course of this symposium is that they're not the only ones with challenges selling IS ideas.

**Professor Chertow:**

Our understanding of the business benefits for IS has changed over the years. Initially considered are the conventional benefits of reducing cost and increasing revenues through resource exchanges that decrease disposal and add new by-product sales: if the business doesn't see the advantages, they don't do it. The next tier recognizes that with the first level alone there are still several unrecognized or undervalued benefits such as productivity increases resulting from labour pooling and resource efficiencies. There are also soft benefits of collaboration that can yield opportunities not related to material flows but through other cooperative efforts both in the present and in the future. IS can also become a catalyst for new innovation driven by a desire to add value to by-products as was demonstrated by Professor Rene van Berkel in Australia.

Emerging business rationales for IS exchanges include:

- 1) Resource availability is a large factor all over the world, especially where resources such as water or electricity are constrained.
- 2) Minimizing the risk of supply interruption is another large factor. The need to stay on schedule can even surpass the drive for low costs in some instances. Where transport or timing is an issue, local suppliers may be more reliable.
- 3) A few studies are showing that collective action has the potential under some circumstances to increase both tangible and intangible benefits to firms. It may also provide regional benefit that exceeds the benefit to any one company.

**PANEL DISCUSSION AND RESEARCH QUESTIONS****Business Benefits of IS**

Many participants shared experiences around IS as source of innovation, value creation, and competitive advantage. An IS approach is being used to improve the economics of energy utilization through improving resource efficiency and value creation at a refinery; also creating synergistic new industrial activity in the area. In China, IS is first a strategy to cut costs and address poor environmental quality and limited resources, but it is also looked to for new business development opportunities. As discussed in Session 3B, the link was made again here to the potential for IS to contribute to regional development by engaging companies, governments, and researchers on a regional basis working together to enable regions to be proactive.

In the Nordic/NISP model, all exchanges are bilateral (some multi-lateral) and voluntary and the distribution of economic benefits is negotiated as with any other supplier/buyer relationship: price including any necessary infrastructure, guarantee of quality, exit strategy, and so on; in the experience of practitioners at the Symposium, it is the same for IS exchanges. Both parties try to make the best deal

they can. As a relationship matures, the companies may be more and more open with each other, and negotiate more honestly. In the experience of one practitioner, many companies are willing to be a little more flexible in their requirements (e.g., payback time of an investment) when the benefits accrue to the environment.

### **Economic Case Not Enough**

Viewing companies as purely rational economic entities is a naïve view from a number of perspectives. Historically, companies were perceived as social arrangements to achieve collective goals. Currently, the sustainability agenda has gained in profile (as evidenced by Mr. Heathcote's presentation in Session 1) bringing with it a balance of economic, social and environmental objectives. We have also heard about situations where commercially viable synergies have not been implemented due to barriers such as company's management culture, risk aversion, or focus on core business (see Session 3A). This multi-objective decision-making presents a challenge to traditional thinking, and a challenge to the IS community to understand why the economic case is not always enough. It is also where the social science perspective is useful in providing a framework for analysing the non-technical, non-economic contextual barriers to IS exchanges.



## Themes and Future Directions

*Dr. D. Rachel Lombardi, University of Birmingham*  
*Mr. Peter Laybourn, NISP*

In this third annual Industrial Symbiosis Research Symposium (ISRS) focusing on Industrial Symbiosis (IS) in Action, the UK National Industrial Symbiosis Programme (NISP) featured prominently, and the company perspective was included for the first time at an ISRS. Further marking the focus on implementation, a matrix of possible approaches to implementing IS emerged. In the geographic review of Session 2, two fundamentally different approaches to IS were discussed: the planning paradigm in ‘developing’ economies such as Korea and China where central governments are using IS as a planning tool to foster regional development and resource efficiency; and the voluntary paradigm in ‘mature’ economies where IS is being applied as an eco-efficiency tool to achieve ‘triple bottom line’ benefits, and as a basis for regional economic development. Other discussion focused on the juxtaposition of a prescriptive approach (where solutions are provided ‘outside-in’ in a consultant model) versus a demand-led approach (where programs like NISP respond to requests by business). In addition, approaches were disaggregated by resource focus, industry sector focus, or geography focus (Session 3B). Further research is needed to determine which approach (or combination thereof) is best suited for each set of conditions.

Notwithstanding the differing conditions and approaches, researchers and practitioners were in agreement over the importance of establishing robust networks, effectively facilitating the networks, the usefulness of a social science analysis for understanding and advancing IS, and quantifying benefits. Debate continues around the optimal role of government and policy instruments, the importance of size and scale for IS, and the relevance of business issues such as innovation and supply chains. And when we as a community can pick our heads up from the details of implementation, the larger question remains for substantive debate: where does IS fit in the sustainability agenda?

### **AREAS OF BROAD AGREEMENT**

#### **The Importance of the Network**

The academic definition of IS includes connecting a network of companies across sectors in a collective approach. The need for working cross-sector was made explicit

by a number of delegates for both understanding problems and providing solutions: Dr. Bailey (Session 3B) made the point that certain waste flows are characteristic of an industry sector (e.g., waste heat in petrochemical industry) thus necessitating looking to another sector for a solution (in this case, food); Mr. Ramaswamy (Session 3B) demonstrated that without considering all sectors, one cannot fully characterise resource flows and potential conflicts in their use. Professor Howard-Grenville's work (Session 3A) introduced methods to characterise the evolution and structure of existing IS networks, with implications for how to strengthen them. The facilitated approach becomes necessary to address the challenges of cross-sector working: businesses lack the awareness of opportunities outside their own sector; they lack information on potential partners outside their own sector; and they lack the time to find the information (Sessions 1 and 3A).

### **The Importance of Facilitation**

In the voluntary approach, new network opportunities are created, for example, through workshops, outreach events, and tapping into existing networks where possible to accelerate the process (Sessions 1 and 3A). This facilitation was likened to supporting companies through the initial phase of dating. The importance of this skill was highlighted in Dr. Bailey's experience (Session 3B) of NISP-YH being sanctioned to do a regional water study for their networking and facilitation expertise, rather than any particular expertise in water networks. Mr. Heathcote (Session 1) also highlighted opportunities that could not have moved forward without the cross-sector connections made through NISP to other companies and entrepreneurs.

### **The Social Science Perspective**

Linking all approaches was concern for the intangibles of the networks and facilitation: the role of trust and of human interaction (Session 3A), and the business decision-making process (throughout). The social science perspective presented by Professors Boons and Baas (Session 4) provided a structure within which to analyse the non-technical, non-economic contextual barriers to potential exchanges, such as management culture, and risk aversion. Social network analysis may advance understanding on the benefits of social ties networks, such as shared norms and trust (Session 3A).

### **Quantifying Benefits**

Following on from ISRS 2004, the importance of quantification arose a number of times. For the practitioner, quantification of IS benefits was vital to substantiate the business case necessary to secure engagement with industry (Sessions 2 and 3A), and to secure credibility and hence funding from government (Session 1). For policy applications, a valid and complete comparison of options requires all flows to be identified and quantified (Session 3B).

Due to its breadth, the basket of benefits from an IS approach may be substantially undervalued, perhaps contributing to policy makers underestimating or not understanding the potential of an IS approach: resource efficiency programs are not

often measured, for example, on jobs created or private investment attracted – both documented benefits of engagement in NISP. To value fully the benefits generated by IS programs requires leveraging the tools from a host of different fields: environmental impact of tonnes diverted from landfill; economic impact of innovation and additional sales; social impact of learning opportunities and jobs protected and created (Sessions 1 and 4). One asks whether such diverse benefits could be converted to a single currency (e.g., carbon) for comparative purposes. From a program standpoint, tradeoffs must be made on a regular basis: which is “better”, a ton of water savings or a ton of landfill diversion, be it waste paper or expired batteries?

## **AREAS OF DEBATE**

### **Debate: Is IS Business as Usual?**

One arena where the academic-led research agenda and the practitioner-led research agenda diverged was around the difference for business between non-IS and IS relationships, if any. Concerns about confidentiality, lock-in, price, and contracts have not borne out through the NISP or Kalundborg experience, but the research evidence to substantiate that experience is lacking. Participants identified literature addressing changes in supply chain evolution that can be used to benchmark supply chains for companies engaged in IS exchanges. Further research and quantification is necessary to clarify whether there are differences in the supply chains and supplier relations for companies engaged in and integrating IS:

- Are there differences, if any, between a non-IS supplier/buyer contract and an IS-supplier/buyer contract for exit strategy, lock-in, distribution of economic benefits, price, other?
- What characteristics, if any, are distinctive for the supply chains of companies that have adopted many characteristics of an IS approach: do they have fewer suppliers than their competitors? Do they have suppliers from more diverse sectors (reflecting increased cross-sector engagement) than their competitors?

### **Debate: Innovation versus Proven Technology**

In the discussion of universal success factors (Session 2), additional assumptions about IS arose: IS as an end-of-pipe technique, not influencing up-stream processes; and proven technology as necessary to counter ‘risk’ of IS exchanges. These generalizations run counter to the experience of NISP (Session 3) that engaging in IS can foster innovation, namely, new applications for proven technologies from other sectors; processes changed to increase efficiency and reduce or eliminate wastes; and new product development opportunities that, once identified through IS, stimulate new research to bring them to fruition. Without acknowledgement by policy makers (supported by an evidence base) that IS can be an instigator of innovation, IS may continue to be viewed as an ‘end of pipe’ solution and thus low in policy priorities.

### **Debate: The Role of Government**

Appropriate policies to foster further IS implementation were discussed briefly. When is it appropriate to use part of an ‘environmental tax’ to support IS networks, and what evidence would be required to do so? Can networks themselves be effectively ‘mandated,’ or could a resource be targeted and exchanges mandated for that resource [see, for example, Chertow and Lombardi 2005]? Before an assessment of appropriate policy instruments can be conducted, the most effective home for IS within the policy framework must be identified: is it a waste program, as most assume? Or is it a resource efficiency program? Or economic development? Should the program reside at the national level, or should it be regional?

The most common association of IS is with waste programs. The legal definition of waste is often found to be unclear, and as such poses a potential barrier to IS implementation (Session 3A). Delegates from Korea, Canada, the USA, the UK, and others, shared the perception that amending the framework surrounding such legal definitions can take years. In the UK, ‘waste protocols’ are being developed through a stakeholder process with the regulators to clarify the intent of the legislation, in many cases removing perceived legislative barrier to IS. The future vision for NISP recognizes the potential for a greater role in informing and shaping policy and regulations. En route is a daunting educational task: to change the perception on the part of government, the media, and companies, that IS is a ‘waste’ or ‘recycling’ programme. This perception hinders the programme’s ability to fully realize its potential to transform the way industry views its material and other resources.

### **Size Matters: SMEs, Aggregation, and Economies of Scale**

#### *Size of Resource Flow*

The economies of scale were raised repeatedly throughout the symposium and across geographies. Small flows were associated with small companies (although not exclusively), and the role of aggregation was discussed. Aggregation was central to the analysis done in India (Session 3B). When dealing with many generators of small quantities of waste and other resources, what determines whether these flows can be aggregated? What factors determine the appropriate geographic scale for aggregation?

#### *Network of Networks*

NISP started as a number of regional IS programs, each defined by a political-administrative region or sub-region. When NISP rolled out nationally, it maintained the regional delivery structure and the personal contacts important for facilitation. The regional work, in NISP’s experience, has been greatly enhanced by knowledge transfer and linkages between networks coordinated at the national level. The issues facing multiple linked networks and the relationship between regions were not addressed at the 2006 ISRS.

#### *Size of Network*

The future vision for NISP recognizes the great potential for growth in membership:

as mentioned previously, NISP has already been approached by the UK government for an indication of the scalability of the programme, that is, how big the network can grow. Research is needed to understand the implications of the scale of the network for effective facilitation, the role of personal contact in building the network and facilitating exchanges, and the necessary tools.

## **SOME FINAL THOUGHTS**

The practitioner-led research agenda alternately converges and diverges with the academic-led research agenda in ways that were interesting to the academic, but obvious to the practitioner. Many of the areas of agreement addressed here were identified in Session 1 as central to NISP's wide acceptance by business: being business-led; its reputation as a trusted and independent facilitator and networker; and the audited quantification of benefits to substantiate the business opportunities from IS exchanges. The greatest areas of divergence fall under the rubric of 'business as usual', where academic concerns have not been borne out in the experience of the practitioners present. Other areas of the practitioners' concerns point to the need to engage other disciplines in the practical implementation of IS: engaging with large multinational corporations; engaging with small companies and entrepreneurs and connecting them with the large corporations where appropriate; identifying and engaging with solution providers (including universities and entrepreneurs); engaging at a national level with multiple regional programs; and efficient and effective knowledge transfer amongst linked regional delivery networks.

### **Debate: IS and Sustainability – When is More Better?**

Industrial ecology, and within it industrial symbiosis, have been positioned many times as contributors to the broader sustainability agenda in the academic literature and throughout this Report [for a review and discussion of industrial ecology and sustainability, see Ehrenfeld 2007; for a review of the conceptualization of sustainability, see Hopwood et al. 2006]. Achieving sustainable development is based on equity in its various forms (inter-generational, intra-generational, geographic, procedural, and inter-species) and, it is generally postulated, will require transformation of existing socio-economic systems. The larger question facing this community is whether and how IS can contribute to that transformation.

The current contribution of IS to sustainability may be primarily through eco-efficiency gains: finding "win-win-win" situations with economic gains for the companies involved and resource-related environmental gains. We have also seen the case for IS as a driver of innovation and business culture change, clearly advantageous for sustainability relative to business as usual – but is it innovation in the right direction? It may be the case that certain regulated materials continue to circulate through the economy, avoiding the 'waste' label through IS exchanges, thus mitigating the impact of environmental policies. Looking to the example of lead in society, yes, we can manage the flows but do we as a society want them mobilized at all? [for a debate on the use of lead, see Lave et al. 1997; Socolow and Thomas 1997a & b] As

more regional programs develop and benchmark one against another, what role the implicit assumption of 'more is better'?

It falls to the research community to explore the system boundaries for IS: what is its potential contribution to advancing the sustainability agenda? What policy and structures are necessary to fully leverage that potential? Under what circumstances (if any) does pursuing IS create a misaligned incentive by mitigating a necessary and proper policy burden? If one accepts that industry has the capacity to contribute toward sustainability, then perhaps the potential of IS has as much to do with its ability to engage industry in change as it does with improving eco-efficiency: opening further dialogue and opportunities on a broad range of issues contributing to sustainability, acting as a necessary bridge in the immediate term to a reformed, if not transformed, business model.

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