

**BROKERING INDUSTRIAL ECOSYSTEMS:
Creating Regional Institutional Forms**

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ABSTRACT

This working paper inductively explores a broker's role in facilitating a regional-focused decentralized institutional form – the industrial ecosystem. An industrial ecosystem is the aggregated web of interfirm waste and co-product exchanges which reduce economically reduce environmental output between involved firms. As an institutional form, an industrial ecosystem is potentially unique in that it has low external visibility, requires continual re-engagement by adopting organizations, and is geographically bounded. The empirical setting for this study involves the activities of a central interfirm broker – the National Industrial Symbiosis Programme – working in the Midlands regions of the UK. In my early analysis, I suggest three sets of activities – conversation, connection, and co-creation - which the broker uses to facilitate an emerging industrial ecosystem, providing insight into an understudied type of institution.

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An industrial ecosystem (IE) is the aggregated web of waste and co-product exchange relationships occurring between regionally co-located firms (Baas & Boons, 2004; Ehrenfeld & Gertler, 1997). In an industrial ecosystem, individual firms engage in industrial symbiosis, "a collective [interfirm] approach to competitive advantage involving physical exchange of materials, energy, water, and by-products" (Chertow, 2000: 314). In other words, firms engage in the exchanges of waste and co-products as one way to improve their environmental and economic performance by finding economic alternatives to landfill or other disposal methods. Industrial symbiosis can take many forms from the seemingly obvious – e.g., recycling paper – to the novel and complex – e.g., reprocessing animal remains for alternative power generation, or construction aggregate.

As an aggregation of interfirm exchanges or ties, an industrial ecosystem can be considered a type of interfirm network - connecting firms and influencing action (Burt, 1992). One well-researched example this is the Kalundborg, Denmark industrial park, where over the past 25 years, the 11 firms in this industrial park have generated some 20 individual industrial symbiosis projects. Individual projects developed without central design or planning, and over time a dense and influential industrial ecosystem emerged, guiding organizational action around how these firms manage their wastes (Ehrenfeld et al., 1997; Jacobsen, 2005).

From an institutional perspective, an emerging industrial ecosystem (IE) provides an interesting and potentially unique perspective on how decentralized may institutions form and self-regulate organizational action over time. First, industrial ecosystems are geographically bounded. As individual industrial symbiosis projects involve the interfirm exchanging physical

waste and co-products - likely relatively low-value materials - firms usually need to be in close enough geographic proximity for the exchange to make economic and environmental sense (meaning the costs of exchange are competitive with traditional disposal). Related to this point of exchange, firm involvement is likely unevenly distributed among those who either regularly produce large quantities of potential waste (e.g., large manufacturers) or can consume large quantities of specific types of waste into their own processes (e.g., alternative power generation plants or aggregate manufacturers). Second, as there is no recognized standardization for firms engaging in industrial symbiosis, there is little or no external signaling value to firms engaging in industrial symbiosis projects - potentially removing a motivation to get involved in the first place (Terlaak & King, Forthcoming; Westphal & Zajac, 2001).

In this paper, I take an inductive approach to understanding the emergence of industrial ecosystems as a decentralized and potentially self-governing institutional form. I explore how one organization, the UK's National Industrial Symbiosis Programme (NISP), is attempting to facilitate the emergence of regional industrial ecosystems in the UK by acting as a broker for firms interested in engaging in industrial symbiosis. Specifically, NISP takes a joining or *tertius iungens* approach, bringing potentially relevant firms together to engage in industrial symbiosis projects (Obstfeld, 2005). Unlike the more studied *tertius gaudens* approach (Burt, 1992), NISP is not trying to completely 'manage' the holes between firms, but to bring those unconnected firms together and closing those holes.

My preliminary analysis of NISP's efforts suggests three interrelated and increasingly involved sets of brokering activities – *conversation*, *connection*, and *consultation* – which facilitate NISP's brokering activities and also influence the emergence of industrial ecosystems regionally. Given the unique facets of industrial ecosystems as an institutional form – that they

are geographically bounded and likely lack external signaling value – these factors likely play an important role in how and whether an industrial ecosystem emerges. Secondly, even when an industrial ecosystem may emerge without external influence, these activities may increase the speed and frequency of individual industrial symbiosis projects by helping firms overcome the novelty and uncertainty inherent in engaging in new partners and new environmental practices, thus increasing the speed at which such practices become institutionalized.

As a working paper of an ongoing study, this paper's findings may be limited. However, it begins to contribute to the literature in the following ways. First, it provides insight into the industrial ecosystem as novel, regionally-focused institutional form. While there has been ample research on high visibility institutional action (e.g., King, Lenox, & Terlaak, 2005; Terlaak et al., Forthcoming), there has been less focus on lower visibility institutional change (see Reay, Golden-Biddle, & Germann, 2006 for an exception). With lower public visibility – but likely stronger interorganizational visibility - public rhetoric divorced from action (e.g., Westphal et al., 2001) may not be effective in engaging the organizational field. Second, the institutional effect of an industrial ecosystem depends not just on adoption but on the continual re-adoption – through the development of new industrial symbiosis projects - over time. Prior institutional forms (e.g., poison pill adoption Davis, 1991) may or may not have involved additional organizational follow through to be effective. Lastly, as this paper explores an emerging institutional form which is still developing, we can see some of the underlying actions and processes as they unfold.

SETTING AND METHODS

National Industrial Symbiosis Programme (NISP)

The focus of this study is on the National Industrial Symbiosis Programme (NISP) and how it facilitates industrial symbiosis projects in the UK – projects with both environmental and economic benefit. Formed in April 2005, NISP’s goal is to “encourage government and industry of the benefit of industrial symbiosis (IS) as a key policy tool in helping the UK to achieve a sustainable economy, further supporting the integration of an IS approach into the nation's resource management strategy” (NISP, 2006: website). NISP acts as a collaborative or *tertius iungens* broker (Obstfeld, 2005) to facilitate new industrial symbiosis projects between interested firms.

Though national in scope, NISP works primarily in a regional capacity - with a semi-autonomous office and staff in each of the UK’s economic regions. Each region houses one or more regional coordinators (RC’s) - analogous to regional account managers, office support staff, and in-house topical experts as needed depending on the region (e.g., chemical industry, government liaising). In interviews, RC’s have described NISP as a business match-maker or dating agency - helping connect interested firms in relevant and appropriate industrial symbiosis projects. To support this, RC’s engage in a range of activities – from hosting regional networking events and IS workshops to making introductions between interested parties between firms to coordinating in-depth consulting-type projects with individual firms – which are discussed in more detail in the analysis and discussion sections.

NISP’s is indirectly funded by the UK government through a number of developmental agencies. Over 70% of NISP’s funding comes from the UK’s Department for Environment, Food, and Rural Affairs (DEFRA), with the remainder coming from regional development authorities (e.g., Advantage West Midlands, London Development Agency). Because of how it

is funded, NISP's success is tracked based on its aggregate environmental and economical impact within each region and nationally, and provides its services free to interested businesses.

Rationale and Approach

This study takes an inductive approach to exploring the role of brokering institutional change in this empirical setting. It began with the broad research question: how does NISP facilitate new industrial symbiosis projects? To answer this question, the research team focused on understanding NISP's activities both from NISP's perspective, as well as that of the firms involved in the brokering activities – collecting data from NISP and several businesses with varying levels of interaction with NISP.

Data Collection

This data is part of a larger research project on industrial symbiosis as an emerging environmental practice in the UK. The research team (comprised of this author, a second researcher, and additional ad hoc researchers as needed) has collected data through three primary methods – interviews, observations, and archival documents. These diverse data enable a more robust and valid data analysis as it allows for triangulation of analyzed themes and perspectives across multiple sources of data (Eisenhardt, 1989) and is summarized in table two.

Interviews. Researchers conducted open-ended formal and informal interviews several NISP regional and headquarters staff. These interviews were often conducted in private one on one (or two on one, if both researchers were present), though on one occasion, we interviewed the management team from one regional office 'en masse' due to scheduling constraints. In these interviews, we focused on learning about how their history and role within NISP, how they

perceived NISP as an organization, their engagement with participating firms, and the potential nuances of their respective regions. In sharing their perspectives, interviewees often used specific examples of successful and unsuccessful IS projects to explain their views. These interviews helped to understand how NISP made sense of their work, and insight into those areas they considered important.

As this study involves understanding the effects of NISP's action, researchers also interviewed representatives from 23 firms who have or are currently involved with NISP. The organizational field here was defined as those firms listed in the NISP membership database. 'Membership', however, could imply as little participation as having replied to an informational mailing or as much as ongoing in-depth industrial symbiosis project work. Thus, a stratified sampling approach was used to find a diverse mix of firms based on size, industry, and level of participation in NISP. Of the firms interviewed, their participation in NISP ranged from having NISP involved in multiple underway or completed IS projects to having only a cursory phone conversation with a NISP staff member. In these interviews, we learned about each firms' environmental practices, waste management and industrial symbiosis activities, and their perception and relationship (where applicable) with NISP.

Observations. One or both researchers also attended a small number NISP staff meetings and related external events as non-participating observers. During these events, extensive notes were taken to understand the activities through the eyes of those involved. Further, when appropriate, researchers informally talked with participants to learn more about their perspectives and place within these settings. These events included an internal strategy meeting held in December 2005 at NISP headquarters. This meeting included all NISP headquarter staff at this time (13 people total, including those who interface directly with local governments, the

academic research community, and participating businesses) to discuss changes associated with NISP's considerable growth during the previous months. Another event included an open workshop jointly sponsored by NISP and a county council in February 2006, for regional businesses to learn about better reducing and managing their wastes and co-products. Here, both researchers were able to talk informally with many attendees, learning about their motives for attending, waste management activities, and thoughts on NISP and industrial symbiosis.

One researcher also engaged as a participant observer in the NISP sponsored Industrial Symbiosis Research Symposium in 2006. In this event, one researcher participated by presenting the ongoing formative analysis of the larger research project from which this study is a part. Participants at this event included senior NISP staff, and also an international mix of academic researchers, practitioners and government officials. While a participant and speaker at this event, the researcher also learned more about non-business perspectives of NISP through informal conversations and formal presentations by participants.

Archival Documents. One or both researchers has also collected a number of public and private documents from NISP. These documents run the gamut from regional project management documents detailing the status of potential and ongoing industrial symbiosis projects, rosters of participating firms, access to details of its online resource matching database, prior funding and status reports to government agencies, published IS cases from its website, etc. These documents help to elaborate on our emerging themes, and also for an additional way to 'triangulate' our findings to build more robust conclusions.

Analysis

This is an early analysis of research findings which developed while exploring the collected data for emerging themes around how NISP differentially engages firms as it facilitates IS projects (Glaser & Strauss, 1967; Miles & Huberman, 1994). I took particular note of those themes arising across multiple sources, using each source to further triangulate and refine my understanding of the phenomenon at hand (Eisenhardt, 1989). These results below are preliminary, pending additional, more formal analyses.

RESULTS & DISCUSSION

This analysis suggests that NISP engages in three key types of brokering activities, which both facilitate new industrial symbiosis projects and also influence the emergence of an industrial ecosystem regionally. These activities, in various ways, are creating the foundation on which regional industrial ecosystems may develop. The activities are summarized in table one and discussed below.

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Having a “Conversation”

These activities involve outreach and education of industrial symbiosis as a waste management practice and of NISP as a firm who can assist firms in IS to individuals representing firms with varying degrees interest, knowledge, and prior experience in industrial symbiosis. The primary activity here was NISP’s ‘Quick Wins’ workshop – regularly scheduled half-day networking and education events open to all businesses in the region. These workshops opened

with a brief presentation introductions to industrial symbiosis and to NISP, and followed with a series of short cases highlighting recent NISP facilitated industrial symbiosis projects in the UK with both strong economic and environmental benefits¹. The opening presentation at the workshop I observed was fast-paced, energetic, and very short. Presenters (NISP regional coordinators) focused on moving through the ‘formal’ presentation quickly so they could get to the facilitated networking. Through the facilitated networking, NISP staff helped participants share and understand their ongoing waste resource needs, and helped create potential waste exchange matches, or ‘synergies’. Though much of this time involved firms detailing their own waste streams, a small number of firms were overtly looking to take specific wastes for their own processes.

The firms represented cover a diverse swath of the UK business sector, and individuals had a variety of reasons for attending – though all shared a common interest in addressing increasing landfill and recycling costs. Many attendees are like Dave and Mike, individuals responsible for the waste management at an HVAC installer and an industrial chicken farm, respectively. Though they had drastically different wastes, they shared an interest in finding novel ways to reduce their waste output in ways which would also generate revenue for their firms. Additionally, there are a small number of individuals like Jim – a business development manager for a private effluent treatment firm – a regular attendee at NISP networking events, who attends hoping to generate leads for his business.

Since its founding in April 2005, NISP has regularly run ‘Quick Wins’ or similar regionally-focused networking and education workshops throughout the country. Each workshop typically hosts 20 to 40 attendees from a diverse range of firms. Through these workshops, NISP:

¹ Though NISP, as a national organization, was less than a year old at the time, it had evolved out a regionally focused organization doing the same thing. Thus, early success stories were pulled from work done by one these of regional groups which later became NISP.

- (a) Introduces companies to industrial symbiosis (IS) as a business practice;
- (b) Facilitates initial IS conversations between individuals attending; and
- (b) Generates potential industrial symbiosis matches – meaning there are two firms who may be willing and able to exchange a given waste stream

With 16 organizations represented, the one workshop I attended was smaller than many. However, even with this small number of participants, the workshop generated 70 potential IS matches including (as a sampling) (a) waste vegetable oil for bio-diesel conversion; (b) recycling waste timber; (c) processing waste tires and concrete for asphalt and aggregate production; (d) reusing second-hand “wellies” or rubber boots. An experienced NISP manager in attendance, who had also run several workshops in a number of regions, stated that at least two to three potential IS matches are typically made for each organization in attendance. Additionally, out of the potential IS matches found in workshops, the managers believe some 40% are at least tentatively pursued by the respective firms.

These workshops are the primary way NISP generates interest in industrial symbiosis in general, and its services in particular. However, a few secondary ‘waves’ of interest has begun through two sources. First, in some regions, local Environmental Agency employees (The UK equivalent to the U.S. Environmental Protection Agency) have begun recommending NISP when visiting firms for inspections and consultations. Second, there are a number of leader firms who are very experienced and active in engaging in industrial symbiosis. These firms are usually large, established manufacturers with strong environmental practices already in place and do not need NISP or only need NISP is a very specialized capacity (discussed more below). However, as environment managers from these firms interact with their counterparts at smaller and less environmentally advanced firms, they occasionally recommend NISP as a resource.

Facilitating a “Connection”

NISP facilitates ‘connections’ between firms with potential IS matches through additional firm contact and interaction - by some combination of one on one email, phone, and in person follow up. Though the follow up with firms is based on potential IS matches generated from workshops, the focus often expands as NISP RC’s learn more about the particulars of a firm’s needs, capacities, and constraints. The point is to connect firms together to generate IS projects. However, to do so effectively, NISP staff feel they need to have enough information about individual firms to make relevant judgments about how and who to connect. This more in-depth information helps NISP makes its introductions and connections more timely and relevant to the firms involved (Hargadon & Sutton, 1997; Uzzi, 1996).

Many of the connections here involve IS projects which NISP consider ‘low hanging fruit’ – with little technological or process novelty. However, this does not mean these projects happen without difficulty, nor even at all – as often it is the social and organizational factors which mean success or failure in these types of endeavors (Baas et al., 2004; Howard-Grenville & Paquin, 2006).

In one project – a steam heat exchange – a tobacco firm (Med-Tobacco²) had excess steam heat capacity and wished to provide the pharmaceutical company (Brit-Pharma) located immediately next door with this excess steam heat for free. Brit-Pharma, with its own highly efficient combined heat and power generation plant on-site, could have effectively turned Med-Tobacco’s excess steam into free energy for itself. However, citing its aggressive stance against tobacco, Brit-Pharma refused to work with Med-Tobacco on this or anything else, for that matter. In the words of Brit-Pharma’s CSR manager:

² The names of all firms other than NISP, and all individuals have been changed.

“We [Brit-Pharma] are passionately, *passionately* anti-smoking... If they were any other business, if they were an arms manufacturer – [our region has] an ordinance factory – that would be different.

But cigarettes, we’ve always had an issue with them being located next door to us. We just feel that it would be totally the wrong thing for us to do” [emphasis in original]

Here, Brit-Pharma – already having the in-house expertise and capacity - was the obvious choice for this particular project. However, because of Brit-Pharma’s own identity and values, such a relationship would not work. Thus, NISP worked with Med-Tobacco to source its excess steam heat to another nearby organization with the expertise, capacity, and willingness to work with Med-Tobacco. In an interesting twist, the organization which Med-Tobacco did end up working with was a local hospital.

For another project, one involving smelting used batteries to extract silver and other valuable metals, the problem was less clear. However, as the manager for Silver-Recycler explains, it was not technological.

This battery recycling project “seemed to die a [slow] death. At one point, they [the other firm] were very keen to get the material in to get it sorted. It wasn’t very big tonnage, but again they saw that they were throwing material and value away... We did quite a few trials, so we could demonstrate that the plant here could [extract the silver]. We really had to keep pushing [Elec-Manufacturer] to say ‘we are ready - what are you doing, can we have some material?’ In the end, it wasn’t clear whether there was a policy change, or a change in manufacturing, but it just sort of died.”

When asking the NISP RC about this project, the author learned that, in fact, Elec-Manufacturer was recycling its batteries, but with a different firm. Though exactly why Elec-manufacturer choose to use a different firm was not clear, NISP introduced Elec-manufacturer to the second

firm when it became clear that the project between Elec-Manufacturer and Silver-Recycler would likely not happen.

Though these two projects were ‘successful’ in that they economically diverted waste from landfill, they suggest some of the difficulties inherent in making ‘connections’, even among ostensibly willing firms. NISP is not merely connecting appropriate firms in terms of technical expertise and capacity, but also in terms of organizational and social compatibility. NISP accomplishes this by gathering information about its own network, both in relation to the extent of resource needs and the relationships with participating firms. RC’s interactions with firms, though overtly about managing waste resources are equally about information gathering and relationship building. This is necessary for at least two reasons. First, successful brokering requires a level of trust with the broker, which is based in part on the broker’s knowledge of what is relevant to the firm (Burt, 1992; Uzzi, 1996). Second, though NISP does have an online interactive knowledge management system, like many firms, this systems is not well utilized (Hargadon et al., 1997; Kellogg, Orlikowski, & Yates, 2006). From this perspective, NISP’s connections are also about RC’s connecting their own information to each other within NISP, as well as connecting interested firms with each other (Hargadon et al., 1997).

Engaging in “Co-Creation”

Co-Creation activities, as the name implies, involves in-depth and novel work with particular firms or sets of firms. As discussed above, with the ‘low hanging fruit’ or relatively straightforward IS projects, there tends to be little novelty. For more novel projects, NISP can play a more active role. In these projects (some examples of which are discussed below), NISP’s

role moves beyond connecting firms to co-creating new IS technical and/or process knowledge or capacity for future projects.

One example of developing a new potential industrial symbiosis project involved a brewery and the disposal of used brewer's yeast. Likely since the advent of beer and cider brewing itself, brewers have sent used yeast and hops to local pig farmers for feed. Additionally, since the early 1900's, brewers could also send their yeast to food-processors to make the well-known sandwich spread, Marmite, or similar products. However, slackening demand in Marmite (and thus, falling prices for used brewer's yeast) and increasing costs of landfilling, caused one brewer to seek out NISP to help find another approach. Pulling from its diverse network, NISP helped the brewer form a research partnership with a local university (funded in part by the brewer) to examine what higher value options may exist for brewers yeast. In the words of the brewing co representative, "This [doing research on potential uses of brewer's yeast] is worth 50,000 pounds to find out [what may work], because yeast disposal is becoming a bigger and bigger problem for us". Should this project bear fruit, it would provide interested firms with another potential approach to managing their use yeasts in economical and environmental ways.

Two other examples of co-creation involve working directly with waste reprocessing companies. Here, NISP was not working to develop new capabilities with these firms but to increase their capacity in managing specific waste streams. This, in turn, influences the ability of firms who produce these streams to potentially engage in industrial symbiosis in the future. In one case, NISP worked with a mid-sized aluminum recycler to develop the business plan and find funding for one million GBP addition to the facility to boost aluminum recycling capacity, substantially increasing the amount of domestic aluminum recycling which could be done in the

UK. In doing so, NISP acted as a business development consultant, facilitating connections between the firm and various public and private funding sources within NISP's network.

In a second case, an animal rendering plant who had previously work with NISP returned for additional help. NISP had previously worked with the firm in a 'connection' capacity in sourcing animal renderings for alternative energy generation and to for use as aggregate in asphalt production. Now, being overwhelmed by unexpected community and local government pressure against its planned expansion, it returned to NISP. Here, NISP worked with the firm to better engage the local authorities and community over its anticipated expansion and to adapt its ongoing expansion plans as necessary to address and community and government concerns.

As shown above, co-creation activities are more involved and novel than conversation and connection activities. As well, as shown with the animal rendering firm, we suspect that co-creation activities stem from prior activities between NISP and the firms in involved. The examples above suggest co-creation activities occur around more complex and novel IS projects. The relationships and successes developed from connection activities likely give firms a sense of NISP's value and relevance to them (Uzzi, 1996). Additionally, as co-creation activities are likely highly intensive projects, NISP seems to reserve this level of engagement for potentially 'big wins' – such as significant increases in waste processing capacity, or novel and potentially high value IS projects – which would potentially change the dynamics by which industrial symbiosis might occur with those waste streams. In doing so, these projects potentially change the underlying regional capabilities which likely influence how and whether an industrial ecosystem might emerge.

INSTITUTIONAL EFFECTS OF BROKERING

Conversation is a wide open approach. Much like the caller outside a jazz joint, NISP hollers to anyone interested. In these activities, NISP focuses on outreach and generating leads to follow up on a later time. At one level, this might be viewed as a ‘sales tool’ for NISP. However, as NISP’s voice gets larger – through generating attention with interested firms and through its reputation with firms it works with – its influence likely also increases. From an institutional perspective, NISP is increasing the discourse for industrial symbiosis (Creed, Scully, & Austin, 2002; Hoffman, 1999; Maguire, 2003) by gathering those interested together. Through this, NISP is expanding the realm of what a relevant waste management practices. Though IS may not be new to all participants in NISP workshops (as they are mostly environmental managers of some sort), NISP’s advocacy and offers of help likely increase these manager’s perceived feeling of legitimacy in attempting to pursue IS within their respective firms.

Connecting, meanwhile, is a more ‘traditional’ brokering activity. NISP introduces unconnected firms from its own network, using its reputation and informational relevance to ‘vouch’ for firms engaging in particular IS projects (Uzzi, 1996). This aspect of NISP’s activities is something akin to Obstfeld’s *tertius iungens* broker – joining relevant others together to collaborate as they see fit (Obstfeld, 2005). Though NISP is clearly an information broker in these activities (Hargadon et al., 1997), NISP is also more than that. It is a broker and facilitator. However, with the success of each new IS project, previously unconnected firms are becoming connected, changing and potentially strengthening the emerging industrial ecosystem. NISP’s non-proprietary perspective here also factors in - as NISP is willing to share its network and information with all interested firms, potentially furthering the conversation of industrial symbiosis.

Co-creation, however, seems to provide something different altogether. Co-creation changes the underlying foundation of the emerging industrial ecosystem. Just as a firm's ability to participate in an IS project depends on its capacity to source the waste stream, a region's capacity to develop an industrial ecosystem depends on the region's aggregate ability to source its waste streams. In co-creation, NISP is increasing a region's capacity to engage in IS in at least two ways – through novel, high value IS projects; and by increasing the capacity of regional waste reprocessing firms. By doing so, NISP is effectively changing the underlying foundation by which the industrial ecosystems emerge over time by changing their latent capacity to process specific wastes.

CONCLUSION

As this paper shows, a developing industrial ecosystem provides a novel setting with which to explore the emergence of potential unique regional-focused institutional form. By exploring the empirical setting of NISP as an industrial symbiosis broker, this paper begins to answer the call to explore change in new settings (Greenwood, Suddaby, & Hinings, 2002) - in this case one where the potential change is geographically limited, decentralized, and lacking any real signaling value for the firms involved. Within this emerging institution, this study shows how the National Industrial Symbiosis Programme (NISP) strategically engages other organizational actors through its conversation, connection, and co-creation activities to influence not only the development of industrial symbiosis projects but also the emergence of an industrial ecosystem (Fligstein, 1997).

In addition, this study raises a number of interesting questions for future research. First, what is the effect of NISP's activities on the field over time? How will NISP's own activities

change as an industrial ecosystem develops and influences firms more strongly? Second, though this paper focused on NISP, the data suggests that firms differentially respond to and engage with NISP based not only on NISP's activities, but also on their own firm attributes (organizational structure, culture, pre-existing partnerships) and experience with various environmental practices (ISO certification, prior IS experience, etc.). From this perspective, future research should explore why firms differentially engage NISP, the effects of that differential engagement on NISP's own success in the field, and also on the emergence the industrial ecosystem overall.

TABLE ONE.
Summary of NISP Activity Types

Category of Activity / Details	Conversation	Connection	Co-Creation
Goal	<ul style="list-style-type: none"> • Outreach to broad range and number of firms in region 	<ul style="list-style-type: none"> • Develop greater knowledge of individual firms within field • Facilitate connections between potentially 'relevant' firms 	<ul style="list-style-type: none"> • Work with firms to create new IS processes, technologies, or capacity for engaging in IS projects
Activities	<ul style="list-style-type: none"> • Primarily 'Quick wins' / networking workshops • Secondarily direct or indirect introduction by other organizations 	<ul style="list-style-type: none"> • Additional follow up with individual firms including sites visits, facility tours • Make introductions between relevant firms 	<ul style="list-style-type: none"> • In depth, project specific collaboration with firms • Secondary 'connection' activities between firms for more novel IS related work
Outcomes	<ul style="list-style-type: none"> • Increased knowledge of IS as an environmental practice among firms in the field • Building name recognition / recognition for NISP as broker • Building NISP IS network for future brokering 	<ul style="list-style-type: none"> • Build stronger relationships with firms in field • Learn more about firms in field, and by extension, gain more field-level clarity • Generate some of the more routine IS projects • Lay groundwork for more complex IS projects 	<ul style="list-style-type: none"> • Facilitate novel, high value IS projects which can be leveraged elsewhere • Increase regional IS capacity by focusing on firms with existing expertise

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