A Social Network Analysis of Sustainability in Georgia’s Carpet Industry

In Fulfillment of the Option Paper Requirement

Evan D. Robertson
Professor Nancey Green Leigh
December 13, 2010
Limitations of the Data: ........................................................................................................................................... 53
Institutional Bridges:.................................................................................................................................................. 55
Figure 3.4: The Carpet Sustainability Triangle ........................................................................................................... 56
Carpet America Recovery Effort: .................................................................................................................................. 56
NSF/ANSI-140 Standard: .............................................................................................................................................. 58
Sustainability Issues Management Team: ...................................................................................................................... 60
Recommendations:......................................................................................................................................................... 62
Figure 4.1: Volume of Diverted Carpet: .......................................................................................................................... 63
Recommendation 1: The Dalton Green Carpet Institute .................................................................................................. 64
Recommendation 2: Local Government Support of Carpet Recycling ................................................................................ 67
Figure 4.2: Map of the Former Bankhead Courts Property .............................................................................................. 70
Recommendation 3: State of Georgia Support for By-Product Synergy ........................................................................... 71
Figure 4.3: A Complex Example of a By-Product Synergy System .................................................................................. 72
Conclusion:....................................................................................................................................................................... 73
Works Cited:..................................................................................................................................................................... 76
Introduction:

Ideas are a funny thing. Some simply die off at the moment of inception, never gaining any traction in the world. Others spread like wildfire, permeating through all parts of the world and altering its landscape for generations. This is a paper about the latter type of idea. Sustainability entered Georgia’s carpet industry as an epiphany. Ray Anderson, CEO of Interface, suddenly realized the impending ecological crisis that our planet now faces and his company’s role in perpetuating the crisis (Anderson, 2009). With this epiphany came sweeping changes occurring throughout all parts of Interface’s production process. Production workers as well as marketing staff were involved in reducing the environmental footprint at Interface. It is likely that this initial spark would have only stayed at the medium sized carpet manufacturer had it not been for two alternative pressures which would fan the flames to other firms in Georgia.

The first pressure came from the EPA who wished to regulate carpet due to the fact that carpet is difficult to handle in landfills and doesn’t decompose (Reallff, 2011). Under threat of EPA regulations, the carpet industry established the Carpet America Recovery Effort (CARE) in 2002. CARE’s mission is “to find market driven solutions to the diversion of post-consumer carpet from landfills to meet the time sensitive goals of the Memorandum of Understanding (MOU) for Carpet Stewardship” (Carpet American Recovery Effort, p. 1). The memorandum of understanding was established by private, government, and non-profit organization who created a ten year goal to “increase the amount of recycling and reuse of post-consumer carpet and reduce the amount of waste carpet going to landfills” (Carpet American Recovery Effort, 2008a). CARE is essentially an industry driven regulatory agency. Members of the CARE board
include individuals from the major carpet producers: Interface, Beaulieu of America, Shaw Industries, and Mohawk Industries. The threat of EPA regulations caused substantial internal change and pushed the idea of sustainability up on industry’s priority list. The fact that the second pressure made this activity profitable insured that sustainability was set as a priority of the industry.

The Leadership in Energy and Environment Design (LEED) was the second pressure that motivated the carpet industry to adopt a sweeping environmental sustainability agenda. The United States Green Building Council (USGBC) was created in 1998 to promote the construction of green buildings. In order to incentivize private developers to build sustainably, the USGBC issued a point system which rated a new or existing real estate development’s energy and environmental design. Within the point system were three points that were pertinent to the carpet industry:

- Material Reuse (MR) Credit
- Indoor Environmental Quality (IEQ) Credit 4.1
- Indoor Environmental Quality (IEQ) Credit 4.3

MR credit 4 requires that the building “Use materials with recycled content such that the sum of postconsumer recycled content plus 1/2 of the preconsumer content constitutes at least 10% or 20%, based on cost, of the total value of the materials in the project” (United States Green Building Council, p. 52).

Using carpet with recycled content could by no means solely earn the developer the two credits available in this category. However, recycled carpet could certainly help the developer achieve the two available points for this credit along with other using other recycled content
building materials. The remaining two credits are aimed at environmental health: IEQ credit 4.1 gives the building one point if the carpet sealants emit no more than 50 grams of Volatile Organic Compounds per liter, while IEQ credit 4.3 gives the building one point if the carpet used in the building meets the Carpet and Rug Institute’s Green Label Plus program (United States Green Building Council, 2008).

The LEED point scheme ultimately pushed private developers and architecture firms to demand green products from the carpet industry. Together with the EPA regulatory pressure, the demand from consumers of carpet pushed the carpet industry to aggressively adopt environmental sustainability practices and standards. These initial sparks within the industry aided by the fact that in this forest the trees were particularly close together created a conflagration of sustainability in Georgia’s carpet industry.

A social network is defined as: Individuals or groups linked by some common bond, shared social status, similar or shared functions, or geographic or cultural connection (Barker, 1999). Networks are fluid entities, with individuals easily leaving and entering the network. The study of these networks has gained only limited traction in the study of local economies. This limited traction is because social network analysis studies social relationships, relationships which are much more difficult to collect data on. However, the social and the economic are becoming increasingly intertwined, especially as our economic structure becomes more knowledge intensive. Social network analysis can be used, together with traditional economic analyses, to study the flow of information or power structures inherent in the local and regional economy. For instance, the spread of sustainability in Georgia’s carpet industry could be understood by the industry’s participation in certain non-profit organizations which set
sustainability standards for the carpet industry. As we will see later in this report, the social network of Georgia’s carpet industry is relatively small and tight knit.

Three major carpet producers, Shaw, Mohawk, and Beaulieu of America accounted for 9.8 billion dollars of the 14 billion dollars in industry sales produced in 2006 (Davidson, 2006). Since the carpet industry is dominated by a few key players, the process of coordinating standards and disseminating sustainable practices is simplified. Moreover, the carpet industry has three important forums which bring leaders together to discuss the sustainability issues of the carpet industry. These public forums are: the Carpet and Rug Institute’s Sustainability Issue Management Team, the Carpet America Recovery Effort board and the National Sanitation Foundation’s 140 standards board. Together, these institutions play a critical role in bringing actors within the industry together, helping them to coordinate sustainability standards and practices. These organizations and the social network of the carpet industry will be analyzed later in this paper.

This research paper combines traditional methods for analyzing an industry with the burgeoning field of social network analysis. The paper is composed into three parts. Part one entails the more traditional analysis of the carpet industry using data from the Census Bureau and the Bureau of Labor Statistics. The data was analyzed paying special attention to the implications it has for the social network of Georgia’s carpet industry. Part two reviews the wealth of literature of social network analysis and innovation. The assumption of the literature review is that industries adopting sustainable practices mimic high innovation industries. Thus, the conclusions and observations of the literature can be used to help inform the paper’s social network analysis of the carpet industry. Finally, part three of this report includes the social
network analysis of the carpet industry along with recommendations aimed at sustaining and further promoting sustainable practices within the carpet industry.

**Carpet Basics:**

Carpet is composed of four basic parts: 1) Tuft, 2) Primary Backing, 3) Secondary Backing, and 4) Adhesive Compound. The “tuft” is the part of carpet to which your feet are the most familiar. Tufts are “the cut or uncut loops of a pile of fabric” which stick out of the floor giving carpet its volume noticed by your feet (2003, pp. 6-16). Tufts are created by sowing synthetic fiber into a primary backing fabric which allows the tufts to maintain their fluffy nature. The secondary backing fabric is adhered to the primary backing fabric and the tufts using an adhesive compound. The secondary backing fabric as well as the adhesive compound together gives the carpet “dimensional stability, strength, stretch resistance, and lay-flat stiffness” (Carpet and Rug Institute, 2003, pp. 6-13). In layperson terms, the secondary backing makes sure that the tuft stays in the primary backing and doesn’t pull out when it is walked upon.

**Carpet Manufacturing Process:**

The manufacture of carpet is a heavily mechanized process that occurs in three essential steps: 1) Yarn Preparation, 2) Tufting, and 3) Dying. While each step of the carpet manufacturing process has numerous possibilities to introduce sustainable practices into the production process, carpet manufacturers have the least control over the production of the yarn. Carpet producers rely on two supplier firms, Invistia and Ascend, to produce synthetic
yarn needed to produce the tuft. Carpet manufacturers generally use two predominant synthetic fibers, Nylon 6,6 (60% percent of the market) and Polypropylene (33% of the market), in the manufacturing process (Carpet and Rug Institute, 2003). Both are petroleum-based products. By virtue of the fact that these products are made from petroleum and require significant amounts of heat to produce, it was found by one firm that supplier carbon emissions accounted for nearly 63 percent of its total carbon emissions (Hensler, 2011). Carpet manufacturers are heavily reliant on these suppliers’ R&D capacity to reduce their environmental impact. Carpet firms have put pressure on their suppliers to become green; however, the carpet industry’s negotiating power is significantly reduced because of the fact that there are only two major suppliers in the industry. Thus, carpet manufacturers can only directly influence sustainability once the synthetic fiber is bought from the supplier firm. The carpet manufacturer is then able to control waste through innovations in the production and dying processes in order to reduce its consumption of the raw materials and, thereby, its environmental footprint. The complexities of sustainability in the carpet production process are a significant contrast to the rather straightforward process of producing carpet.

Carpet begins its life outside of the carpet manufacturer’s premises. As noted earlier, the synthetic yarn (which comprises 99 percent of the tufting market) begins its life in one of two supplier firms: Invistia and Ascend. At these suppliers, polymers are heated until they become molten. The molten material is then “forced through tiny holes in a spinneret or metal plate,” cooled and then wound unto spools creating Bulk Continuous Fibers (Carpet and Rug Institute, pp. 1-3). However, if the carpet manufacturer requires a shorter fiber for their carpet production called “staple fiber”, then the yarn production is a little more complex. Similar to
the bulk continuous fiber, the staple fiber is first melted and forced through little holes. But, before the fiber is wound unto spools it under goes three important processes: Blending, Carding, and Drafting. After the fiber is extruded, the fiber is dried and cut. The fiber trimmings are then placed into bales. In order to ensure that the fiber is uniform, the different fiber bales are blended together. Blending the different fiber bales is important because it prevents aesthetic defects from occurring in the dying process, it ensures that the dye is absorbed uniformly. Next the yarn is carded, during which a machine “aligns the fibers and puts them in a continuous sliver (rope-like) configuration” (Carpet and Rug Institute, pp. 1-4). After the carding process, the rope-like fibers are drafted. Drafting essentially entails blending the different rope-like fibers together to ensure uniformity. The staple-yarn can be spun into spools once the drafting process is complete. It is at this point in the production process that the carpet manufacturers enter the scene.

Unlike the production of the actual yarn, manufacturing carpet is a fairly simple process provided you have the costly machinery to tuft the synthetic fibers into carpet. The spools of synthetic yarn are fed from either one large spool (tufting from beam) or multiple smaller spools (tufting from creel) into the tufting machine. The machine itself is filled with needles that insert the yarn into the primary backing fabric. Below these are “loopers, devices shaped like inverted hockey sticks, timed with the needles to catch the yarn and hold it to form loops” (Carpet and Rug Institute, 2003, pp. 1-9). At this point, the tufted carpet (synthetic fiber plus the primary backing) undergo a dying process. Once the carpet is dyed, adhesive is applied and the secondary backing is attached to the unfinished tufted carpet.
The process sounds deceptively easy. Yet, due to the wide variety of aesthetic tastes, carpet tufting machines and the dying process has become increasingly more complex. Moreover, the rise of modular carpet tiles has added increased complexity into the carpet manufacturing process because the carpet must be designed and manufactured with the knowledge that they finished product will be cut into 18 in. by 18 in. blocks. This adds wide variability of the production processes and can cause problems when the spools of synthetic fiber must be changed out during a production run (Hensler, 2011).

The complexity which has entered the manufacturing process, driven by the need to design for consumer’s aesthetic and environmental preferences, has helped to pressure the industry to adopt sustainability practices. These practices have become pervasive throughout the industry. The industry engages in a competitive environment in which each carpet company competes with others to become the “greenest” company, to create the “greenest” product (Realff, 2011). Firms, through market signals and marketing information about new green products, share their sustainability ideas and practices with other firms. These practices are then easily adopted by the other firms who replicate the new “green” product in order to stay at least level with the competition. This environment is easily fostered by the structure of the industry.

**Industry Structure:**

Georgia’s carpet industry dominates the national carpet industry. In 2009, Georgia’s carpet employment accounted for 73 percent of the nation’s carpet employment (United States Bureau of Labor Statistics, 2009a). Moreover, Georgia’s carpet industry constituted 67 percent
of the industry’s national capital expenditures and 73 percent of the industry’s total value of shipments in 2007 (United States Census Bureau, 2007a). The profound dominance of the south in the tufted carpet market demonstrates that the trends occurring in the industry at the national scale are ancillary to the trends occurring in some 65 square miles around Dalton, Georgia. But, it should be stressed that the carpet industry didn’t start in Georgia, it is where the industry ended up. One specific innovation in carpet, the incorporation of tufting formally used in bedspreads into the carpet manufacturing process, allowed the Georgia’s carpet industry to relegate and eventually replace their northern carpet competitors.

The structure of the tuft carpet industry has evolved since its inception in the south during the 1930s and early 1940s. Patton (2003) describes the structure of the early industry, “the new industrial environment of Dalton was characterized by the rapid multiplication of new firms. Barriers to entry into tufting were low and opportunities for choosing a place of employment, or self-employment, expanded for a generation” (Patton & Parker, p. 287). The invention of the tufting machine by Joe Cobble lowered the labor requirements for the tufting process, allowing almost any profit-seeking entrepreneur with enough capital to enter the tufting business. The machine lowered the barriers to entry for the industry, creating a positive environment for small firm entrants.

The structure of the industry, a large group of small firms competing for profit, would remain intact throughout the 1940s, 50s and 60s. During this time period, small carpet manufactures enjoyed sizable profits from the postwar housing boom and the public’s insatiable thirst for single-detached family housing (Patton & Parker, 1999). So long as national
home square footage increased, the carpet industry had enough profit to go around for all the small players. But, the early 1980s would prove a trying time for the industry as the housing market contracted due, in part, to the savings and loan crisis and the weak economy during this time period.

Davidson describes the effect of the 1980s recession, “The crippling recession of the early 1980s killed dozens of smaller manufacturers, eliminated thousands of jobs, and helped spur sweeping consolidation” (Davidson, 2006). The S&L crisis caused large consolidation within the carpet industry, the effect of which is that now the carpet industry has relatively few competitive players in the industry. As Davidson points out, Shaw Industries, Mohawk, and Beaulieu of America represent 70 percent of the industry’s 14 billion dollars in sales during 2006. The consolidation of the industry into a few large producers like Mohawk and Shaw Industries has reduced the size and number of establishments within the industry. Georgia has lost 78 carpet and rug establishments between 1987 and 2007 (United States Census Bureau, 2007a). Of these establishments, Georgia lost 37 small establishments and 41 large establishments (United States Census Bureau, 2007a). These trends are reflective of the national carpet industry trends. The nation lost 29.8 percent of its carpet establishments over the same time period, compared to 31 percent decline in Georgia carpet establishments(United States Census Bureau, 2007b). However, the nation differed in the types of firms it lost. For instance, the nation lost only 23 percent of its small establishments and 36.3 percent of its large establishments while Georgia lost 33.9 and 28.7 percent of the same establishments,

---

1 Small establishments are defined as establishments employing 19 people or less. In contrast, large establishments are defined as establishments employing 20 people or more.
respectively. Figure 1.1 shows the decline in the number of carpeting establishments in Georgia over a 20 year period. As can be seen in the graph, the number of small carpet establishments has declined rapidly while the decline in the number of large carpet establishments has leveled off between 1997 and 2007.

Based on Davidson and Deaton’s insight into the consolidation of the carpet industry, the decline in small establishments is occurring because of two reasons: 1) Small firms are being pushed out of the market, and 2) Large firms are moving production from their smaller establishments to their larger production facilities. That is to say, the changing market conditions, the increased competition in the flooring market, and the expense of creating green products is pushing smaller, non-competitive firms out of the market. At the same time, large firms are shifting from smaller carpet production facilities to larger carpet production facilities. Consolidating smaller production facilities into larger production facilities allows large carpet manufacturers (Mohawk and Shaw Industries) as well as medium sized producers (Milliken and Company and Interface, Inc.) to leverage their investments in sustainability across all of their flooring products. For instance, Shaw Industries’ waste to energy facility in Dalton, Georgia provides over 70 percent of its Plant 81 facility using wood and recycled carpet as fuel (Floor Daily, 2008). Such a plant would be prohibitively costly to build at all of its production facilities, unless of course, if it co-locates or moves production to a few central plants.
Beside establishment size, the carpet industry is changing in another important respect. Employment is becoming more geographically concentrated. Georgia’s location quotient, a measure of geographical employment concentration in an industry, has increased 15 percent between 2001 and 2009 (United States Bureau of Labor Statistics, 2009a). Figure 2.2 demonstrates that the concentration of carpet employment in Georgia has occurred mostly between 2003 and 2009. The employment concentration is being driven by declining carpet industry employment occurring in the national carpet industry. The nation lost 31 percent of its carpet employees between 2001 and 2009 (United States Bureau of Labor Statistics, 2009a). On the other hand, Georgia only lost 23 percent of its carpet employees during the same time period (United States Bureau of Labor Statistics, 2009a). Georgia’s lower rate of carpet job loss
has led to the increase in Georgia’s location quotient for the industry. In 2009, Georgia
represented 73.2 percent of all carpet employment in the nation, up from 64.8 percent in 2001.

Figure 1.2: Location Quotients of Georgia’s Carpet Industry

The structure of the carpet industry has fostered the spread of sustainability within the
industry. Three structural factors have played into the industry’s favor in terms of spreading
sustainability. Firstly, the consolidation of firms and, consequently, the number of firms in the
carpet industry has made it easier to coordinate sustainable practices. As we will see later, the
carpet industry relies on a few important public forums in which the major carpet firms can
transmit sustainability information and intentions. It is questionable whether these forums
would be as effective if a diverse number of players and interests had equal voice in the
sustainability standards of the industry. Secondly, the reduction of establishments has allowed
firms to concentrate their carpet production in larger facilities. The concentration of production
helps to make on-site waste-to-energy or solar power facilities economically viable for the carpet companies. Finally, the geographic concentration of firms helps to spread sustainability throughout the industry. The geographic concentration of industries promotes knowledge spillovers such as those that occur when an employee from a carpet company gets employed at a competing company. This employee is transferring the employee’s knowledge and sustainability plans from the original firm to the competing firm. This further improves the flow of sustainability information between competing carpet firms.

The carpet industry in Georgia has evolved from a new industry in which many new firms entered into the market place to exploit new technology to a mature industry that is dominated by a few large competitive firms. Yet, the carpet industry has not lost its competitive spirit that drove the industry to success in the 1940s-1960s. Today, the industry is experiencing a competitive spirit over issues of sustainability. Large carpet manufacturers are looking to out-do other competitors over issues like the total amount of carpet recycled, amount of renewable energy used as a percentage of total energy, amount of carpet diverted from the land-fill, water-usage and number of on-site waste-to-energy plants. Sustainability issues will likely cause the structure of the industry to change once again. As the case study of Shaw Industries will show, carpet firms are trying to get a hold on all of their production inputs in order to control for cost and environmental sustainability. The total lack of control over the industry’s fibers suppliers are pushing firms to vertically integrate. Thus, sustainability is pushing carpet firms to become even larger companies. One expects that the vertical integration of the large carpet firms will further put pressure on smaller firms to either exit the industry or be purchased by these large firms, especially if carpet purchasers are looking for these smaller
firms to meet the same sustainability requirements of the larger firms. Sustainability, then, is likely to drive the further transformations of the carpet industry’s structure into the foreseeable future.

**Employment, Labor Productivity and Wages:**

The invention of the tufting machine was the invention of a labor replacing technology. Instead of workers sowing each tuft into the primary backing, manufacturers could automate the process at a faster, more efficient pace. But, the invention of the tufting machine didn’t replace all the labor in the carpet firm. Indeed, firms still had to hire people to watch over the machines, feed the machines their raw materials, and move the finished carpet into storage rooms until it was ready to be sold. This requires about three or four employees to work alongside the tufting machine to make sure that the machine hums along at an efficient pace (Davidson, 2006). Due to the heavily mechanized carpet production process, one would expect that the amount of labor employed would track closely with the amount of capital expenditures spent by the carpet industry. However, this isn’t necessarily the case. The capital expenditures in the carpet industry are highly cyclical, large investments generally occur every 10 years which can be seen in Figure 2.1. As you’ll also notice, Georgia accounts for a large portion of capital expenditures in the national carpet industry. At its peak in 1992, Georgia accounted for 84 percent of capital expenditures in the industry. At its trough in 2002, Georgia still accounted for 52 percent of all capital expenditures within the industry.² But, employment in the carpet industry has not been cyclical for either the United States or Georgia. During this same year

---

² Given that the Economic Census is conducted every five years, new 2012 data is not yet available for capital expenditures within the industry. The new data may reveal a new trough in capital expenditures, especially with the heavy contraction of the U.S. housing market.
time period, the United States lost 15,609 carpet employees (a 29 percent decline since 1987) while Georgia lost 8,362 employees, a 25 percent decline in employment since 1987 (United States Census Bureau, 2007a). The steady employment declines in the industry indicate that the installation of newer, more efficient tufting machines are still having the same labor replacing effect that it did when the first tufting machine was introduced into during the 1940s. The tufting machines have not only had an effect on the number of carpet employees, but also the productivity of the retained labor force.

Figure 1.3: Capital Expenditures

Despite the fact that the carpet and rug industry has lost 15,609 national jobs during the twenty year study period, the industry has been able to increase its output. The national industry’s value of shipments from 1987 to 2007 increased from $9.8 billion to $13.1 billion (United States Census Bureau, 2007b). In other words, the national carpet industry was able to increase output by 34 percent with 29.2 percent less labor. The labor within the national carpet
industry is more productive. The total shipments per employee increased quite substantially during the twenty year study period. In 1987, the national value of shipments per one employee was $187,711 (United States Census Bureau, 2007b). Twenty years later the value of shipments per employee increased by 90 percent to $348,256 per employee (United States Census Bureau, 2007b). However, the 2007 financial crisis and subsequent economic recession has put significant downward pressure on the productivity of the national carpet industries labor force. Figure 2.2, derived from data published from the Bureau of Labor Statistics’ Industry Productivity and Costs data, shows that labor productivity enjoyed substantial gains during the a three year period between 2001 and 2004.

**Figure 1.4: Labor Productivity (Index)**

![Labor Productivity Chart](image_url)

*Source: United States Bureau of Labor Statistics*

However, labor productivity (output per hour) has dropped significantly since its peak. In 2008, labor productivity had fallen 10 points below 1997 levels (United States Bureau of Labor Statistics, 2008a). This drop in labor productivity was most likely caused by the collapse of
the housing market. Between 2004 and 2008, housing starts fell from 2.07 million to 905,400, a 56.2 percent decline in just four years (United States Census Bureau, 2009). The reduction in homes being built reduces the demand for flooring products, especially carpet. This significant drop in demand meant that carpet industry producers had to drop output of their product.

Thus, the drop in labor productivity is more indicative of the fact that carpet firms have reduced their output while maintaining their labor force. Carpet companies would rather reduce output before laying off employees because the industry’s largest expense is raw materials. The labor cost at one firm, Mohawk Industries, is only 10 percent of the firm’s total cost (Davidson, 2006). Hence, carpet manufactures would rather reduce its output first and maintain the existing labor force in case of increased demand once the downturn in the business cycle is reduced.

**Figure 1.5: National Carpet Output (Index)**

![National NAICS 31411: Output Index](source)
Consequently, the reduction of output for the industry has made labor more expensive. Nationally, unit labor costs have increased 67.8 percent in just four years (United States Bureau of Labor Statistics, 2008b). The causes of the increasing labor costs for the carpet industry are twofold: 1) the carpet industry has held onto labor but reduced output and 2) carpet industry has been forced to increase wages in order to maintain a skilled and knowledgeable labor force.

The last pressure has been of special concern to Georgia’s carpet industry. The annual salary of employees in Georgia’s carpet industry has risen considerably over the last few years as can be seen in Figure 2.4. The figure indicates that carpet employees earned just over 36,000 dollars, but that they also enjoyed a 21 percent increase in the annual compensation between 2001 and 2009 (United States Bureau of Labor Statistics, 2009b). This substantial rise in the average salary of a carpet employee demonstrates that Georgia’s carpet industry is concerned about their ability to hold onto high quality labor. Davidson describes why the industry has trouble holding onto labor, “located in small towns and rural areas, and not paying the wages of higher-skilled professional jobs, the mills typically have jobs open at any given time, executives and industry observers said” (Davidson, 2006). Although rising labor costs and the dominance of machines exist in the industry, labor is still extremely important to the success of Georgia’s carpet industry.

---

3 The index for unit labor costs increased from 81.7 to 137.3 between 2004 and 2008. However, unit labor costs for the ten year study period, 1998 to 2008, only increased 37.3 percent.
Georgia’s labor in the carpet industry is highly competitive relative to labor at the national scale. As Figure 1.7 shows, Georgia’s Value Added per Employee has been greater than the United States average in all years between 1987 and 2002.\(^4\) Georgia’s carpet industry increased their value added by 91 percent during this period while the national carpet industry value added per employee only increased by 77 percent (United States Census Bureau, 2007a). Moreover, if you include Georgia’s 2007 value-added data, Georgia’s value-added per employee increased 202 percent, a 58 percent increase between 2002 and 2007 alone. Tangent to this, Georgia’s carpet industry increased its value of shipments by 38 percent, from $6.9 billion to $9.5 billion (United States Census Bureau, 2007a). Thus, the 21 percent increase in labor costs coincided with a 38 percent increase in shipments and a 202 percent increase in

---

\(^4\) Value Added for the NAICS 31411 was not reported at the national level for 2007. Hence, the analysis only goes to 2002.
total value added per employee.\textsuperscript{5} Georgia’s carpet industry enjoys a significant competitive advantage in carpet production relative to the nation. The high productivity of Georgia’s carpet laborers is a significant driver of this competitive advantage.

**Figure 1.7: Value Added Per Employee**

![Graph showing value added per employee from 1987 to 2002](image)

*Source: United States Census Bureau*

**Implications for Georgia’s Carpet Industry:**

The adoption of sustainable practices among Georgia’s carpet industry is facilitated by two key industry attributes. The first attribute is the structure of Georgia’s carpet industry. Both the heavy consolidation that occurred in the 1980s and the reduction in the number of carpet establishments foster the industry’s efforts to become green. With relatively few actors and companies, coordinating the industry’s sustainability practices and standards is a much simplified task. The reduction in the number of carpet establishments also means that the firms

\textsuperscript{5} In terms of actual value added, Georgia’s carpet firms increased value added by 125 percent between 1987 and 2007 (Census, 2007). To put this into perspective, the overall textile industry (NAICS 314) only increased its value added by 60 percent over the same time period (Census, 2007).
within Georgia’s carpet industry don’t have to spread sustainability initiatives and education across many different plants. Moreover, the smaller number of larger production facilities helps to increase the financial motives for instituting sustainability initiatives. For example, the landfill methane capture facility in LaGrange, Georgia that powers Interface’s production facility may not have been economically viable had the company’s production processes been spread out across a large number of smaller establishments. The second attribute is the nature of the production process. Since mechanized labor does much of the production work, the carpet industry’s labor has a broader view of the whole production process. This broad view of the production process can improve the workers ability to identify sustainability problems and solutions in the production process. Line workers at Interface, Inc. have positively impacted the company’s sustainability goals by offering suggestions to improve the carpet production process (Anderson, 2009). But, these two attributes aren’t the only thing that promoted the diffusion of sustainability in the carpet industry. Indeed, Georgia’s carpet industry was able to rapidly diffuse sustainability throughout its industry because of the social networks that are embedded in the industry. But, before we can look at the social structure of the carpet industry and how it facilitates the diffusion of sustainability ideas, we must look at the literature on social network analysis to determine the implications that the social structure of Georgia’s carpet industry may have for the diffusion of sustainable ideas.
Literature Review:

In *Collective Invention*, Robert C. Allen chronicles a rather unique occurrence among iron and steel firms located in England’s Cleveland District. During the industrial revolution, industry competitors openly traded information on their plant designs. This free exchange of information helped increase the overall output of the entire industry. Competitors within the iron and steel industry only shared two simple pieces of information: the height of the plant’s blast furnace and its operating temperature (Allen, 1983). The information that the competitors shared was anything but novel. But, for an industry that lacked any research and development capacity, these pieces of information were vital in allowing firms to *experiment* with the design of iron and steel plants. The result of the experimentation was that the height of Cleveland’s furnaces grew by 30 or more feet and their blast temperatures increased by 800 degrees (Allen, 1983). The overall effect was a decrease in the amount of fuel used to manufacture pig iron (i.e. cost savings through increased efficiency).

Cleveland District’s collective knowledge was disseminated mainly through formal networks created by the industry’s plant engineers. Firms of Cleveland’s iron and steel industry allowed the engineers to not only freely reveal the plant’s height and furnace temperature, they also allowed the engineers to divulge the new plant design’s fuel use, a critical piece of information for competitors in the industry (Allen, 1983). The amount of fuel a newly designed plant uses acted as a signaling device to show other firms in the industry that the new design had a positive impact on the firm’s financial viability. With permission from their respective firms, the plant engineers published the plant design and its fuel consumption in trade journals and gave speeches on the plant design at trade conferences. These journals and reports
permitted the firms in Cleveland’s iron and steel industry to obtain the latest best practice on designing a plant, thereby reducing the uncertainty associated with using a new plant design. With each new plant, the overall knowledge of the industry increased as the implications for that new design were better understood. These changes occurred in conservative increments, not through a radical upheaval of England’s iron and steel industry. Collective invention is, thus, a path of incremental innovation (Allen, 1983; Nuvolari, 2004).

The presence of collective invention in a rational market is a bit of a mystery. The neoclassical economic argument against collective invention is that the firm with knowledge of the furnace height’s influence on fuel consumption would have a significant competitive advantage over other firms. This leads to the economically rational conclusion: the firm should not divulge proprietary knowledge in order to maximize its profits. Indeed, had the knowledge been kept as a trade secret the iron and steel firm could have produced pig iron at a far cheaper cost than its competitors, thereby raising profits and the potential to aggressively acquire competing firms. This argument does raise an important caveat of collective invention and other free revealing innovation practices: Collective invention is preferable to patented invention only under certain conditions.

Allen finds three conditions in which a firm might freely reveal information about its practices. Firms will freely reveal information about their practices when 1) the personal benefits to employees at the firms, such as career advancement, outweigh the costs of freely revealing information 2) firms find that keeping such information is prohibitively costly or 3) firms have a profit motive to freely reveal information (Allen, p. 17). The first two incentives are
fairly clear. The last condition is rather perplexing since it is generally assumed that the only method to profit from an invention is to have the right of exclusive use via a patent or copyright. In Allen’s case, the iron and steel industry of Cleveland was vertically integrated, firms within the industry owned or leased the supplying mines which produced fixed royalties for the firms. The increased efficiency of the aggregate industry increased the value of the ore deposits within those mines; hence, each firm was able to profit by the diffusion of innovation across the whole industry.

The Cleveland iron and steel industry is not the only example of collective invention turning profit for firms during the industrial revolution. Nuvolari writes of the collective innovation in the Cornish mining district: 6

*Adventurers were usually not tied to the fortunes of a single mine but often acquired shares of different mine ventures. Consequently, they tended to be more interested in the overall profitability of the district than in that of individual mines.*

(Nuvolari, p. 356)

The information being freely revealed by the “adventurers” were the designs of pumping engines which pumped water from the mine. The diffusion of efficient pumping engines across the whole industry increased the efficiency at which the miners could extract the mines’ valuable ore, thereby increasing the value of the mine to the “adventurers” (Nuvolari, 2004).

The collective innovations of Cleveland’s iron and steel industry and Cornish’s mine industry occurred despite the presence of England’s patent system. The innovations occurred

---

6 The Cornish mines are wholly separate from the mines owned by the Cleveland Iron and Steel Industry.
outside of the patent system because the economic incentives to freely reveal information outweighed the incentives for keeping them proprietary. Regardless, even if an innovating firm chooses not to reveal their innovation to the rest of their industry, the rival firms are likely to have knowledge of a competing firm’s innovation soon after the new product is invented. One study found that rival firms generally had knowledge of a competitor’s development decision within 12 to 18 months, while rival firms had knowledge of a competitor’s new product or process within 6 to 18 months (Mansfield, 1985). A lag of 6 to 18 months between a firm’s product innovation and the rival firm’s knowledge of the invention is a relatively short time for the inventor firm to profit from the invention. Applying for a patent would help the innovative firm lengthen the amount of time in which it can collect profits for its initial invention. Still, many firms may forgo applying for the patent since the patent’s underlying purpose is “to disseminate knowledge through disclosure” (Arundel, p. 623). The patent forces the inventor firm to reveal their innovation (and the technology behind it) in exchange for the sole rights to profit from the invention. The patent system produces a social benefit because it reduces the replication of inventions. Since firms are allowed to use the invention for a fee, competing firms don’t have to invest in R&D to create a novel innovation that another firm has already patented. Society benefits from the increase in economic efficiency because firms don’t have to “invent” the same invention multiple times. From the rival, non-patent holding firm’s perspective this might not be such a good deal since the firm must secure rights of use (usually in exchange for royalties) to the patent holding firm. The rival firm is likely to design around the original patent to forgo paying royalties to a competing firm (Arundel, 2001). Or, if firm is very large and the patent holding firm is much smaller, the large firm may be motivated to infringe
upon the patent because the smaller firm is likely not able to enter into a prolonged patent infringement suit (Arundel, 2001). Thus, small firms are more likely to keep their innovations a secret, free of a patent (Arundel, 2001).

Despite the fact that patents are ineffective at preventing rival non-inventing firms from profiting from another firm’s innovation, firms still use patents as a viable tool to protect their intellectual property. Innovating industries enjoyed a significant surge in patent rates after the Court of Appeals for the Federal Circuit (CAFC), a court responsible for strengthening the enforcement of firm’s intellectual property, was created (Arundel, 2001; Hall & Ziedonis, 2001). Hall and Ziedonis’s study of the semiconductor industry found that “patenting per million real R&D dollar in the semiconductor industry doubled between 1982 and 1992” as a result of the stricter enforcement of patent rights (Hall & Ziedonis, p. 102). Most importantly, the study also found that the proliferation of patents did not lead to a ‘tragedy of the anticommons’. Heller and Eisenbery describe the anticommons situation, “A resource is prone to underuse in a “tragedy of the anticommons” when multiple owners each have a right to exclude others from a scarce resource and no one has an effective privilege of use” (Heller & Eisenberg, p. 698). The every growing complexity of innovation is forcing firms to secure the rights of use from multiple patent holders in order to 1) create a new patentable idea or 2) manufacture a novel product. The complexity thereby creates the “tragedy of the anticommons” since firms will underuse the intellectual property because securing the rights to the patent is prohibitively costly. Let us take a hypothetical, real world example. Genes and the processes of coding genes are patentable “novel” ideas according to the U.S. Patent Office and the United States’ court system (Heller & Eisenberg, 1998). While the exact amount is not scientifically known, we, humans, are made up
of an estimated 20,000 to 25,000 genes (United States Department of Energy, 2008). Let us imagine that 1,000 firms held patents for 20 genes each. If a researcher needed access to say 100 genes to discover a cure for a rare genetic disorder, then the researcher would need the rights to 100 gene patents which would be held by 5 to 100 firms depending on the distribution of patents across the firms. Obtaining five rights of use for the gene patents is manageable; however, obtaining even 20 different rights of use from firms would be prohibitively costly. The time spent obtaining the rights of use from the firms may increase the research’s cost beyond the critical threshold in which the research is profitable. Crossing this threshold incentivizes the firm to forgo the innovation. Moreover, if a manufacturer would like to produce the researcher’s cure then they would need patents from the same 5 to 100 firms, a costly and uncertain proposition. While Hall and Ziedonis find that the problem of the anticommons was not present in the semiconductor industry, Heller and Eisenberg are fearful that it will arise in the biotechnology industry. Regardless of whether the “tragedy of anticommons” is industry specific or a strictly hypothetical problem, the patent proliferation occurring across industries will only exacerbate the complex process of innovation.

Innovation occurs in many different channels regardless of whether it is protected by a patent, kept as a trade secret, or is openly revealed to competing firms. Innovation is no longer an artifact of an individual firm’s R&D department. The adoption of sustainable business practices and creation of sustainable products in the carpet industry points to this fact. The firms within Georgia’s carpet industry engage in the type of collective invention which occurred in the industrial revolution described by Allen and Nuvolari. The carpet industry must rely on this type of social invention because carpet firms don’t have the R&D capacity to create radical
sustainability innovations. This can be seen both through the R&D budgets of carpet firms and through the fact that the innovations coming from the industry are incremental. In terms of spending, Interface Inc. spent just two percent (12.7 million dollars) of its operating budget on R&D (Interface Inc., 2009). Moreover, the innovations coming from the industry aren’t radical innovations, solely incremental. The largest indicator of this is the fact that the industry still uses Nylon 6, 6 as their main production material. The most radical sustainability impact the industry had would be to develop a more sustainable fiber that isn’t petroleum-based. As stated earlier, the industry simply doesn’t have enough capacity or R&D funding to cover the years it would take to develop such a product. Finally, collective invention can be seen in the carpet industry because the products and processes which the firms employ resemble one another. For instance, Tanus and Shaw Industries both use vegetable oil collected from local restaurants in their broilers (Carpet and Rug Institute, 2010). Further, Interface and Shaw both use on-site renewable energy facilities to power their plants and Milliken and Interface purchase sustainability credits to offset the CO2 they generate from production. These process innovations drive their major product innovation: green carpet. These incremental innovations are driven by the industry’s use of collective innovation. The carpet firms in Georgia mimic high technology, knowledge intensive firms. Unlike these knowledge intensive high-tech firms, Georgia’s carpet industry must rely on its tight-knit social network to drive the industry’s innovation. Thus, this industry can learn from the literature describing the effects of social network structure on innovation.
Literature Review Methodology:

Sustainable firms are similar to knowledge intensive firms because they must use innovation to reformulate existing products, re-think supply chains, and alter their business model in order to meet their sustainability goals (Anderson, 2009). Since sustainable firms have much in common with knowledge intensive firms, the wealth of existing research on the intersection between innovation systems and social network analysis can be tapped to guide this research study. This literature review identified key journals that study innovation and social network analysis. In a *Technovation* editorial article, Jonathan Linton identified 10 of the most predominant technology and innovation management journals that utilize social network analysis as seen in Table 2.1:

**Table 2.1: Technology Journal Rankings**

<table>
<thead>
<tr>
<th>Journal</th>
<th>Modified Impact Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Policy</td>
<td>2.7</td>
</tr>
<tr>
<td>Journal of Engineering and Technology Management</td>
<td>1.4</td>
</tr>
<tr>
<td>Technological Forecasting and Social Change</td>
<td>1.4</td>
</tr>
<tr>
<td>IEEE Transactions on Engineering Management</td>
<td>1.4</td>
</tr>
<tr>
<td>R&amp;D Management</td>
<td>1.3</td>
</tr>
<tr>
<td>Journal of Product Innovation Management</td>
<td>1.3</td>
</tr>
<tr>
<td>Technovation</td>
<td>1.1</td>
</tr>
<tr>
<td>Technology Analysis and Strategic Management</td>
<td>0.7</td>
</tr>
<tr>
<td>Research Technology Management</td>
<td>0.7</td>
</tr>
<tr>
<td>International Journal of Technology Management</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Source: (Linton, 2006)

Key planning and economic development journals were added to Linton's top ten list in order to obtain economic development planning perspectives on social networks and innovation systems. These journals included: *The Journal of the American Planning Association,*
Economic Development Quarterly, European Urban and Regional Studies, and the Journal of Economic Geography. The full list of journals from which articles were taken is shown in Table 2.2. The methodology yielded 200 articles that dealt with the subject of social network analysis and innovation. The aggregate journal article list was further refined by reading the abstracts of the resulted articles for relevance. This yielded 67 journal articles from a variety of journals only a handful of which appear in this literature review.

**Table 2.2: Summary List of Journals**

<table>
<thead>
<tr>
<th>Journal</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Policy</td>
<td></td>
</tr>
<tr>
<td>Journal of Engineering and Technology Management</td>
<td></td>
</tr>
<tr>
<td>Technological Forecasting and Social Change</td>
<td></td>
</tr>
<tr>
<td>IEEE Transactions on Engineering Management</td>
<td></td>
</tr>
<tr>
<td>R&amp;D Management</td>
<td></td>
</tr>
<tr>
<td>Journal of Product Innovation Management</td>
<td></td>
</tr>
<tr>
<td>Technovation</td>
<td></td>
</tr>
<tr>
<td>Technology Analysis and Strategic Management</td>
<td></td>
</tr>
<tr>
<td>Research Technology Management</td>
<td></td>
</tr>
<tr>
<td>International Journal of Technology Management</td>
<td></td>
</tr>
<tr>
<td>Journal of the American Planning Association</td>
<td></td>
</tr>
<tr>
<td>Economic Development Quarterly</td>
<td></td>
</tr>
<tr>
<td>European Urban and Regional Studies</td>
<td></td>
</tr>
<tr>
<td>Journal of Economic Geography</td>
<td></td>
</tr>
</tbody>
</table>

**Social Network Analysis and Innovation:**

At first glance, the sixty seven journal articles seem to be an incoherent jumble of various uses of social network analysis. The articles ranged from Moodysson and Ola Jonsson’s *Knowledge Collaboration and Proximity: the Spatial Organization of Biotech Innovation Projects* to Lindkvist’s *Mistrust and Lack of Market Innovation: A Case Study of Loss of Competitiveness*. 
in a Seafood Industry. Both articles differ on their theoretical foundations and application of social network analysis. Moodysson and Jonsson founded their research upon Alfred Marshall (1920) and Porter (1990) works on spatial proximity of businesses, agglomeration economies and industrial districts. For Moodysson and Jonsson, the social space of innovation is more an aspect of physical proximity. In other words, the geographical closeness of social network actors is vital to explaining how the social relationships between actors produce knowledge collaboration (Moodysson & Jonsson, 2007). The fact that the authors focus on physical, geographic space shouldn’t be surprising since their literature review focuses on a philosophical lineage which stresses the importance of physical proximity to knowledge spillovers and a firm’s overall economic performance. In contrast, Lindkvist’s article draws from the philosophical lineage that developed social network analysis: Sociology.

The sociological foundations for social network analysis began with Köhler who stressed, “the organized pattern through which thoughts and perceptions are structured” (Scott, p. 8). Sociologists that stemmed from the ‘gestalt’ tradition created social network analysis to provide insight into the structure of society’s thoughts and perceptions. From this lineage, Lindkvist draws from Putnam’s views on social capital. Lindkvist’s social network analysis is concerned with the relationships between actors, more specifically, the trust between actors (Lindkvist, 2010). Lindkvist’s focus isn’t on the geographic space in which the actors are located, but the social space in which the actors influence other actor’s decisions.

The contrast between these two theoretical perspectives indicates that social network analysis is not a theoretical ideology; social network analysis is a tool that has been transformed...
to fit the needs of a multitude of academic fields. Scott states this point succinctly, “Social network analysis is an orientation towards the social world that inheres in a particular set of methods” (Scott, p. 37). Social network analysis is a methodology, not a theoretical paradigm which holds one certain viewpoint over another. Since the authors of the sixty seven articles come from different fields, their social network analyses utilize their field’s theoretical foundation. Hence, the perceived jumble of conflicting theoretical foundations in which the authors attempt to explain their perspective. Despite the diversity of often conflicting viewpoints, there are a few common themes and concepts that are pertinent to the study of social networks.

Themes:

Complexity of Innovation:

The complex view of innovation is the first theme shared by the articles. The authors view innovation through the paradigm of technological network theory which, “stresses the importance of the sources of information that are external to the firm: clients, suppliers, consultants, government agencies, government laboratories, university research, etc” (Landry, Amara, & Lamari, p. 685). Innovation is not a simple act of a lone inventor who devises a new product by himself or herself. Nor is innovation the sole act of a single company. Innovation, to this body of social network analysis literature, is a complex process that involves a variety of actors who are interdependent. This collaborative view of innovation has much in common with the collective innovation as Allen postulated. The complexity of today’s innovations, the rapid flow of information (read: globalization), and the decreasing length of the product cycle
has only exacerbated the need to innovate in a social setting (Rycroft, 2007). The social network between innovative actors catalyzes innovation in a variety of ways. For instance, the innovator’s social network helps to reduce environmental uncertainty in the innovation process (Eisingerich, Bell, & Tracey, 2010). The social network gives the innovator access to up-to-date information on market conditions, competitor’s innovations, and new technological achievements discovered by research institutions. The ebb and flow of market conditions is particularly important for those innovations that have a targeted audience in mind. The needs of the targeted audience may have altered in some way during the R&D process. Contact within the target audience improves the information flow between the innovator and end-users, so that the innovator can make an economically valuable product to the end-user (Hippel, 2005).

This leads to the second theme: Innovation is a social process.

*Innovation as Social Act:*

As was alluded to earlier, various actors are involved in creating a successful innovation. The innovator requires knowledge from a wide swath of sources in order to generate a novel invention. While the articles agree on the overall social nature of innovation, the articles do disagree over the exact process behind the knowledge transfer between innovator and its supporting actors. On the one hand is the body of literature that explains the firm’s ability to gain new knowledge through the process of knowledge spillovers (Cantner & Graf, 2006; Casper, 2007; Gilding, 2008; Waters & Smith, 2008). This body of literature primarily uses the idea of economic clusters in order to describe that geographically proximate social networks exchange knowledge through spillover effects. On the other hand, are the articles which argue that knowledge is transferred through a more formal process, via direct knowledge transfers
(Midgley, Morrison, & Roberts, 1992; Rycroft, 2007; Sorenson, Rivkin, & Fleming, 2006; Waguespack & Birnir, 2005). These articles place emphasis on the type of knowledge being transferred, arguing that certain types of knowledge will not be transferred regardless of how strong the network. The importance of knowledge is not given equal weight by these two groups of scholars, leading to the final theme: The conflict over knowledge.

**Knowledge:**

The final theme is one of disagreement. Throughout the literature, particular groups of articles treat knowledge differently. The treatment of knowledge and its transferability across the innovation system can be divided into two camps: The cluster methodology and the diffusion methodology. The authors using social network analysis to analyze economic clusters are deeply rooted in economic and regional development philosophies. This body of research is based on the idea of knowledge spillovers that occur in Marshillian Industrial Districts. The geographical clustering of firms improves the diffusion of innovative ideas because firms within these districts are able to transfer knowledge through a common labor pool. In contrast, the research utilizing social network analysis to explain the diffusion of innovations across industry attempts to codify the knowledge being shared in order to make conclusions about the ability to transfer the knowledge across a social network based on an individual’s position in the network. This methodology is oriented towards formal knowledge transfers that occur between actors. Knowledge isn’t treated equal and is ranked in a variety of ways, but the basic idea is that more complex knowledge is difficult to transfer across the network irrespective of the structure of the network or an actor’s position in the network.
Concepts:

Clusters and Knowledge Spillovers:

Knowledge spillovers are one key concept identified by the cluster methodology literature. The literature indicates that a mobile labor force, connected by formal and informal social networks, spread innovative ideas between firms. Alfred Marshall’s vision of an industrial district describes this dynamic labor pool that transfers knowledge between firms. Markusen describes the Marshallian District’s labor market, “Individuals move from firm to firm, and owners as well as workers live in the same community, where they benefit from the fact that ‘the secrets of industry are in the air’” (Markusen, Lee, & DiGovanna, p. 29). As Markusen indicates, Marshallian Districts exhibit a highly mobile workforce that moves from firm to firm. Within the new firm the newly hired individual shares their previously acquired knowledge with the new firm of the old firm that hired them. This knowledge spillover can improve the innovativeness of the particular cluster simply by offering firms an informal method of sharing innovative processes, ideas or technical knowledge (Cantner & Graf, 2006). Social network analysis has been used to create a more thorough understanding of the social networks driving the knowledge spillovers.

These social network analyses either come directly from the field of sociology or use sociological theory to found their analysis. Granovetter’s Strength of Weak Ties offer a strong theoretical foundation for social network analyses. Granovetter’s study describes the networks used by individuals to obtain employment, the study finds that individuals primarily rely on weak, informal social relationships to find job opportunities (Granovetter, 1973). Granovetter found that information about job opportunities coming from distant friends or acquaintances
were much more valuable in terms of finding employment than information coming from family or close relatives. Steven Casper’s longitudinal study of San Diego’s biotechnology cluster expands upon Granovetter’s study by focusing in on the potential of social networks to establish a sustainable labor pool. Casper followed managers within the nascent cluster of the late 1970s to the height of San Diego’s biotechnology cluster in the early 2000s. Casper’s study shows that the San Diego biotechnology cluster was able to become sustainable because the social network “developed a shared labor market pool that helped consolidate and then expand a viable network backbone for the San Diego biotechnology industry” (Casper, p. 453). San Diego’s biotechnology cluster established a mobile labor force in which managers starting in one firm transferred to other firms across the industry cluster.

Another social network study coming out of the field of sociology is Brian Uzzi’s *The Sources and Consequences of Embeddedness for the Economic Performance of Organizations: The Network Effect* (1996). Uzzi defines a key term used in social network analysis: Embeddedness. Uzzi defines embeddedness, “ongoing social ties that shape actors’ expectations and opportunities in ways that differ from economic logic of market behavior” (Uzzi, p. 676). Uzzi argues that social networks defy market behavior because, “actors do not selfishly pursue immediate gains, but concentrate on cultivating long-term cooperative relationships that have both individual and collective level benefits for learning, risk-sharing, investment, and speeding products to market” (Uzzi, p. 693). Social networks offer a forum for actors to establish an environment of reciprocity, engendering cooperation between actors. This environment forms long-term cooperation between firms as well as permitting knowledge spillovers.
Together, these three authors allude to the importance of social networks to the creation of spillovers in the economic cluster. Social networks create knowledge spillovers by finding individuals’ employment, sustaining shared-labor pools, and reducing uncertainty which promotes acceptance of shared labor pools among firms within an economic cluster. Any social network analysis of economic activity, especially a study looking at the spread of ideas, should be mindful of knowledge spillovers. Knowledge spillovers are an informal way in which firms within a given cluster share knowledge between one another. These spillovers promote the overall health of the industry cluster.

**Knowledge Loop:**

Highly embedded, local social networks can enter into a knowledge loop in which the social network recycles a novel invention thereby creating only incremental improvements to the original invention (Lobo & Strumsky, 2008). Over time, as the cluster plays out the innovation, the novelty of the innovation fades along with its financial profits. This circular chain has been shown to lead to the decline of the cluster’s innovativeness thereby reducing the innovation output of the particular cluster (Cantner & Graf, 2006; Lobo & Strumsky, 2008). One method to prevent the cluster from entering the knowledge loop is to establish ties outside of the local social network: Gilding’s study of Melbourne’s biotechnology cluster stresses the importance of international ties to local innovation systems especially to dedicated biotechnology firms (DBFs), “Above all, Melbourne-base DBFs – like DBFs in other places from world hubs – form collaborations with more international partners than local and national partners combined. Moreover, their international collaborations are formed for specific ends,
to access expertise and resources unavailable locally” (Gilding, p. 1143). Despite the fact that Gilding finds international social networks are vital to Melbourne’s biotech cluster, the study cautions against the sole focus of international social relations since these relationships are difficult to maintain due to the high transaction costs. The tension between the importance of local networks and global networks pervades the literature. Global networks are seen by some authors to prevent knowledge loops from occurring in local social networks. In contrast, local networks transfer knowledge between complementary innovations which beget new innovations. Whittington et al. offer a solution to the argument, “Students of innovation would be well advised to consider multiple conceptions of location, because propinquity and centrality are intertwined, making the organizational orientations toward these different positions important factors in the equation of linking networks, geography, and outputs” (Whittington, Owen-Smith, & Powell, p. 115) The interplay between global and local social network connections is dynamic. Local innovation networks benefit from global connections because they prevent social networks from entrenching in anyone idea, production process, or product. Local networks must constantly reevaluate their innovation’s relevance in a global market place. Granted, a local social network with only global ties doesn’t provide any of the benefits that stem from local social networks. These benefits include the networks ability to find and exchange complementary technologies to discover novel innovations.

**Diffusion Speed:**

Finally, the concept of diffusion speed is important to the study of social networks. Not all ideas are equally transferable. Some ideas take a few moments to transfer successfully to
another actor, while others may take months or years to transfer between actors. This is to say that all ideas have transaction costs built into them. “Stickiness” is a term developed by Eric Von Hippel to describe the transaction costs transferring of innovative ideas between firm actors. Hippel defines stickiness as, “the incremental expenditure required to transfer [a] unit of information to a specified location in a form usable by a specified information seeker” (Hippel, p. 67). Stickiness is a measure of transaction costs between an innovator and an individual looking to replicate that innovation. When these costs are low then information is easily transferable. If transaction costs are high, then the information is highly difficult to transfer between individuals. The implication is that high levels of stickiness will prevent the innovation from permeating through the local social network while low levels of stickiness will facilitate the transfer of information across the innovation social network.

One attribute that induces a high transaction cost between the innovator and the innovation seeker is the complexity of the knowledge that is being transferred. Sorenson et al. define complexity as “the level of interdependence inherent in the subcomponents of a piece of knowledge” (Sorenson, et al., p. 995). Knowledge complexity mimics stickiness. Highly complex knowledge impedes knowledge transfer across the social network, while low levels of knowledge complexity are easily transferable across the social network. Sorenson et al. provide further insight into the relationship between the knowledge complexity and an actor’s location in the social network:

_all recipients, socially near and far, compete on equal footing when receiving and extending simple knowledge; incremental search suffices to reproduce simple_
knowledge, so guidance from a prior success has little value. Highly complex knowledge, on the other hand, equally resists diffusion to both classes of would-be recipients. Hence, at both extremes of complexity, the close recipient has no lasting advantage over the distant. In contrast, for knowledge whose ingredients display a moderate degree of interdependence, superior but imperfect access to the template translates into greater success in receiving and building on preexisting knowledge. The close recipient can complete its initially imperfect replica via local search, but local search alone cannot guide the distant recipient to an accurate replica.

(Sorenson, et al., p. 1009)

A social network is only valuable if a moderately complex idea is transferred across firms. In this one passage, Sorenson et al. finds that the individual’s position in the network facilitates information diffusion. Highly complex knowledge cannot be transferred to an individual in the social network regardless of how embedded the individual, whereas knowledge with low complexity is easily transferred across the network. Thus, individuals at the periphery are able to obtain the same information as the individuals at the core of the network are able to obtain. The study adds some insight into the study of knowledge flows because the authors’ study of the inter-relationship between knowledge complexity and the embeddedness of actors in a social network.

Both Hippel’s stickiness and Sorenson’s idea of knowledge complexity impact the speed of an innovative idea’s diffusion. While diffusion speed is not formally defined in the literature,
a rudimentary definition for diffusion speed is the amount of time it takes for an innovation to spread throughout the social network. The speed at which the knowledge is transferred across a social network has an influence on the ability of the network to absorb and retransmit the information. For instance, Rycroft finds that “There is no reason to suspect that even when produced, increased innovation speed is always a benefit to a network. It is more likely that faster innovation is variable and a mixed blessing, at times overwhelming the same networked organizations trying to produce it” (Rycroft, p. 575). Too rapid diffusion of an innovation can create a negative feedback that damages the network’s ability to adopt an innovation. Imagine, for instance, if your computer’s operating system underwent major structural changes every week, the rate of society’s ability to adopt technology would be adversely impacted by the too rapid technological change.

**Implications of the Literature Review:**

These three concepts are pertinent to the social network analysis of Georgia’s carpet industry. Firstly, the social network analysis will have to be cognizant of the occurrences of knowledge spillovers. Such spillover effects in the carpet industry may help to explain how the industry was able to rapidly diffuse sustainable practices amongst the industry and may help to explain why the sustainability initiatives at the major carpet firms look strikingly similar. Secondly, the social network analysis will have to pay attention to intra-regional ties, that is, actors not directly a part of Georgia’s carpet industry. If Georgia’s carpet industry does have outside connections then this may determine whether the industry is at risk for getting stuck into a knowledge loop. Finally, the social network analysis will have to be conscious of what
type of information the social network is actually transmitting across the network. For instance, the transfer of simple knowledge such as new production practices of using vegetable oil as fork lift hydraulic lubricant may be easier to transmit than technical designs of new tufting machines. With these three points in mind, we will now move to part three of this report: the social network analysis of Georgia’s carpet industry.

**Social Network Analysis of the Carpet Industry:**

As the old adage goes, “it’s not what you know, it’s who you know.” Social network analysis is an underutilized tool in the study of the local and regional economy. While the principles and techniques have been around since the 1960s, the study of the economy’s social space has taken a backseat to the study of the geographical and structural nature of firms within the local and regional economy. However, issues like global climate change and the increasing complexity of innovation are forcing all actors within the local economy to collaborate. Social networks are the grease in the collaborative economy’s wheels due to their ability to engender an environment of reciprocity and to provide a forum for knowledge exchange. As the literature on social networks and innovation reveals, these social networks afford actors within the network the opportunity to search for new ideas or identify potential barriers to research. Yet the usefulness of the social network analysis is not solely academic. Social network analysis has practical applications that are valuable to local economic development planners.
Social network analysis (SNA) provides valuable information to local economic
development planners, policymakers, and other individuals seeking to effectuate change
because SNA identifies:

- Key actors in the social network,
- Real and potential information flows, and
- Barriers to a fluid information flow

The identification of key actors is the first practical application of SNA because it identifies
embedded actors who can provide assistance in formulating and implementing local economic
policy. For instance, if a local economic development planner wishes to roll out a new
sustainability strategy then it would behoove the economic developer to incorporate local,
well-connected leaders in the for-profit and non-profit sectors. These well-connected leaders
may or may not be the organization’s CEO, usually a first choice when forming a stakeholder
group. Secondly, social network analysis affords the economic development planner the
opportunity to understand the flow of information in the regional economy. While not the
purpose of this study, SNA can be used to understand the relationships between patent
creators thereby providing valuable insight into how one firm is able to create a patent. Such an
analysis may find that the firm relies on public or not-for-profit research institutions to develop
its patents or, whether the firm seeks co-inventors in other knowledge specific industries. For
example, the economic development planner, through a social network analysis, may find Firm
A (a robotics company) relies on co-inventors from a photonics company (Firm B).
Understanding the complex innovation relationship between the two firms could prove grounds
for a targeted industry strategy aimed at attracting a photonics firm or sponsoring entrepreneurial activity in the photonics industry. Finally, SNA identifies key gaps in the flow of information between actors. This understanding plays a key role in addressing a break-down in communication between two different groups. For example, the local government may have a taskforce to promote sustainability in the local economy, whilst a group of businesses have a separate sustainability taskforce to address sustainability within the industry, and yet a third sustainability organization composed of concerned citizens may also be operating in the area. A social network analysis would allow the economic development planner to identify the social overlaps of all three groups and potentials for improving the cohesion and collaboration of all three different taskforces to promote sustainability objectives.

**Methodology:**

The social network analysis conducted for this research began by interviewing a deeply embedded scholar of carpet sustainability. The interviewee identified three organizations that were central to the diffusion of sustainability within the carpet industry. The organizations that were identified were the Carpet America Recovery Effort (CARE), the Carpet and Rug Institute’s Sustainability Issues Management Team (SIMT), and the National Sanitation Foundation’s 140 Standard Joint Committee (NSF-140). After these organizations were identified, board membership data was directly gathered from the Carpet America Recovery Effort and the National Sanitation Foundation. Unfortunately, gathering membership data on SIMT proved difficult to obtain. As a replacement, independently gathered information on the list of

---

7 The National Sanitation Foundation is a not-for-profit group that creates standards for food, water and consumer products. In the case of the Carpet Industry, the National Sanitation Foundation was the facilitator in developing the green carpet standard for the industry.
presenters at CARE’s annual conference was collected. Admittedly, this data is not the ideal replacement for SIMT membership because CARE’s annual conference included many individuals outside of the carpet industry’s embedded social network. The social network of CARE’s annual conference had the fewest connections to the other two organizations. As is probably the case, using SIMT membership would have been well-connected to the other two organizations, especially since SIMT spearheaded the creation of the NSF-140 Standards (Mehta, 2010). But, the annual conference data does give insight into the mechanism in which the carpet industry’s social network gathers information outside of itself.

Once the data was gathered, it was compiled into an excel spreadsheet to create a list of actors who participated in the two boards and the annual conference. This list of actors included individuals who were either: a 2010 board member of CARE, a 2010 member of the NSF-140 Joint Committee, or a presenter at CARE’s 2010 annual conference. Once this list was compiled, the list of names was placed into NodeXL. NodeXL is a, “free, open-source template for Excel 2007 and 2010 that lets you enter a network edge list, click a button, and see the network graph, all in the Excel window” (Hansen & Shneiderman, 2009). In other words, NodeXL is a social network analysis program that utilizes a Microsoft Excel Spreadsheet to develop a social network analysis graph. The program also conducts basic social network analyses like centrality, betweenness centrality, and density. NodeXL uses two columns (vertex 1 and vertex 2). The first column includes the actor’s name and the second column includes the name of the individual to which the actor is related. After each actor was matched up with every other actor in the social network, all duplicate edges (edges are the connections between the individual actors) were merged to create a more coherent, and composed social network
Finally, the relationships that occur within the firm were accounted for by assuming that the actors who worked at the same firm knew each other.

**Results:**

The social network analysis of the carpet industry revealed that the industry’s social network is divided into three primary cliques. Cliques are a subset social network of the whole social network itself, essentially a social network within a social network. Of course, this finding shouldn’t be surprising since data was gathered by utilizing membership data from three different organizations. The three separate nodes represent the three different organizational membership data. The clique to the top right of Figure 3.1 is the board of the NSF-140 Standards, the cluster of actors at the left side of the graph represents the board of CARE and the bottom of the graph represents the presenters at CARE’s annual conference. Figure 3.2 shows the actors who act as social bridges between the three different network cliques. The cluster of seven red dots towards the upper center of Figure 3.2 are individuals who serve on both the NSF-140 Joint Committee and CARE’s board. Interestingly, only 3 of the 7 individuals are representatives of carpet manufacturers, while 2 are

---

8 Merging the duplicate edges should have no influence on the measures of centrality, betweenness centrality, or density.

9 The technical definition of a clique is “a sub-set of points in which every possible pair of points is directly connected by a line and the clique is not contained in any other clique” (Scott, p. 114).
representatives of regulatory agencies, and the remaining 2 individuals represent suppliers and customers. These individuals have a high betweenness centrality of 35.62. Scott defines betweenness as a measure of “the extent to which a particular point lies ‘between’ the various other points in the graph” (Scott, p. 86). A high measure of betweenness centrality indicates that an actor acts as an intermediary between other actors or groups of actors while a betweenness centrality of 0 would indicate that the actor plays no intermediary role between actors or groups of actors. The three red dots at the bottom left of the graph represent individuals connected to both the CARE board and presented at a CARE annual conference. These individuals have a higher betweenness centrality of 61.7 indicating that these bridging actors are more connected than the NSF/CARE bridge actors. These individuals are more connected because they have direct connections to CARE and its annual conference presenters, as well as the seven actors in the NSF/CARE Bridge. Thus, the three actors have an indirect connection to the NSF-140 Joint Membership while the NSF/CARE actors have a more indirect route to the annual conference presenters. Finally, the most connected individual has a betweenness centrality of 344.37. This individual is located at the center of the graph and enjoys connections to all actors within the graph. Moreover, this lone actor has connections to all three institutions within carpet’s social sustainability network.
Other important connections in the social network include the connections that occur between actors within the same firm. Actors who know people within the same firm are able to bypass the network bridges composed of social actors. That is to say, these actors can directly coordinate and exchange the knowledge they gain in their own network clique with actors of their firm in a different social network clique. Figure 3.3 highlights these important inter-firm social relationships and how these relationships work to bypass the three central social network bridges. As figure 3.3 shows, these social network bridges directly connect individuals from the NSF-140 clique and the CARE clique. Moreover, two of the inter-firm social relationships connect individuals from annual conference clique to the bridging actors between CARE’s board clique and the NSF-140 clique.

This is an important connection because the CARE annual conference clique is the most segregated from the rest of the social network. Firms who allow different employees to serve on the different boards (CARE and NSF-140) are able to bypass the central bridging actors between the NSF-140 Joint Committee and the Carpet America Recovery Effort board. While this allows the firms to circumvent the bridging actors and coordinate its strategy on both boards, it may be more advantageous for the firm to actually have an

---

10 The CARE annual conference group is segregated from the rest of the network because of the fact that it has only 4 social actors who tie it into the network, rather than the 7 actors who tie the NSF-140 clique and the CARE clique together.
individual who acts as a network bridge. It is more advantageous because the network bridge can build relationships between both organizations and coordinate the efforts of both committees rather than simply executing a much narrower firm strategy.

Overall, the carpet industry’s social network is well-connected. The density of the social network is measured at .475. Network density is the measure of the connectedness between all actors in a social network. A network density of one would indicate that all members of the social network are connected to all other members of the social network. In contrast, a network density of zero would indicate that none of the actors within a social network are connected to any of the other actors within a social network, leading to a valid conclusion that a social network between these hypothetical actors doesn’t exist. A measure of .475 indicates that actors within carpet’s social network are connected to around half of the total actors within the network. The existence of the bridging actors signifies that carpet’s social network depends on 11 important actors who provide connections between carpet’s three sustainability institutions: Carpet America Recovery Effort, National Science Foundation’s 140 Standards Joint-Committee, and CARE’s annual conference presenters.

**Limitations of the Data:**

The methodology as well as the data has some limitations that prevent this study from mapping the carpet industry’s whole social network. The first limitation is the fact that the board-membership of the Sustainability Issues Management Team (SIMT) was left out of the study. The presence of the SIMT data would have certainly altered all of the measures used to analyze the carpet industry’s social network such as the actor’s betweenness centrality, the
networks overall density, and different social bridges between the carpet industry’s three major sustainability organizations. Another limitation is more systematic. The use of board membership data limits the view of the industry’s total social network. Board membership data narrows the carpet industry’s total social network to 54 actors, of an industry that employs 37,000 people. The industry’s social network transcends the board membership and annual conference data used in the study. Broadening the view of the carpet industry’s social network would pick up on important connections to institutions and organizations outside of itself.

Another major limitation of the data is its lack of nuance. In order to achieve a nuanced view of the carpet industries social network, a survey of the actors within the network would have to be conducted. This survey could reveal the type of information being exchanged in the social network, the decisions that occur within the boards themselves and the strategies the different actors use to influence the boards decisions. Unfortunately, this research study was unable to conduct a survey due to time and cost constraints. Finally, due to the nature of the data obtained, the analysis of knowledge spillovers couldn’t be performed since the data only provided a one-year snapshot of the industry. Despite these limitations, the social network analysis did find that the National Sanitation Foundation, the Carpet America Recovery Effort and CARE’s annual conference did connect individuals within the carpet industry. These institutional bridges connect the industry and provide a forum in which these individuals can address issues of sustainability.
Institutional Bridges:

Non-profit institutions in Georgia’s carpet industry act as social bridges; much like the individual actors bridged the different cliques in carpet’s social network. Social bridges are people or institutions that connect two disparate individuals together in a social network. Three non-profit institutions in particular bridge the actors in the carpet industry around issues of sustainability. Figure 3.1 visualizes these three bridging institutions. The Carpet America Recovery Effort (CARE), the National Sanitation Foundation (NSF), and the Carpet and Rug Institute’s Sustainability Issues Management Team bring carpet company leaders, government agency representatives, and end-users together to set “green” carpet label standards, carpet recycling initiatives, and coordinate the growing demand for sustainable products caused by Leadership in Energy and Environmental Design (LEED). The main coordinating institution is the Carpet and Rug Institute’s (CRI) Sustainability Issues Management Team (SIMT). In this respect, figure 3.4 is somewhat misleading as the connections between these bridging institutions are far from equal. For instance, SIMT was directly involved in harmonizing the nascent carpet sustainability standards being generated by different organizations. SIMT’s effort resulted in the industry-wide National Science Foundation/American National Standards Institute’s 140 standards (NSF-140) which established a, “system with varying levels of certification to define sustainable carpet” (National Sanitation Foundation, p. 1). Both CARE and NSF are loosely connected to one another due to the different goals of each organization; however, the actors who participate in these organizations directly connect them together as was found in the preceding social network analysis. The connections between these organizations are solely
caused by the same industry actors sitting on both boards. While all three organizations promote sustainability in the industry, each has a different approach.

**Figure 3.4: The Carpet Sustainability Triangle**

![The Carpet Sustainability Triangle](image)

Source: Image Created By Author

**Carpet America Recovery Effort:**

The Carpet America Recovery Effort was founded in January 2002 in an effort to, “facilitate market-driven solutions to divert post-consumer carpet from landfills” (Carpet American Recovery Effort, p. 1). CARE’s creation was an attempt to obviate any potential Environmental Protection Agency (EPA) regulation of carpet. The agency identified carpet as a key contributor to greenhouse gas emissions through its Waste Reduction Model (WARM) and concluded that carpet would be a prime target for landfill diversion regulation. The model is a tool that “helps solid waste planners and organizations track and voluntarily report greenhouse gas (GHG) emissions reductions from several different waste management practices” (United States Environmental Protection Agency, 2010). WARM does this by creating a life cycle analysis of products being disposed of in landfills. Through the WARM study, the EPA found that only
3.6 percent of the 2.6 million tons of disposed carpet were recycled (United States Environmental Protection Agency, 2003). Moreover, the difficulties of handling the material in landfills pushed the EPA to target carpet. The result of EPA’s targeting efforts was a two year long discussion with the industry culminating in the creation of Carpet American Recovery Effort which has a mission to, “divert 40 percent of end-of-life carpet from landfill disposal by 2012 (United States Environmental Protection Agency, p. 1).

The EPA’s regulatory interest in carpet led to the creation of a coalition of carpet manufacturers, the Carpet and Rug Institute, state and federal governmental organizations focused on carpet recycling. This coalition has remained relatively intact over CARE’s eight year history. CARE’s board has representation from non-profit organizations like the American Chemistry Society’s Green Chemistry Institute, state government organizations, carpet recycling entrepreneurs, and representatives from the carpet industry. CARE’s board membership was initially dominated by industry representatives. Seventy three percent of CARE’s board was composed of industry representatives in 2002. As of 2010, the firms within the carpet industry and the major representative of the carpet industry (CRI) compose half of CARE’s board (Carpet American Recovery Effort, 2011b). Representation of carpet recycling entrepreneurs increased markedly during this time period, from less than 10 percent of the board in 2002, to 22 percent of the board in 2008 (Carpet American Recovery Effort, 2011b).

The rise of entrepreneurial representation is indicative of CARE’s value to the carpet sustainability social network. CARE brings together not only industry leaders but varying outside entrepreneurs who either recycle carpet or have business that use recycled carpet as a raw
material. CARE brings together these two groups in two respects: 1) the board connects individuals at different firms together, and 2) CARE’s annual conferences connect individuals from different firms, organizations, and/or interests. The board directly brings together industry actors from different industry backgrounds and interests to address the lack of diversion and recycling infrastructure in the industry. CARE’s second role as a network bridge occurs at the organization’s annual conferences. CARE’s annual conferences provide a forum to establish global ties, bringing fresh ideas into the industry. Researchers, carpet recycling non-profits, industry and government representatives give presentations at the conference on a variety of topics. Some are wholly technical like Sighn and Vorrey’s presentation on *Structural Composites from Waste Carpet* while other presentations are aimed at conveying straightforward messages of product stewardship like Smith’s *The 10 Obstacles to a Successful Stewardship Program*. CARE’s annual conference creates an opportunity for the industry to gain ideas from outside of the industry, an important method of preventing a knowledge loop. Moreover, the information presented is at a low level of knowledge complexity which may assist the speedy diffusion of new, innovative ideas since the information is easily transferable between actors.

**NSF/ANSI-140 Standard:**

Unlike CARE, the NSF-140 was developed without any pressure from government regulators. The NSF-140 standard was a Carpet and Rug Institute initiative that was a “response to a small number of companies in the industry working independently with an unrelated organization to draft a standard” (Mehta, 2010). The developing green standard for carpet was advantageous to these companies because it would prevent green washing from occurring in
the sustainable carpet market (Realff, 2011). At the time, some organizations like the California Department of General Services were developing stringent standards to define carpet sustainability. However, CRI, through its Sustainability Issues Management Team, “felt strongly that enrolling many companies in a well designed sustainability effort, while still providing a high bar for the best performers, would be the most effective way to move the whole industry towards sustainability” (Mehta, 2010). CRI championed an inclusive standard to obtain buy-in from the major carpet manufacturers rather than an exclusive standard in which only a few firms could meet.

The composition of the NSF-140 Joint Committee is the culmination of STIM’s efforts to obtain an inclusive standard. This principle of inclusion was not limited to carpet manufacturers. The joint committee is composed of carpet users (38 percent), public health or regulatory agencies (27 percent), and industry representatives (35 percent). The large representation of carpet users was especially important since the standards were being developed in response to the growing needs of architects and designers to meet LEED certification requirements. In fact, the NSF-140 standards follow a point system that is strikingly similar to the LEED point system. This similarity was a conscious choice as the Joint Committee wanted to prevent carpet users (architects and designers) from “having to learn a whole new lexicon” (Mehta, 2010). Instead, carpet users could use their knowledge of the LEED point structure and apply it to the NSF-140 standard which divides the product into silver, gold and platinum.
The bridging capability of the NSF-140 standard is tied to the Joint Committee and the stakeholder groups. The Joint Committee connects members of the carpet industry together through developing a common agreed upon green standard for the entire industry. This creates an environment conducive to cultivating long-term cooperative relationships, the kind of which have, “both individual and collective level benefits for learning, risk-sharing, investment, and speeding products to market” (Uzzi, p. 693). Also, the large contingent of carpet users legitimizes the standard by ensuring that the green standard developed by the Joint Committee matches market demand. The NSF-140 Joint Committee supplements the CARE network bridge by bringing together a different array of individuals around the creation of sustainable carpet. The issues covered in the NSF-140 standard involve individuals who deal with carpet at the middle of its life cycle (when it is purchased and installed in buildings) rather than carpet at the end of the life cycle (when it enters the waste stream). Ultimately, the committee is aimed at creating an environment of reciprocity. Through the committee, industry leaders, consumers, and regulators are able to develop a relationship of mutual trust all the while trying to represent their firm’s special interest in influencing the sustainability standard.

**Sustainability Issues Management Team:**

The Sustainability Issues Management Team (SIMT) is a small subset of the much larger Carpet and Rug Institute (CRI). CRI is, “a nonprofit trade association representing the manufacturers of more than 95 percent of all carpet made in the United States, as well as their suppliers and service providers” (Carpet and Rug Institute, 2011). The organization also coordinates with other segments of the industry to promote the use of carpet and proclaim the
benefits of tufted carpet. The coordinating efforts of the institute are handled by a professional staff while the institute’s policy is set by the corporate executive officers of the member organizations of CRI. Member organizations include all of the major firms in carpet manufacturing: Beaulieu Group LLC; Interface, Inc; J & J Industries; Milliken Carpet; Mohawk Industries, Inc.; and Shaw Industries, Inc. CRI itself plays an integral role in establishing a cooperative environment in the carpet industry. Of course, this cooperative environment doesn’t always include issues of sustainability. In order to ensure that sustainable issues became a priority for the industry, the Carpet and Rug Institute established the Sustainability Issues Management Team.

The Sustainability Issues Management Team came into existence to address the sustainability movement begun by the United States Green Building Council’s LEED program and to develop a standard for sustainable carpet (Mehta, 2010). As noted earlier, SIMT’s role in the latter issue was important for preventing a wide array of discordant standards from being developed by other firms. SIMT’s work in this arena spawned the NSF-140 standard, a singular green product standard for the entire carpet industry. SIMT’s role as a network bridge is specifically to be the first point of contact for industry leaders to address broad sustainability issues in the industry. In this respect, SIMT’s is much more flexible than organizations such as CARE and NSF-140 simply due to the fact that SIMT’s purpose is broad in scope. The team is not solely dedicated to one singular task like increasing carpet recycling or creating an industry-wide green standard. The team acts more of a facilitator as was seen in the organization’s role in founding the NSF-140 standards. Unlike both CARE and NSF-140, the SIMT is not as inclusive
as the other two organizations. One cannot separate the fact that SIMT is a subset of an organization (CRI) which is solely dedicated to representing the carpet industry’s interests.

**Recommendations:**

It is a challenging task to offer recommendations for an industry that has approached environmental sustainability in what can only be defined as forward thinking and holistic. The industry’s social network and the three industry institutions and the eleven actors that bridge the network were certainly responsible for the rapid, holistic address of the industry’s sustainability issues. But, the industry does face key long-term and short-term challenges to its sustainability efforts. The most pressing short term challenge is diverting carpet from landfills. On September 30th, 2010, the governor of California signed Assembly Bill 2398 into law. The law requires that carpet manufacturers submit a carpet stewardship plan to California’s Department of Resources, Recycling, and Recovery by September 30th, 2011. The bill also assesses a $0.05 per square yard tax on carpet sold by the manufacturer in the state between July 1st, 2011 and January 1st, 2013. The proceeds of which will go to fund the implementation of the stewardship plans but must “achieve measurable improvements in the landfill diversion and recycling of postconsumer carpet” (Legislative Counsel's Digest, p. 2). A possible explanation for why the state of California enacted the legislation lies in CARE’s annual report. Figure 4.1 compares the actual amount of carpet diverted from landfills with the targets set forth by the original 2002 Memorandum of Understanding (MOU). As the figure shows, the industry diverted only 331 million pounds of the 1.2 billion pound MOU target goal in 2009 (Carpet American Recovery Effort, 2010). The industry missed the mark by nearly a billion
pounds. The state of California took a preemptive measure to foster the growth of carpet recycling infrastructure in the state through legislating a stewardship plan and providing a financing mechanism (the $0.05 per square yard of carpet tax). The passage of AB 2398 indicates that a proactive approach to sustainability does not eliminate regulatory risk. However, the industry’s dense social network along with the three institutions that coordinate its efforts improves the manufacturer’s ability to address and cope with state regulations.

**Figure 4.1: Volume of Diverted Carpet:**

![Volume of Diverted Carpet](image)

*Source: Carpet America Recovery Effort Annual Report 2009*

The industry also faces sustainability challenges in the long-term. The most daunting of which is finding an environmentally friendly raw material, a material that can replace the wholly unsustainable synthetic fibers such as Nylon 6,6 and Polypropylene. The industry lacks the R&D resources necessary to pursue the development of a sustainable fiber that performs at the same level as the popular synthetic fibers (Realff, 2011). Since the carpet manufacturers lack
the capacity to develop the fiber, the next viable candidate to pursue the research and development are the fiber suppliers themselves. However, the incentives behind developing such a fiber are relatively weak for the synthetic fiber suppliers. The oligopoly of the fiber producers creates a financial disincentive to invest in an environmentally friendly fiber, especially because carpet manufacturers have no other viable alternative. The choice for the carpet industry is use the synthetic fibers that the suppliers sell or not manufacture carpet. Until this fiber issue is addressed, the industry will continue to make incremental, albeit important, sustainable innovations in carpet products.

The following recommendations attempt to address both short and long term issues of sustainability in the carpet industry. While the bulk of the research paper covered the social networks within the carpet industry, the connectedness of the industry and its ability to organize and collaborate is not an exigent issue. The recommendations occur in three categories: Innovation, local government support for carpet recycling, and a state level by-product synergy strategy. These recommendations hope to improve upon the already strong social cohesiveness of the carpet industry and its efforts in sustainability.

**Recommendation 1: The Dalton Green Carpet Institute**

As Robert C. Allen pointed out in 1983, industries can create external R&D capacity that benefits the firm but occurs outside of the firm’s boundaries. Today, this is usually described as “open” innovation. Open innovation allows firms to spread the financial costs and risks of developing new products and processes across the whole industry. An open innovation
approach to industry wide research and development is ideal for industries with limited innovation capacity. Furthermore, Allen and, later, Nuvolari both alluded that open innovation ideally occurs in industrial districts. These districts are ideal for open innovation policy because there is an established level of trust between actors within the different firms allowing them to sacrifice short-term gains for the long term health of the industry. Georgia’s carpet industry meets both conditions. The industry has limited innovation capacity in terms of sustainability. The industry’s ability to develop alternative fibers is severely restricted, especially because the industry’s R&D departments must constantly create new products that meet changing consumer tastes and new regulatory requirements for carpet products (such as new LEED carpet guidelines). The industry is also an industrial district, co-located in the city of Dalton with a mature development of trust between carpet producers.

In order to pursue an open innovation policy, where the industry’s’ collective knowledge is utilized to create long term innovations in sustainability, the industry should create the Dalton Green Carpet Institute. The institute could either be housed under the umbrella of the Carpet and Rug Institute or become an independent organization with heavy stakeholder buy-in from carpet manufacturers. Initially, the Dalton Green Carpet Institute (DGCI) will be a network bridging institution for the industry’s engineers, plant operators, and carpet researchers engaged in the research of sustainable carpet. This type of social network bridge is lacking in the industry’s current three network bridging institutions. DGCI will hold monthly meetings and an annual conference during which the participants will give technical reports on ideas related to sustainable fibers and other aspects of the industry’s sustainability efforts. These early

---

11 Carpet researchers include university researchers as well as researchers in the industry. The term researcher is meant to be inclusive.
meetings will create a collaborative learning environment in which engineers, plant operators, and carpet researchers can tackle the most technically challenging sustainability issues for the carpet industry: sustainable fiber production and the integration of the fiber into the industry’s production processes. These early meetings and conferences should, at a later date, turn into a permanent staff engaged in research for sustainability in the carpet industry, innovations which ensure the longevity of the industry.

The DGCI will at first require little upfront financial investment although the DGCI will require a significant amount of investment in time and trust. In terms of trust, the DGCI will require that the industry coordinate meetings and allow their operations staff to prepare for presentations and attend the meetings. In regards to trust, the various manufacturers in the carpet industry will need to trust that the firm’s participants at the meeting will not give away product innovations being specifically developed for the firm. The participants should only share technical information in regards to issues pertinent to the long term sustainability goals of the industry. The industry should also develop a sustainability patent pool to ensure the needed level of trust between actors. This patent pool would ensure that innovations in sustainability are accessible by all firms within the industry. A patent pool is “an agreement between two or more patent owners to license one or more of their patents to one another or third parties” (United States Patent and Trademark Office, p. 4). The DGCI’s sustainability patent pool would allow carpet manufacturers to cross-license patents to each other, allowing the whole industry to benefit from innovations created through the DGCI’s meetings. Moreover, a fee could be levied through the cross licensing agreements which could be used to finance a permanent DGCI.
The goal of the DGCI is to connect the carpet industry’s technical staff in a similar way in which the industry’s top level managers are currently connected. By connecting these technical experts, the industry can increase its R&D capacity through open innovation. The purpose of the industry’s open innovation strategy would be to develop solutions to the carpet industry’s long-term sustainability research dilemmas and allow firms within the industry to externalize cost and risk associated with long-term research and development projects. The creation of a patent pool for carpet sustainability innovations is integral to the DGCI. Such patent pools will create trust between participating firms while allowing firms to utilize innovations to increase their overall environmental sustainability.

**Recommendation 2: Local Government Support of Carpet Recycling**

Local governments in Georgia would do well to learn from California’s example. California’s example isn’t solely related to its forward-thinking tax on carpet. While this tax would offer a steady stream of financing for the promotion of carpet recycling, California could certainly do more to enhance the tax’s effect. The law states that the levy of $0.05 per square yard of carpet sold will be given to CARE or carpet manufacturers to fund their product stewardship plans. By giving back these proceeds to either organization, the state of California is missing out on an opportunity to tie this investment to broader goals such as increasing social equity, preserving industrial land, or co-locating recycling facilities to create economies of scale for California’s recycling industry. California’s tax will raise $5 million dollars a year (provided the industry sells 100 million square yards of carpet) which “may be used by the recyclers to invest in new, innovative technologies, new product development or market introductions that
will further the achievement of the goals set out in AB 2398” (Carpet American Recovery Effort, 2011a, p. 1). In order to further promote carpet recycling, local governments could improve the regulatory environment for these facilities by reviewing zoning codes, preserving land for industrial recycling use, or providing one-stop shop facilities that will reduce the time it takes for recyclers to receive the necessary local, state and federal government permits to operate a recycling facility. As California’s example demonstrates, there are relatively low-cost solutions to promoting carpet recycling within the local economy.

It is questionable whether emulating California’s tax on carpet would be the proper policy response to enhance Georgia’s carpet recycling efforts. Currently, Georgia is home to 12 carpet recyclers, of which 5 facilities are owned by the major carpet manufacturers (Carpet American Recovery Effort, 2008b). These major carpet manufacturers are able to invest in both the technology and infrastructure necessary to develop sustainable carpet recycling processes since the recycled material can be used in the production of new carpet thereby lowering the cost of goods sold for the producers. Thus, levying a tax on carpet sold in Georgia has the potential to negatively impact the recycling efforts within the state because the tax would only be taking away revenue from the major carpet recyclers in the state, the carpet manufacturers. However, this is not to say that local governments in Georgia or Georgia itself should sit idly by while states such as California position themselves as leaders in carpet recycling. Furthermore, local governments should learn from California’s example by tying in strategies promoting carpet recycling within the state with broader goals of social equity, preserving industrial land, and creating co-located recycling facilities to develop economies of scale for waste-to-profit businesses.
The city of Atlanta is particularly well-suited to develop carpet recycling businesses in its local economy. The city acts as a transportation hub for the southeast and is well-connected to rail infrastructure. Shipping the carpet by rail would help to limit the environmental impact of shipping the bulky, heavy carpet into Georgia from the region. Furthermore, it would allow carpet to be shipped in bulk quantities to local carpet recyclers in the city. In order to promote carpet recycling facilities and the business that may spawn from them, Atlanta should both develop a zoning code specific for waste-to-profit type business (such as carpet recyclers) and zone underperforming residential land or commercial land near industrial land for this new zoning category. A prime target for such a zoning category would be the now derelict Bankhead Courts property owned by the Atlanta Housing Authority. Bankhead Courts is divided by Donald Lee Hollowell Parkway in the west-side of Neighborhood Planning Unit G as seen in Figure 4.2. The site is particularly well-suited for such a facility because of its proximity to I-285 and the Tilford rail yard just to the north. Locating such a facility at the site is in agreement with the neighborhood’s master plan. Along with the new zoning code, the Atlanta Development Authority could work with local entrepreneurs within the neighborhood and the Carpet America Recovery Effort in order to development a carpet recycling facility at this location. The facility would be a cooperatively owned facility that provides the neighborhood residents with access to training and employment in the recycling industry. The recycling activity in the neighborhood may also foster entrepreneurs to use the recycled material in new and

12 As a side note, developing this partnership between CARE and the ADA would allow the city to tap into the already strong social network within the carpet industry. The partnership would act as a network bridge, allowing Atlanta to tap into new ideas for developing a sustainable economy in the city of Atlanta.
innovative ways. These entrepreneurs would have sufficient space to locate their businesses in the Atlanta Industrial Park.

Figure 4.2: Map of the Former Bankhead Courts Property

Another low-cost policy that local governments could implement would be to develop one-stop shop capabilities for recycling businesses. This one-stop shop would act as a clearing house for recyclers by providing recyclers with the necessary building permits, zoning changes or variances, and other documents required by local and state laws. This one-stop shop would
reduce the time it takes for an entrepreneur to open a carpet recycling business, possibly lowering the start-up costs for the entrepreneur.

**Recommendation 3: State of Georgia Support for By-Product Synergy**

Finally, the state of Georgia should create a by-product synergy network within Georgia. A by-product synergy network is a network in which “companies work together to match unwanted by-products as resources for new products and processes” (Mid-America Regional Council, 2011). In other words, a by-product synergy network links one company’s waste to another company’s raw material. For example, the Chaparral Steel Company sold its steel slag to Texas Industries (a cement manufacturer) which used it as a raw material in their production of cement (Bridging the Gap, 2011). While this example is relatively straight-forward, by-product synergy networks can become a complex, inter-related network as demonstrated in Figure 4.3. Such a synergy network increases sustainability across firms within the network because it reduces the raw material use alone. Furthermore, the network diverts the wastes of the manufacturer from landfills, reducing the environmental burden of production.
Figure 4.3: A Complex Example of a By-Product Synergy System

Source: The Kalundborg Centre for Industrial Symbiosis

Luckily, Georgia already has the organizational and technical infrastructure in place to create such a network. The Sustainability Division of the Georgia Department of Natural Resources provides “free, non-regulatory and confidential technical assistance in the areas of pollution prevention, resource conservation, waste reduction, by-product reuse, and recycling” (Georgia Department of Natural Resources Sustainability Division, 2011). The Sustainably Division also runs the Georgia Industrial Materials Exchange program which offers manufacturers a web-interface which allows them to list their industrial wastes along with the amount, production frequency, and price. In order to support the Sustainability Division and the Georgia Industrial Materials Exchange program the state of Georgia could create a by-product synergy taskforce which would include representatives of the Sustainability Division, the Environmental Protection Agency, leaders in Georgia’s carpet manufacturing industry and manufacturers from all parts of Georgia. The taskforce would identify ways to increase the use of the Georgia Industrial Materials Exchange program as well as create a by-product synergy
plan which identifies methods for discovering wastes and inputs for Georgia manufacturing firms. With a list of inputs for manufacturers, the Sustainability Division could begin to selectively target certain manufacturers to link the waste streams. The by-product synergy taskforce would mimic the bridging institutions currently embedded in the Georgia carpet manufacturing industry’s social network.

Of course, a serious approach toward creating a by-product synergy network would require some investment by the state of Georgia. Financing for the by-product synergy efforts could be raised from an increase in the state’s hazardous waste disposal fees. Revenue from these fees would be funneled to the Sustainability Division. The increase in revenue would allow the division to create new capacity within its organization, fund the studies necessary to investigate the product synergies between Georgia’s manufacturers, and allow the Sustainability Division to improve upon the Georgia Industrial Materials Exchange (GIME) program and web-interface as well as provide funds to broadly market GIME throughout the state.

**Conclusion:**

During the late 1990s, Georgia’s carpet industry was given a choice: to be regulated or to self-regulate. The industry chose the latter and sustainability has been deeply entrenched within the industry ever since. It would be naïve to think that this choice was arrived upon by the sole good intentions of the industry. The demand from consumers and the regulatory risk from the EPA made taking a proactive approach to sustainability an intelligent business decision. The EPA threatened to regulate carpet and carpet consumers were demanding
environmentally friendly products. Faced with the choice, the carpet industry decided to take the industry’s regulatory fate in its hands. The self-regulation of the carpet industry has direct financial benefits to the industry as it allows it to better shape the regulations that it will eventually have to comply with. Self-regulation also allows the industry to broadly spread the costs of regulation across all of the firms, rather than a few firms paying a disproportionate share of the regulatory burden. Yet the self-regulation of the industry required coordination and input between all firms within the industry and needed a tight-knit social network. This need for coordination resulted in the creation of institutions that served to bridge the carpet industry’s social network around issues of sustainability. These institutions proved vital in the negotiation and coordination of the industry’s sustainability efforts. Far from colluding, organizations such as the Sustainability Issues Management Team, the Carpet America Recovery Effort, and the National Sanitation Foundation offered forums in which carpet’s social actors could set the sustainability agenda for the industry, facilitating the broad adoption of sustainability within the industry.

However, the industry’s early efforts to adopt sustainable practices will be met with new challenges. Sustainability in the carpet industry faces technical challenges, such as developing a new, sustainable raw material, and regulatory challenges from state governments looking to grow carpet recycling in their state. The industry’s early efforts in developing an industry-wide sustainability agenda will reduce the burdens of new state regulations; however, how the industry will tackle its deeper technical challenge remains to be seen, as do the resiliency of these social networks. Social networks are plastic. These networks are molded by every changing shift in power, cooperative ties, and participants. The strong social ties of
Georgia’s carpet industry can easily be dismantled if certain highly connected actors drop out or disagreements over strategy led to fragmentation in the network. But, social networks are an important aspect to the carpet industry’s adoption of sustainable practices. Economic development planners and policymakers would do well to understand the social networks embedded in the local economy before implementing policy seeking to promote sustainability among firms in their economy.
Works Cited:


