2012

Green City: Environmental and Social Responsibility in an Industrial Cluster

Ferrer, Geraldo

Journal of Industrial Ecology, Volume 17, Number 1, pp. 142-152.
http://hdl.handle.net/10945/43653
Green City
Environmental and Social Responsibility in an Industrial Cluster

Geraldo Ferrer, Sandro Cortezia, and Jaqueline Morbach Neumann

Keywords:
industrial ecology
industrial symbiosis
shoe and leather industry
sustainable operations
utility sharing
waste reduction

Summary
This research analyzes the Green City project in the town of Três Coroas, Brazil. We describe its management system, evaluating the change process and the economic, social, and environmental benefits since the recycling center has been in service. We demonstrate a successful case of operational and cultural change in the disposal of industrial waste, describing the key points that helped the adoption of a new set of procedures, and illustrating the role of the champion in the implementation of a symbiotic cluster.

Introduction
Industrial clusters, that is, companies or industries concentrated in a geographic region by markets, products, supply chains, or related institutions, have long been seen as a source of competitive advantage for the companies that comprise them. Many are characterized by a large number of small manufacturing plants operating in the same industry. Such clusters develop significant expertise retained by the local population in the production of the same type of product, as the economies of scale are obtained when the companies join forces to sell their products in the international market. The Brazilian shoemaking industry generally operates in industrial clusters, and it has become the focus of several studies due to its significant success in the international market. Most studies were based on the Sinos Valley region, located in a 50 kilometer (km) radius around the city of Novo Hamburgo, in the southern state of Rio Grande do Sul. The region has been described as an industrial “supercluster” because of the concentration of the entire range of materials and service providers in the shoemaking supply chain, characterized by deep interfirm relationships, dense information flow, and frequent coordination of efforts on behalf of the collective (Schmitz 1995a, 1995b).

The Paranhana Valley, also in southern Brazil, followed on the heels of the Sinos Valley to become another successful shoemaking cluster. In the town of Três Coroas there are approximately 90 small factories manufacturing shoes and their components. Job scarcity in some towns and subsequent development of the industry in the wider region led to the growth of the shoemaking industry in the valley. Both the Sinos Valley and the Paranhana Valley saw fast industrial development, leading to a population growth rate of 4.8% per year from 1975 to 1995, while the rest of the state was growing at less than 1.5% per year, reflecting the significant job opportunities in the region. While the Sinos Valley producers focused on the export market, the Paranhana Valley concentrated on shoe production for domestic customers; roughly 70% of the plants sell their output in Brazil only.

Until the early 1990s, Brazilian firms in the shoemaking industry were not concerned with their environmental impact. In 1993 the state environmental agency found that 86% of all toxic solid industrial waste in the state originated in the shoe and leather supply chain (Serrano et al. 1998). This finding established the heavy environmental impact of the industry. At the same time, the law that consolidated the state’s solid waste policies was approved. In addition to requiring the firms to
obtain environmental licenses to operate, this law established that the waste generator and the waste processing agent would be mutually responsible for violations. As a result of intense inspection by federal and state environmental authorities, many firms were subjected to severe fines for inappropriate waste disposal practices. Increased regulatory pressure did not allow firms to become complacent or they would lose their license to operate. Faced with these challenges, the firms sought new ways to increase their competitiveness.

Many firms acted alone in search of a solution to the industrial waste problem. In some cities of the Paranhana Valley, the firms delegated the coordination of industrial waste management to local trade organizations. This usually required the creation of an industrial landfill. However, the firms in the industrial cluster of Três Coroas adopted an approach that was both economically viable and environmentally efficient, starting with the collection of all industrial waste generated by the shoe factories, leading to the recycling of two-thirds of all solid waste.

In this article we focus on the action that the Três Coroas Shoemaking Trade Association took in turning the Paranhana Valley into a model industrial cluster. Yin (2009) generally classifies case studies in two dimensions according to the number of cases in the study: single- or multicase study, and the number of units of analysis drawn from each case. If many units of analysis are present, we have embedded studies within the study. If only one unit of analysis is measured, it is termed a holistic study (Yin 2009). The case study on the Cidade Verde (Green City) project, the solution adopted in Três Coroas, is a single-case holistic study where the unit of analysis is the industrial cluster. The main source of information was the director of the trade association, through two formal interviews (Ruppenthal 2005, 2010) and a small number of email communications. An additional interview with a local manager provided additional perspectives on the cluster (Furlanetto 2006). Much of the information was verified with publicly available data in local newspapers, in brochures of the trade association, in national reports, and in the national trade association’s website, http://ww3.assintecal.org.br/.

When an industrial cluster is composed of facilities that operate in parallel and compete for the same resources, they may need to find cooperative alternatives to by-product exchange if they seek to engage in industrial symbiosis. In Três Coroas, they found it through the leadership of the trade association.

This study lies in the intersection of two research streams, industrial clusters and industrial symbiosis, which we briefly discuss in the next section. Then we summarize the environmental impact of the manufacturing operations at Três Coroas and describe the Green City project, its recycling process, and the role of the champion in the implementation of the project. We discuss the project’s immediate benefits and its long-term evolution over more than 10 years. The role of the trade association as a facilitator of environmental compliance efforts for small and medium enterprises (SMEs) is discussed whenever these firms operating in isolation cannot achieve economies of scale.

**Literature Review**

In what follows we briefly discuss two literature streams that are related to our study: (1) the industrial organization in regional clusters, and (2) industrial symbiosis. Our study lies at the intersection of the selected research.

**Industrial Clusters**

Interorganizational networks (such as trade organizations) are increasingly important because of their capacity to mediate the complex interdependence and cooperation between firms in the same industry. These networks have been studied under many approaches.

British economist Alfred Marshall described the positive externalities enjoyed by small companies in industrial districts, explaining that small industrial firms tend to locate near their key suppliers, customers, or competitors, creating an environment that fosters innovation (Marshall 1919a, 1919b). This concept received renewed attention with the sprouting of successful industrial clusters in Salzburg (Austria) and parts of Baden-Württemberg (Germany) that brought attention to the advantages of this industrial organization. Likewise, several authors studied the phenomenal development of the region known as “Third Italy,” a region defined by the geographic triangle formed by the cities of Udine, Pisa, and Ascoli Piceno, centered in Bologna and Florence (Fiore and Sabel 1984; Pyke et al. 1992). The newer literature distinguishes the northern Italian districts from the old industrialized areas in the northwestern part of the country in that much of the economic value is generated in SME clusters (Becattini 1990). Several authors studied the complex cooperation and competition within networks of small and medium-sized companies operating in clusters. These networks, based on formal or informal relationships, are responsible for superior competitiveness and/or quality performance, creating new access to markets previously restricted to large firms, including the export market (Pyke et al. 1992; Saxenian 1996).

Many authors define the term cluster in similar fashion: the concentration of companies and industries in a geographic region that are interconnected by the markets they serve and the products they produce, as well as by the suppliers, trade associations, and educational institutions with whom they interact (Porter 1988; Schmitz 1995b). We focus on the instances when the cooperation between the organizations in the network helps improve the operational performance of the collective with reduction of their environmental footprint.

The success of industrial clusters in developed countries usually lies in the use of collective efficiency, the joint action benefits and the economies of scale generated by clustering (Schmitz 1995a). In this regard, several studies have highlighted the local collective institutions, such as trade associations, and the services they create (Best 1990). Nadvi (1999) studied how local trade associations represent the collective interests of the cluster, especially in developing countries, in a work comparing the Sinos Valley cluster in Brazil with other shoe manufacturing clusters in Mexico, India, and Pakistan. He indicated that the
creation of the Brazilian cluster was driven by the collective attempt to overcome the supply chain inefficiencies created by diverging interests of each subsector association and to raise their competitiveness in the export market. Because of intrinsic economies of scale and greater self-reliance, large companies are usually less concerned about the development of the cluster. However, SMEs in the shoe manufacturing clusters expect their trade associations to be equipped to address their collective or even individual needs, as seen in Três Coroas. The potentially diverging interests of large firms and SMEs, and of producers and suppliers within the cluster can be a problem for local trade associations in the effort to remain relevant and to achieve collective efficiency. In Três Coroas, this tension is largely absent due to the predominance of SMEs in the cluster, as observed in this study.

**Industrial Symbiosis**

Industrial symbiosis has been defined as the "physical exchanges of materials, energy, water, and by-products among diversified cluster firms" (Chertow 2007). It has been classified into three types: (1) utility sharing (when one or more plants share the provision of a utility), (2) joint service provision (when a group of plants share the usage of ancillary services provided by a third party), and (3) by-product exchange (when one plant's by-product is used as input in another plant) (Ashton 2011; Chertow et al. 2008). These types of exchanges or sharing typically generate positive environmental externalities and reduce the consumption of raw materials, water, or energy by improving the scale economies.

By-product exchange is perhaps the most easily recognizable form of symbiosis. It depends on idiosyncratic conditions, where plants of unrelated industries may discover that one's undesirable by-product may be the other's valuable raw material, exemplified by the town of Kalundborg (Ehrenfeld and Chertow 2002; Jacobsen 2006). For this reason, by-product exchanges may be more common in multi-industry clusters, given that plants operating in the same industry usually have the same types of inputs and outputs. The chances that one firm will identify a neighbor that can use its by-products are generally low, but they are greater if that neighbor performs different activities.

Utility sharing and joint service provision types of symbiosis may exist both in single-industry and in multi-industry clusters, considering that plants in many industries have the same needs: electricity, steam, water, wastewater disposal, solid waste disposal, etc. Hence they can be found in multi-industry clusters such as Kalundborg, as well as in single-industry communities such as the pharmaceutical cluster in Barceloneta (Ashton 2011; Chertow et al. 2008) or the tannery cluster in Palar Valley (Kennedy 1999).

In Barceloneta, Puerto Rico, eight companies representing 13 pharmaceutical and chemical plants formed a cooperative initiative to treat their wastewater, convert the sludge into fertilizer for use in nearby agriculture, and have its solid waste collected by a local broker for recycling (Chertow et al. 2008). In the supercluster of Palar Valley, India, with more than 500 tanneries, several local arrangements were developed for the creation of common effluent treatment plants (CETPs) to treat the wastewater (Kennedy 1999). In both cases, the joint effort was prompted by increased vigor in the execution of environmental regulations. However, they had limited (environmental) success. According to Ashton (2011), the effort in Barceloneta did not focus on the environmental benefit and, in fact, may have used its economic weight in the community to shirk close regulatory oversight and to focus on a cost-effective solution with limited environmental benefits.

Although industrial symbiosis can be used to economically mitigate the environmental impact in many clusters, these opportunities are not always fully exercised because of a lack of coordination. This raises the importance of having a "champion" to lead the initiative. Hewes and Lyons (2008) compare the actions of Peter Lowitt, who led the development of the eco-industrial park in Devens, Massachusetts, and Valdemar Christensen, who led the development of the park in Komsonomsk, Ukraine. Both champions had prior success leading the development of eco-industrial parks elsewhere. In the new projects, both had to deal with issues of trust and long-term viability, considering that they were outsiders in the respective projects. A common feature was that both champions had to devote substantial personal energy to developing social relationships as part of their efforts to get buy-in from the members in their clusters.

The following section discusses the Green City project that was introduced in the city of Três Coroas, part of the Paraná Valley industrial cluster. Because of the parallelism of the production systems in this area, most facilities vie for the same resources and face the same waste disposal challenges. Consequently, a symbiotic relationship relying on by-product exchanges would be hard to develop among the members of the cluster. Rather, they cooperate in the creation of a waste disposal infrastructure through the local trade association. The role of the champions is noted, as well as their influence in garnering the necessary support to conduct the project.

**Case Study: Três Coroas Shoemaking Cluster**

Três Coroas is a small city located 92 km (58 miles) from Porto Alegre, the largest city in southern Brazil. The region is known for its natural beauty, the challenging rapids of the Paraná River, and for hosting international kayaking and rafting championships. Over the years the community realized the need to protect its natural environment—a source of sustenance, tourism, and international recognition.

On the economic front, the city boasts more than 90 shoe and component plants, in addition to 380 contract shops (ateliers) that take on specialized jobs for the shoemaking industry. In 2006 they made 16 million pairs of shoes per year, employing 4,200 skilled workers. Most final assemblers use their own brands to sell in the Brazilian (85%) and Latin American...
markets. More competitive firms export their output to more than 40 other countries.

Shoe production in Três Coroas is a manufacturing process organized in a fashion similar to an assembly line. Most shoe components and some chemical components, such as glue and finishing products, are obtained from other firms in the region. Generally the most important raw material is leather sourced from nearby tanneries. Shoe factories do not make the components needed for final assembly; instead they often buy raw materials and outsource production of components from contract shops. This occurs especially in the production of soles and in labor-intensive activities, such as cutting uppers and sewing. When these activities are outsourced, the shoe factories maintain supervision and control of the operation: not only they are responsible for the quality of their products (with obvious impact on the firm’s long-term success), but they also remain legally responsible for the supply of materials and waste disposal.

**Problem Identification**

Before the implementation of the Green City project, there was very little environmental awareness, and the shoemaking industry was not engaged in any recycling activity. Federal and state environmental laws were poorly understood or enforced. All the waste generated by shoe factories and component factories was incorrectly disposed of in the municipal landfill, or clandestinely incinerated, and no reliable records were generated. Figure 1 shows a representation of the materials flow prior to the establishment of the Green City project.

Environmental concerns were quite limited until the 1990s. According to the director of the Três Coroas Shoemaking Trade Association, the companies disposed of their industrial waste without any separation. It was mixed with domestic waste and sent to the municipal landfill. Some firms incinerated their waste in open-air sites, generating a considerable amount of smoke that would accumulate over the city, surrounded by mountains, deep in the valley. “The smell was unbearable” (Ruppenthal 2005). In addition to the inadequate and illegal waste disposal practices, most companies did not have the operating license required by the waste management authorities, leading to hefty fines issued by federal and state environmental authorities. Throughout the state, the shoemaking industry felt the impact of the enforcement. Under this new challenge, different clusters adopted different solutions.

Trade organizations are constantly under pressure to prove that they are relevant. In Três Coroas, the business leaders decided to cooperate and find a common solution under the leadership of the trade association’s director, Fabio Ruppenthal, who led the design and championed the waste management initiative.

**Solution Approach**

Upon recognition that they could not individually reduce the environmental impact of their industrial solid waste, the shoemaking companies united their efforts through their trade organization to develop a solid waste collection process with the long-term goal of recycling all the collected industrial refuse. The process involved sorting the waste generated by each industrial facility, followed by collection and transport to the recycling center, where the wastes were consolidated for sale in secondary materials markets.

While other cities chose traditional solutions, such as building dedicated landfills for industrial and contaminated waste, the community of Três Coroas decided on a long-term affordable solution that would satisfy environmental concerns, eliminate environmental liabilities, and, ideally, pay for itself. The solution required the proper separation of industrial waste at its source, facilitating potential recycling opportunities.

Fabio Ruppenthal, director of the trade association, was the leading force, with the technical support of his wife, biologist Giovana Ruppenthal. They realized that the family-run SMEs in the cluster would not have the technical skills, managerial capability, and economies of scale to address the problem individually. Hence they recommended the project under the trade association’s leadership. Most firms joined the project, entirely conceived without direct influence from the government or other nongovernmental organizations. He explained their motivation:

Our solution was more expensive up front, but we do not have the maintenance expense and logistics problems associated with leaching: the percolation of toxic residue from landfills... Why duplicating the work? Why contaminating and having to decontaminate later? Our approach is a little more expensive in the outset, but it pays off in the end (Ruppenthal 2005).

The negotiation with the members of the trade organization was difficult, since many firms could not understand the value of the effort and did not want to incur the expense:

We held several meetings to show the importance of the approach... since it was a radical transformation from previous practice... We had to explain to everyone that, starting August 19, 1996, bubble wrap could not be disposed in the

---

*Figure 1 Material flow at Três Coroas before implementation of the Green City project. FGI refers to finished-goods inventory.*
same container as leather, that synthetic leather could not be put together with leather... everything should be segregated in the respective category... It was a radical change... What did we achieve? The factories became more organized and we transformed the region. Everything was clean, waste burning stopped... it was a jump in our quality of life.

I fell in love with this. Giovana and I feel committed to the cause. You must “like” to work with residues... and that is something that eventually becomes part of you... It is good, it is great to work for the good of the environment and of the population. When it comes to water, we are in a strategic area, because Três Coroas lies in the highlands of the Sinos River basin. The cleaner the water flows down, the better is the quality of life for the population of other regions that source from the river (Ruppenthal 2005).

On the date scheduled for project implementation, all factories began to segregate their residues, while the trade association managed the waste management infrastructure. It was a significant housekeeping effort for all participants. A recycling center was created for sorting, storage, residue management, and distribution of recyclable materials to the respective processor. The trade association was also responsible for training the individuals involved with waste segregation at the plants, as three significant factors continually complicated the process:

1. Shoemaking uses a diverse variety of materials in the product and in the package, including leather, rubber, paper of many weights, cardboard, and low-density polyethylene. None of them has significant postindustrial value in low volumes.
2. Each participant collects a relatively small volume of each recyclable material, keeping the collection in each site at a very small scale.
3. Fashion and seasonality combine to create a large variability of types and quantities of materials collected during the year.

The success of the Três Coroas project depended on achieving economies of scale for all recyclable materials. At the same time, it was important to educate the firms about reducing waste of all sorts generated in each plant. The trade association developed the educational materials about the segregation process, types of residues, and recycling potential of the materials collected. Figure 2 shows a simplified process flowchart, explained below:

**Step 1.** The recycling center prints barcode labels indicating the type of residue and the factory that generated it. The labels are distributed to each participating company with separate collection bags for each type of residue.

**Step 2.** Factories receive the respective barcode labels. An employee is responsible for internal collection and for contacting the recycling center as needed. A designated worker supervises the sorting process and dispatches the collection bags to the recycling center. This person is also the point of contact for occasional discrepancies in the sorting process.

**Step 3.** The recycling center contracts a custom-designed truck to collect the bags daily. It has side openings for easy loading, and it is designed so that the collected material is protected from the rain, and does not fall off during the collection rounds.

**Step 4.** At the receiving dock of the recycling center, the material is verified to confirm that the residue was correctly classified and that there are no mixed materials. If there is any discrepancy, the material is returned to the respective processor.

**Step 5.** Materials are weighed and registered in the management system.

**Step 6.** Residues are pressed in packs by material type and class.

**Step 7a:** Recyclable materials are sold.

**Step 7b:** Non-recyclable residues are transferred to industrial landfill.

**Step 8:** Residues are stored separately until an economic recycling process is developed.
plant for correction. If it is a recurring problem, additional training is provided or the respective management is notified.

**Step 5.** If the contents of the bags match the labels, they are weighed on a precision scale connected to the computerized management system. The barcode allows recording of the type and class of the residue, the factory that generated it, the receiving date and time, and the weight of the waste.

**Step 6.** Material from different facilities is grouped and pressed in packs, according to the residue type and class.

**Step 7a.** Material that is recyclable is stored in the recycling center, where it stays until sold. The management system tracks inventory levels, making adjustments after every sale.

**Step 7b.** Material that does not have a recycling solution is shipped to the industrial landfill. Transportation is restricted to sunny days, to protect the material from the rain.

**Step 8.** The association’s landfill is divided into multiple ditches covered by a structure that slides on rails to protect the residues against the weather, ensuring that they are kept dry. This prevents leaching (which generates bad smells and may contaminate the groundwater), and maintains the possibility to recycle the material in the future if the appropriate technology is developed.

Describing the process, Ruppenthal clarified:

The separation is simple because the firms never generate mixed residue... [Each type of residue] is created separately. What needs to be done [at the plant] is to collect the residue, keep them segregated, place the label and deliver to the recycling center... At the end of each day, 1 know what each firm brought in of each [type of] residue (Ruppenthal 2005).

**Contrasting the Três Coroas with the Palar Valley Clusters**

It is worth mentioning that the tanneries in the Palar Valley, India, faced similar legal challenges in 1995, when the Supreme Court ordered closing one-third of them due to their toxic wastewater release (Kennedy 1999). The Indian solution required the creation of several effluent treatment plants (CETPs) separating the toxic sludge from the water to be safely disposed. The greatest hurdle, however, was to change the mindset of constant competition to adopt a cooperative solution. Kennedy clarifies:

In addition to technical knowledge, effective operation of a collective treatment plant to meet stringent pollution controls requires extensive internal coordination. Peer monitoring to ensure cooperation puts tremendous pressure on the group, and some treatment plants fare better than others in securing compliance from members (Kennedy 1999, 1673).

A tragedy of commons (Hardin 1968) developed in some communities in the Palar Valley, given the inability to measure the inputs and to enforce the quotas allocated to each tannery of any given CETP. The CETPs did not have the means to verify the amount of wastewater or the amount of pollutants in the water, which led to free riding. Close-knit communities resorted to social mechanisms to ensure cooperation, while communities with more arms-length relationships adopted the threat of temporary closures. Ultimately, larger tanneries that had the economic means attempted to leave the cooperative and open their own effluent treatment plants, leaving the smaller tanneries to manage the CETPs themselves. Such action could have jeopardized the economic and technical viability of CETPs that relied on the expertise of a larger tannery.

This cooperation hurdle was more readily overcome in Três Coroas for a number of reasons: (1) the trade association predated the environmental crisis (cooperation through the trade association was already an important feature); (2) the leadership standing of Fabio Ruppenthal facilitated the building of the necessary trust to find a joint solution (members of the cluster had a familiar face to promote and protect the initiative); (3) the industrial waste collection was transparent, with every company fully aware of the quantity and quality of the waste generated each month (free riding was not possible). It was in each firm’s best interest to improve process efficiency and to reduce the amount of solid waste released; the recycling process helped that.

**Operational and Environmental Outcomes**

The support system at the recycling center tracked all residues generated in each participating plant. Figure 3 shows the balanced flowchart of one small plant in the project. This particular factory does not produce leather shoes, so most of the waste that is not recyclable comes from polyurethane (PU) soles and polyurethane synthetic laminate. Materials classified as “toxic” are mainly cleaning residue from regular sweeping (4%), shoe parts that are not recyclable (2.24%), and damaged shoes—still in usable condition—that are donated to poor communities (0.97%). Among the recyclable materials there is synthetic material for making soles (45%), paper (12%), metallic parts (2.5%), and plastics (2.3%). The system accounts for all solid residue. Materials that are not recyclable with current technology are stored for future recycling.

Figure 4 shows the community flowchart for the year ending on October 31, 2006. It shows that the community performance since the implementation of the project is similar to what appears in figure 3. The residues are similar to what is seen in a single factory, except for the wider variety of materials that are used in the many plants. The recyclability of material that has been disposed of depends on choices related to product and process design in each firm, in addition to changes driven by season and fashion. According to the recycling center, approximately 68% of all materials received are recycled. Our analysis finds a slightly lower index.

In the first year of operation, only 8% of all waste collected was recycled. In 1997 the recycling center found markets for 14% of the collected waste, increasing to 38% in 1999 and 68% in 2001, performance that remains today. For comparison purposes, of all the material that is not used or recycled within...
the plant (on-site) in Brazil, only 1.78% is effectively recycled (ABRELPE 2008). In the United States, only 33.6% of the solid waste from the fabric and apparel industry is recycled (Franchetti 2009). The performance is even more impressive when we consider that all participants in the recycling scheme have engaged in improvement projects to reduce the proportion of their inputs that leave the plants in the waste bins.

During the period analyzed, the recycling center received 4.6 thousand tons of industrial waste. About 15% of this amount was cellulose insoles, followed by rubber sheets or synthetic materials for making soles (9.5%), fabrics (8.44%), and other synthetic laminates (5.5%). These materials are fully recyclable. Other common rejects (chrome-treated leather, 5.3%; cracked leather, 4%) are not economically recyclable. In general, two-thirds of all solid waste generated by the industrial cluster is recyclable and one-third is stored in the landfill for future recycling opportunities. Figure 5 provides an overview of the material processed from 1999 to 2005. Annual variations were due to external factors (changes in fashion, consumer preference, or market share fluctuations) and to process improvement (better use of inputs leading to a reduction in some waste categories).

The total project cost approximately 6 million real (R$) (3.75 million U.S. dollars [US$]) in the first ten years, born by participant enterprises in the cluster. Construction of the landfill consumed about 20% of this amount, while the annual operating cost of the recycling facility was about R$0.8 million (US$0.5 million) in 2006. Participant plants share this expense according to the quantity of waste generated.

The recycling center generates an income of about R$265,000/year (US$165,000/year). This resource is not used...
to pay for operating expenses, which are fully covered by participant SMEs. It stays in the trade association to cover unexpected future expenses, additional investments, and educational campaigns. For example, the trade association recently had to build an extension to the chrome-leather ditch, which filled up. In this respect, the process is still not sustainable because some of the most toxic raw materials are still present in the supply chain. However, the cost of running the recycling operation is equivalent to the disposal costs that the companies faced previously, without the liability for violating environmental protection regulations.

In addition to the formal monthly report that the recycling center generates for each participant, to meet requirements of the state environmental protection agency, the trade association sends a feedback report about their waste generation, which helps the small companies manage their operations, improve controls, and reduce waste. Some firms have decided to keep some categories of residue on-site to recycle them into their processes. Many implemented substantial improvements in the cutting process (an area where much of the residues are generated) and better control of purchased materials. Finally, occasional pilferage was all but eliminated.

However, not all managers realize the indirect benefits and possibilities created by this process. According to the director of Calçados Ceconello, a participant firm, "Many firms do not perceive the amount of money that they lose with raw material waste, components misused, and returned shoes with quality problems" (Furlanetto 2006). For instance, if a used can of glue weighs more than the standard weight, the glue was not fully used and some of it is being wasted. Likewise, companies may execute input-output raw material analysis to determine if the fraction of a given material that is wasted each month is trending upward, downward, or is stable, and if it is consistent with the current product line. The recycling center has resources to monitor this information and to provide the companies with variance information. Ruppenthal says, “Once I did a study of defective shoes that were thrown away, and I showed the firms that they wasted approximately R$17 million (US$10.5 million) per year...just considering raw material's average price per weight" (Ruppenthal 2005). Some participants use this information to focus their operations, reduce quality problems, and lower costs.

The main benefit of the recycling process is the quality of the solution adopted: it is environmentally superior, cost effective, and promotes better understanding of the operating process, leading to further cost reductions. It seems that all participating companies are conscious of the environmental benefits. The benefits affect the managers at home: “Many managers own stios. You show them that the water in their creek is protected, and they can fish from the pond knowing that it is safe to eat” (Ruppenthal 2005).

The project did have its share of disappointment with meeting the regulations. “Certain actions do not receive the proper incentive. The legal and tax problems discourage potential investors to reuse industrial waste” (Ruppenthal 2005). There was a long delay in obtaining an operating license, and the recycling facility has to treat their inputs as dangerous. This adds 40% to the labor expense—the "dangerous working environment" tax in the payroll:

We handle the same residue that the firms use every day, but since we call it residue, we need to give the hazardous pay to our workers...Moreover, the government does not encourage: we have to pay value-added tax in advance, even for donated material, and this discourages recycling (Ruppenthal 2005).

Leather remains the most difficult residue to manage. Since most shoes made in Brazil are tanned with chemical products based on chrome, which is highly toxic, its potential for reuse is quite low. In the period 1995 to 2005, the trade association accumulated a 5,000 cubic meter (m³) (176,000 cubic foot [ft³])
leather residue stock. To reduce this flow, product redesign seems to be the only solution in the near term.

Moving Forward

In 2006, Fabio Ruppenthal started expanding the project’s reach to increase member benefits. The association initiated marketing efforts to associate the products with a positive environmental concern and social responsibility. They created a certification stamp with the catchphrase Produção Consciente (Responsible Production). To use the stamp, a cluster firm must comply with all national and state environmental regulations, in addition to certain standards for production, storage, transportation, and reuse defined by the members of the trade association.

The stamp is promoted in a marketing campaign with the distribution of leaflets inside the shoeboxes. In addition to helping the companies follow environmental legislation, the Green City project promotes the citizens’ concern for environmental preservation, promoting many community actions involving schools and community centers. Moreover, members of the trade association realized that the Green City title would better serve the town of Três Coroas, which had been using it to remind the public of its touristic attributes, than the shoemaking industry itself. In 2007 Responsible Production, the certification stamp with its industrial theme, became the project’s name.

The program is recognized locally and internationally as an example of positive externalities created by environmental protection investments. Representatives from technology centers and universities all over Brazil and from more than 70 countries have come to Três Coroas to study the project with the objective to implement similar ideas in other clusters of SMEs. The project treats the environmental effort as an investment, rather than an expense, adding productivity and competitive power to the cluster. It fosters communication among members through intense knowledge sharing.

In 2007 nine firms in the cluster joined forces with Pontifícia Universidade Católica do Rio Grande do Sul (PUC-RS), a local university, and received a R$330,000 grant (US$330,000) from the Ministry of Science and Technology to develop the EcoShoes product line, specifically to reinforce and exploit the cluster’s environmental reputation. The initiative intended to identify new materials that could be used in the industry. In 2010 the project expanded to include seven additional firms, which have been able to design shoes entirely made of recyclable materials, offering their products with a price premium in the international market.

At the same time, the trade association dedicated a new building with space for management, classrooms, and a shop for environmental training, next to a separation and sorting warehouse, all self-financed. Its mission is to become a source of technological innovation and community development. In addition to specific training for shoe production and waste reduction, it offers classes of artisanship using recycled materials and provides common space for an organic garden and for the members’ leisure.

Fabio and Giovana Ruppenthal successfully used their standing in the community, leadership position in the trade association, technical expertise, personal empathy, and managerial skills to acquire the buy-in from all members of the cluster. They ensured that the initial success led to reinvestments in the project and recognition by the city, creating an environment where the project would remain a priority in this community.

Reminiscing upon 14 years as head of the project, he summarized the motivation of many owners in Três Coroas: “Sustainable development is viable and desirable. Initiatives such as Green City/Responsible Production should be commonplace, not the exception. And if we replicate it in other clusters, we may have a better perspective in life for this and future generations” (Ruppenthal 2010).

Environmental Compliance and the Small Factory

An environmental management system (EMS) provides a facility with a systematic approach to improve its operations for better environmental performance. A facility with an EMS can achieve more reliable performance and compliance, can verify its reporting requirements more efficiently, and can be inspected more quickly, when needed. An organization with a well-defined EMS has procedures for consistently reducing the frequency of accidents, spills, and other environmentally damaging events; it may also identify more opportunities to improve its environmental performance beyond compliance (Ferrer 2008). However, a complete EMS, with all its administrative requirements, may overwhelm a small enterprise with few employees. Small factories such as the ones in the Três Coroas can impact the environment as much as a large factory with similar inputs, when we adjust the impact for the size of the operation. However, given the scale of operation, some modern management procedures may be too burdensome to adopt. Designing environmentally sound procedures, though extremely important, may not seem urgent to the manager of a small company that—despite its size—might be a significant source of pollution. Hence small and medium-size enterprises located in an industrial cluster are particularly well positioned to benefit from collaborative solutions in the development of an EMS that meets international standards.

Industrial ecology research is generally concerned with the sustainable relationships between the natural environment and economic activity. Recent studies have found several instances where geographically close industrial facilities have established symbiotic relationships similar to ones found in nature, where two species cooperate to improve each other’s chance of survival. A common thread that can be observed in industrial symbiosis with by-product exchange is that there is a potential for interdependency in their operations. In other words, the waste generated in one facility can be used (modified or not) as input in another facility—just as we see in symbiotic relationships...
between natural organisms. However, although resource exchange contracts may mitigate the environmental impact in many industrial clusters, such exchanges would have limited results in a competitive environment, such as the one in Três Coroas. There, the main concern lies in the solid waste that has no value in the local community but may be valued elsewhere. Utility sharing in the form of cooperative waste collection and recycling is the type of symbiosis adopted in this community.

The literature indicates that clustering enhances the easy, informal, and rapid flow of information and knowledge among local producers, traders, and institutions. In a joint project, such as Green City, knowledge is shared and created through a process of “collective learning.” The competitive power of the cluster is enhanced because the entire value chain, not just a single firm, asserts environmental responsibility. This can differentiate the cluster’s product with both retail and corporate customers. Although individual firms at Três Coroas did not adopt an EMS, the project reduced the risk of environmental liability for everyone—firms in the industry cluster and their corporate customers.

**Recommendations and Future Actions**

Despite its advances, the Três Coroas industrial cluster remains under increasing scrutiny due to its close proximity to many environmental hot spots. To maintain their competitive edge, leading companies are moving to adopt advanced environmental practices that bolster environmental performance and competitiveness. EMSs are increasingly recognized as the most systematic and comprehensive mechanism for improving environmental performance. While business benefits are important motivations for adopting innovative management systems, advanced environmental practices reflect a corporate commitment to high levels of quality, safety, and environmental performance (Gavronski et al. 2008).

Given the success of their experience, the firms in this cluster could extend this project by developing an environmental program that could work at two essential levels: the cluster and the firm. The cluster-level EMS would help identify economies of scale opportunities in the selection or avoidance of certain materials and processes that affect cluster performance. The trade organization would oversee the development of the joint EMS, and the certification (if desired) for individual firms in the cluster, while establishing the EMS for the cluster as a whole. EMS adopters could extend the vital lessons learned by practices and initiatives originally implemented in their plant to their relationships in the community. Individual firms in the industry cluster could establish and preserve their own EMSs, integrating them and their activities into other management systems without losing their identity and competitive advantage, while benefiting from the cooperation led by the trade organization.

Recent studies have shown the positive impact of symbiotic relationships with by-product exchange (Chertow 2007; Jacobsen 2006). Industrial clusters characterized by competing facilities with parallel operations, such as the one in Três Coroas, cannot readily adopt a by-product exchange because they compete for similar inputs and dispose of similar types of waste. Considering the competitive advantages that these clusters provide, it is important to identify arrangements for reducing their environmental impact through utility sharing. Achieving economies of scale of any such arrangement might be the key constraint. The Green City project overcame this hurdle with a transparent process under credible leadership.

The success of the waste reduction experience indicates that the trade organization could eventually support clear and simple standards for a formal EMS that extends upstream to raw material suppliers and contract shops, and downstream to processors, distributors, and transporters. This EMS would be tailored to the unique character and needs of the cluster and its member firms, focused on its principal product and markets, building upon its competitive strategy.

At the local level, to improve recycling performance, the recycling center could consider promoting the reduction of raw material variety, increasing the opportunities where economies of scale are achieved by the system. As a future study, it is worth considering the process efficiency in individual facilities through rigorous input-output analysis to identify recyclable materials that provide the best yield to the producer, thus generating lower waste volume. On a broader scale, it is important to understand how extending the cooperative arrangement to include material choice could affect the competitiveness and the innovative capability of industrial clusters.

**Acknowledgements**

The authors would like to thank Fabio and Giovana Ruppenthal for sharing their valuable insights about the Green City/Responsible Production project at Três Coroas. We also thank Reid Lifset and three anonymous referees for many suggestions that led to substantial improvement of this article.

**Notes**

1. The term ton in this article refers to metric ton. One metric ton = $10^3$ kilograms (kg, SI) ≈ 1.1 short tons.
2. A sítio is a type of rural property, typically a second home built in a wooded area.

**References**

ABRELPE (Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais). 2008. _Panorama dos resíduos sólidos no Brasil [Overview of solid residue in Brazil]._ São Paulo, Brazil: ABRELPE.


About the Authors

Geraldo Ferrer is an associate professor at the Graduate School of Business and Public Policy of the Naval Postgraduate School, in Monterey, California. Sandro Cortezia and Jaqueline Morbach Neumann were graduate students at Unisinos, in São Leopoldo, Brazil, at the time of this study. Currently Sandro Cortezia is an assistant professor at Unisinos and a business consultant. Jaqueline Morbach Neumann is an adjunct professor at Faculdade Cenecista, in Nova Petropolis, Brazil, and a consultant for the Federation of Industries of Rio Grande do Sul, Brazil (the statewide industry organization).