Sustaining Pittsburgh's Steel Technology Cluster

Carey Durkin Treado
Center for Industry Studies
University of Pittsburgh

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Center for Industry Studies
Department of Economics
University of Pittsburgh
Pittsburgh, PA 15260
http:/www.IndustryStudies.pitt.edu

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As also mentioned in the report, the Steel Technology Cluster is difficult to identify with traditional statistical methods. Thus, this research has depended critically on the cooperation of the Association of Iron and Steel Technology and access to their rich information on the suppliers to the steel industry. Ron Ashburn and Joann Cantrell have been instrumental in providing data as well as the benefit of their experience with, and access to, the broader world of steel technology.

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Executive Summary

With a critical mass of both product and service providers, the Pittsburgh region has become a key source of steel technology in the global steel value chain.[1] In addition, the Steel Technology Cluster has served as an important source of resilience for the Pittsburgh regional economy during a period of profound industrial transition.

Unfortunately and somewhat surprisingly, the role of the Steel Technology Cluster in the global steel industry and the regional economy is not well known by most Pittsburghers. A long term research project at the Center for Industry Studies has sought to clarify the size and scope of the Steel Technology Cluster and, with the support of the Heinz Endowments, to explore the relationship between the Steel Technology Cluster and regional economic development.

A key finding from the Center's research is that the low visibility of the Steel Technology Cluster has the potential to hamper its future ability to thrive in the region. By drawing on the Center's research and interviews with key regional players, this report seeks to improve the visibility of the Steel Technology Cluster and its prominence in the region by providing an overview of its current structure, its key markets and technological innovations, its strengths and weaknesses, and its future prospects

Overview of the Steel Technology Cluster

- The Steel Technology Cluster is made up of firms that provide a diverse array of products and services as part of the supply chain of the steel industry. This supply chain can be divided into four main components:
    - Production equipment used by steel mills;
    - Engineering services that assist mills in the selection, design, and upgrading of that equipment;
    - Parts and supplies needed to keep that equipment operational; and
    - Raw material inputs to the production process.
- Although all of the firms in the cluster sell their output to the steel industry, it is important to note that only rarely do they sell exclusively to the steel industry. Cluster firms report sales to markets for nuclear power; the automotive industry; the health care industry; and other materials industries, such as aluminum and glass.
- According to an industry directory published by the Association for Iron and Steel Technology (AIST), Pittsburgh has the single largest concentration of firms that supply goods and services to the steel industry. Of the 1800 firms in the directory in 2003, 329 are in the Pittsburgh region, representing 18% of the directory listings. It takes the Chicago-Gary region (199 listings) and Cleveland (124

[1] Throughout this report, the Pittsburgh region will be defined as the seven counties that constitute the Pittsburgh Metropolitan Statistical Area, as defined by the U.S. Bureau of the Census unless otherwise indicated. Those seven counties are Allegheny, Armstrong, Beaver, Butler, Fayette, Washington, and Westmoreland counties.

listings) combined to reach the same number of supplier firms, and the concentration of firms falls steeply after that.

- Estimates of employment in the Steel Technology Cluster are well over 12,000 people, with an average wage of $56,000. This represents a 50% increase over the average regional wage of $36,051 and a 10% increase over the average wage for Iron and Steel Mills in the region of $51,000.

- Through the combination of steel producing firms and those of the Steel Technology Cluster, steel provides nearly 25,000 regional jobs. In terms of wages and revenue, the regional income received from just *one* steel company, US Steel, is nearly $2 billion.

The Development of the Steel Technology Cluster

- Because the decline of the size of the steel-making capacity in Pittsburgh was so dramatic, there is a common assumption in the Pittsburgh region that all ties to steel-making were diminished to the same extent.
    - The decline in Pittsburgh steel capacity was also the steepest decline experienced by any of the major steel-making cities. The current steel-making capacity of the Chicago metropolitan area (which includes the Gary, Indiana, region) remains larger than Pittsburgh's steel-making capacity during the peak years of the 1970s.

- Contrary to this assumption, the intermediate suppliers of goods and services to the steel industry have managed to not only survive the loss of steel-making capacity in the region, but to transition successfully into an integral part of the global steel supply chain.
    - Although Chicago, Detroit, and Cleveland have maintained a much larger share of U.S. steel-making capacity than Pittsburgh, their share of the number of firms who supply the steel industry is noticeably smaller.

- The development of the Steel Technology Cluster arose from the process of de-verticalization of the steel industry.
    - When the steel industry was vertically integrated during the 1960s and 1970s, producer firms incorporated many of the upstream and downstream processes of steel production within the firm.
    - As the steel industry contracted in the 1980s, many of these activities and services were "outsourced" from the steel firm to other entities.
    - Today, many of the activities previously performed within steel mills by mill employees are now performed by outside vendors.

- De-verticalization of steel production has had two main effects on the role of intermediate suppliers.
    - First, they have expanded their role in the supply chain to include services as well as products, such as the bundling of material handling with the supply of raw materials.

- Second, they have developed a network of relationships with each other in order to coordinate the supply of products and services to a global (rather than local) industry. Although geographic proximity to the customer is no longer as critical to the suppliers, geographic proximity to other suppliers has risen in importance.

- With the development of the cluster, the relationship between other regional organizations and steel production has also changed. The connections to university research programs and the regional economic development community have been weakened during the transition process.
- The global steel industry is currently growing rapidly, resulting in rapid growth in demand for the products and services of the Steel Technology Cluster.
    - World steel production has more than doubled from record lows in 1982 to reach over 1.3 billion metric tons of production in 2007. U.S. steel production has increased by 45% over the same period.
    - As the BRIC (Brazil, Russia, India, and China) countries expand their infrastructure and industry, they are driving much of the demand for steel. Between 2000 and 2006, the Chinese steel industry tripled output and doubled the number of firms, and India's consumption of steel grew 64%.
    - Pittsburgh-based firms have been involved in the expansion of U.S. steelmaking capacity at several recent projects that are collectively worth over $10 billion.
- Key technological developments include advances in the metallurgy of steel; improvements in the production process; and environmental controls.

Strengths of the Steel Technology Cluster

- The key source of the cluster's strength lies in the industrial heritage of the Pittsburgh region and the technical proficiency of its people.
    - Pittsburgh's rich and diverse industrial heritage in industries such as glass, aluminum, and nuclear power—as well as the steel industry—has contributed to a critical mass of technical knowledge in the region.
    - Interviews with participants in the cluster indicate that the most important factor in the cluster's success is the technical knowledge of Pittsburgh's people.
- The industrial heritage and technical proficiency of Pittsburgh has been supported by three types of institutions:

1. *Educational Institutions*: Pittsburgh's network of colleges and universities provide an excellent supply of technically proficient graduates to the Steel Technology Cluster.
    - The Pittsburgh region is home to 35 colleges and universities, with a total enrollment of nearly 130,000 students. Of the 30,000 degrees awarded each year, over 5,000 are in engineering, science, and technical fields.

    - Enrollment in metallurgical and materials engineering, however, is declining locally and nationally. The result is a "knowledge gap" in which steel technology is getting more complex as academic curricula move away from teaching steel technology.

2. *Research Organizations*: Pittsburgh has a unique combination of industry and university knowledge in materials engineering.
    - Both Carnegie Mellon University and the University of Pittsburgh have engineering-based steel research centers, and five corporations (Bayer, Westinghouse, PPG, Alcoa, and US Steel) have major materials research labs based in the Pittsburgh region.
    - Unfortunately, few of the firms in the cluster report having any connection with local research organizations, resulting in a "communication gap."

3. *Trade Associations*: Pittsburgh is the headquarters of several key trade associations and professional societies for engineers within the steel industry as well as several related industries, such as mining and automotive.
    - The presence of these organizations appears to be both the result of a strong engineering base in Pittsburgh as well as a factor in attracting additional engineers and engineering-based companies.
    - However, none of these organizations truly serve as a regional networking organization for the Steel Technology Cluster, resulting in a "representation gap." The absence of a regional voice is contributing factor to the low visibility of the Steel Technology Cluster in the region.

Weaknesses of the Steel Technology Cluster

1. *Pittsburgh International Airport*: The most common concern within the cluster about the Pittsburgh business environment was the declining number of flights at the airport. Anticipated concerns, such as businesses taxes or fragmented regional government, were not raised nearly as often or with as much vigor as the airport issue.
    - Before September 2001, there were 633 daily nonstop flights leaving the Pittsburgh International Airport. The current number of nonstop flights has dropped by over 70%, averaging just 170 today.
    - Currently, Pittsburgh is the largest market for U.S.-European travel without a direct flight, having lost its last flight to Europe in 2004.
    - Continued efforts by organizations such as the Regional Air Service Partnership (RASP) to improve air service to the Pittsburgh region are an important regional goal for the cluster.

2. *Engineering Shortage*: The current shortage of engineers and technical labor is being fueled by both a surge in demand for steel, and thus for steel-related technology, as well as by a rising average age in the industry. If the retiring workforce is not replaced regionally, then Pittsburgh may lose its reputation for being home to a specialized, skilled workforce

- Educational organizations, trade associations, and industry representatives are working to address this shortage by expanding educational programs and recruiting young workers. The goal for the Pittsburgh region is to address the labor demand issues of the industry better and faster than other competing industrial regions.
- The Pittsburgh region has an opportunity during the current period of talent shortage to both capitalize on and increase its reputation as a center for excellence in steel technology. This opportunity will depend on the region's ability to recognize the virtuous circle that can exist between its academic institutions and its local industry.

3. *Visibility of the Cluster within the Region*: The issue of cluster visibility represents a critical weakness of the cluster with potentially far-reaching effects.
    - Research on clusters in a variety of industries and locations has found that the supporting organizations of a region can be important to the growth and success of an industrial cluster.
    - With the exception of the steel-related trade associations and research centers, there was little awareness among the Pittsburgh regional organizations of the size and national relevance of the Steel Technology Cluster.
    - Although low visibility may have hampered regional recognition of the Steel Technology Cluster in the past, the economic development and financial community of the Pittsburgh region is poised to support the cluster in the future.
    - As the community becomes better informed of the role that the cluster plays in regional resilience and economic growth, synergies between these organizations and the cluster should be easier to discover.

Future Prospects and Policy Recommendations

- The Steel Technology Cluster is a technology-based cluster with a global reputation for excellence that has quietly established a Pittsburgh base with only limited regional recognition.
- Although the cluster has done well thus far, it does face challenges that could be better addressed with improved regional support.
    - Opportunities to improve metallurgical education, attract research funding, encourage local steel technology firms, supply non-US mills, or increase air travel access may be missed if their relevance to the cluster is not fully understood.
    - If Pittsburgh continues to see the steel industry as part of its past rather than an asset for the future, it may miss these critical support opportunities.

- More than any specific policies, the most important regional goal for the Steel Technology Cluster is to improve its ties to regional support organizations, focusing on the following two groups.

  (1) Regional colleges and universities and

  (2) Regional economic development organizations, which include governmental, non-profit, and financial organizations.

- In order to address the visibility issues that have thus far prevented these types of ties from forming, a concerted effort may be needed to bring the appropriate stakeholders together for a mutually beneficial discussion of their shared concerns.
  - This effort may involve the identification of a coordinating organization or, more simply, the arrangement of a one-day stakeholders' workshop.

The Steel Technology Cluster offers the Pittsburgh region the opportunity to continue to play a vital role in the global steel value chain. The steel industry is expanding rapidly, creating skilled jobs and revenue growth throughout that value chain. By maintaining its reputation as place that "understands how steel is made," Pittsburgh can participate in the economic benefits of a high-growth and high-tech global industry. It can attract and retain a technically proficient workforce; offer high wage jobs; and bring revenue from other regions of the country and the world into the Pittsburgh economy.

Introduction

Although Pittsburgh lost most of its steel-making *capacity* during the end of the 20th century, it did not lose its steel-making *expertise*. This expertise has become the basis for Pittsburgh's 21st century role in the global steel industry. Pittsburgh's Steel Technology Cluster has been built on the region's ongoing understanding of the steel production process and its reputation for understanding critical steel-making technology.

With a critical mass of both product and service providers, the Pittsburgh region has become a key source of steel technology in the global steel value chain. There is no other metropolitan region in the United States that has as many establishments engaged in providing goods and services to the steel industry. In addition, the Steel Technology Cluster has served as an important source of resilience for the Pittsburgh regional economy during a period of profound industrial transition.

Unfortunately and somewhat surprisingly, the role of the Steel Technology Cluster in the global steel industry and the regional economy is not well known by most Pittsburghers. Both tangible statistical issues and intangible perception issues have contributed to the cluster's lack of visibility in the region. A long term research project at the Center for Industry Studies has sought to clarify the size and scope of the Steel Technology Cluster. The project began with an online survey of regional steel-industry suppliers in 2005 and was followed up with a series of on-site interviews in 2007. With the support of the Heinz Endowments, the project has been further expanded during 2008 to explore the relationship between the Steel Technology Cluster and regional economic development.

A key finding from the Center's research is that the low visibility of the Steel Technology Cluster has the potential to hamper its future ability to thrive in the region. By drawing on the Center's research and interviews with key regional players, this report seeks to improve the visibility of the Steel Technology Cluster and its prominence in the region by providing an overview of its current structure, its key markets and technological innovations, its strengths and weaknesses, and its future prospects. In addition, the report will offer some policy recommendations to support the continued growth of the cluster within the region. The challenge for the Pittsburgh region is to become more aware of the asset that the Steel Technology Cluster represents as well as the future needs of that asset.

Overview of the Steel Technology Cluster

The Centrality of Pittsburgh

The Steel Technology Cluster in the Pittsburgh region is the central source of steel-industry equipment, supplies, and services in the United States. The Association for Iron and Steel Technology (AIST), a trade association that represent both steel producers and suppliers, publishes the *AIST Directory Iron and Steel Plants* each year. With over 1800 listings for intermediate suppliers to the steel industry, the *AIST* Directory is the most widely used directory in the industry. Because of the directory's status in the industry, suppliers are highly motivated to participate in the directory's listings.

As described in Table 1, over half of the suppliers listed in the *AIST Directory* are found in just 8 metropolitan areas. The United States and Pittsburgh area locations of these firms are mapped in Figure 1 and Figure 2. These maps make clear the ongoing centrality of the traditional steel making areas from Pittsburgh to Chicago in the supply of steel technology, with the largest concentration of firms in Pittsburgh. The Pittsburgh map also indicates the geographic dispersal of the cluster firms are in the region, although there is some concentration of firms in Cranberry, downtown, and the airport region.

The *AIST Directory Iron and Steel Plants* includes nearly 1800 supplier firms, half of which are in just eight metropolitan regions. With an 18% share of the firms listed, Pittsburgh clearly has the single largest concentration of firms.[2] It takes the Chicago-Gary region and Cleveland combined to reach the same number of supplier firms, and the concentration of firms falls steeply after that. This achievement is particularly noteworthy since both Chicago and Cleveland currently have more steel production capacity than the Pittsburgh region, as shown in Figure 4 and discussed further in the section on the "Development of the Steel Technology Cluster" below.

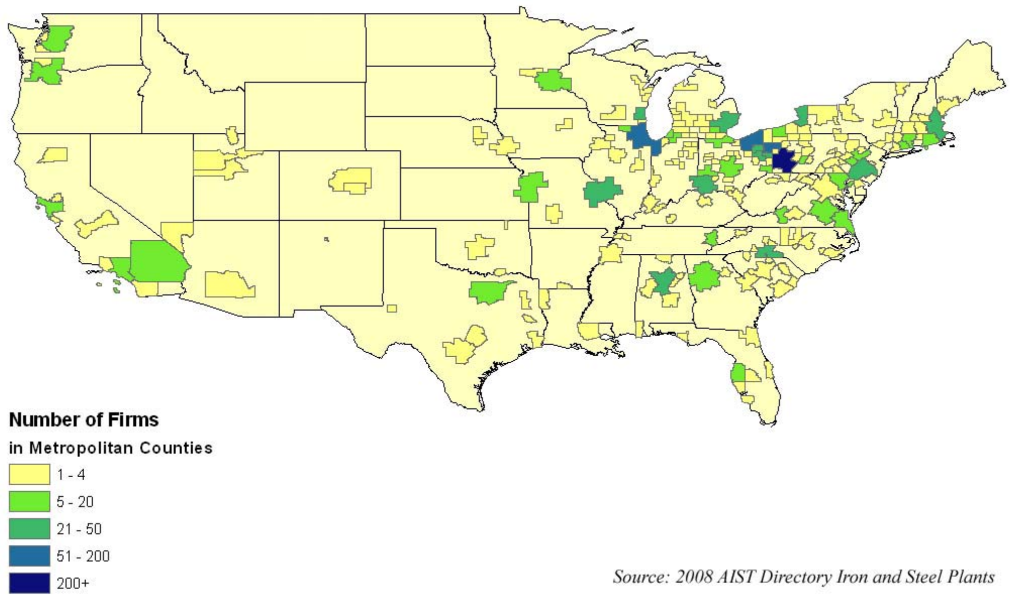
Table 1: Top U.S. Metropolitan Locations of Steel Industry Suppliers

Metropolitan Area (2008)	**Number of Firms**	**Share of Directory Listings**	**Cumulative Share**
Pittsburgh, PA	329	18%	18%
Chicago-Naperville-Joliet, IL-IN-WI	199	11%	29%
Cleveland-Elyria-Mentor, OH	124	7%	37%
Youngstown-Warren-Boardman, OH-PA	58	3%	40%
Detroit-Warren-Livonia, MI	55	3%	43%
New York-N. New Jersey-Long Island, NY-NJ-PA	51	3%	46%
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	40	2%	48%
Cincinnati-Middletown, OH-KY-IN	39	2%	50%

Source: *AIST Directory Iron and Steel Plants*, 2008

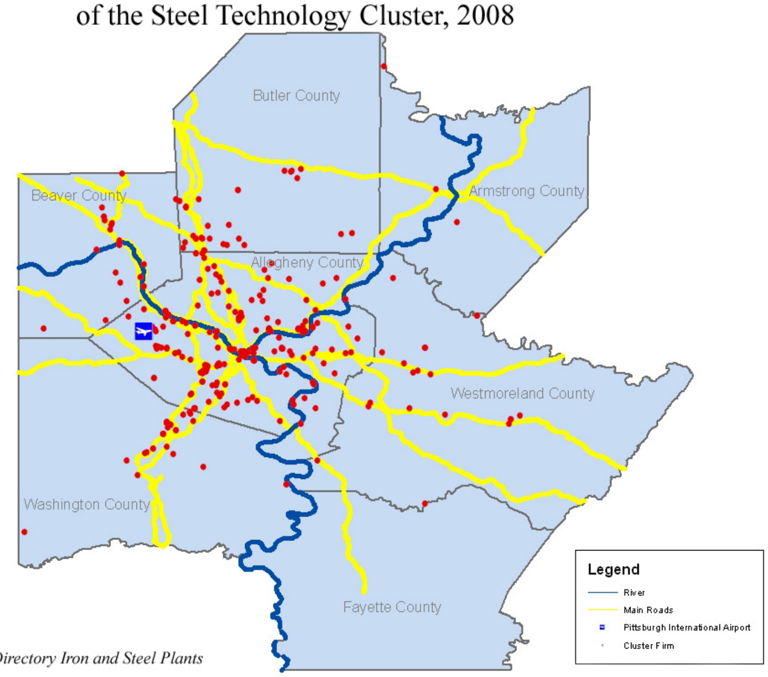
[2] The centrality of the Pittsburgh Steel Technology Cluster to the industry has been confirmed by other supplier lists as well as by industry sources. The 290 supplier listings in the "Buyers Guide 2007" of *Metal Producing and Processing* (July/August 2007), a metals industry trade journal, are also concentrated in the same top three metropolitan areas: Pittsburgh (10%), Chicago (10%), and Cleveland (8%).

Figure 1: United States Locations of
Steel Technology Companies, 2008



Source: 2008 AIST Directory Iron and Steel Plants

Figure 2: Pittsburgh Region Locations
of the Steel Technology Cluster, 2008



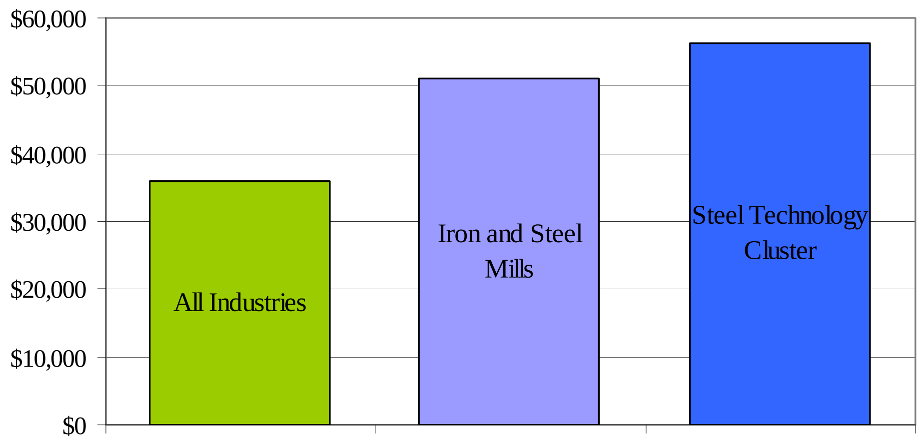
Source: 2008 AIST Directory Iron and Steel Plants

Benefits of the Cluster

Although the firms in the Steel Technology Cluster are not as visible as the steel mills once were, they represent a significant source of jobs and income. Using the *2003 AIST Directory* in combination with establishment-level data from the U.S. Bureau of Labor Statistics, we have been able to estimate that the Steel Technology Cluster employed well over 12,000 people in 2003 with an average wage of $56,000.[3] This represents a 50% increase over the average wage in Pittsburgh in 2003 of $36,051.[4]

Pittsburgh's Steel Technology Cluster also represents an industry that is comparable in size and wages to the regional steel industry. Employment in Pittsburgh in Iron and Steel Mills (NAICS 3311) was estimated at 12,151 by the 2002 census, with an average wage of just under $51,000.[5] As further evidence of the growing importance of the Steel Technology Cluster as a source of regional income, the United States Steel Corporation (US Steel) reported spending $1.24 billion on suppliers in the Pittsburgh region in 2007, almost three times its annual Pittsburgh area payroll of $433.8 million.[6]

Figure 3: Pittsburgh Average Annual Wages by Industry, 2003



Source: Bureau of Labor Statistics and the Census Bureau

[3] U.S. Bureau of Labor Statistics, *Quarterly census of employment and wages (ES202)*, 2003.
[4] Regional Economic Information System, Bureau of Economic Analysis, U.S. Department of Commerce. Wage data from Local Area Personal Income tables. See http://www.bea.gov/regional/reis.
[5] Census Bureau, U.S. Department of Commerce. Data is taken from "Sector 31: Manufacturing: Geographic Area Series: Industry Statistics for the States, Metropolitan and Micropolitan Statistical Areas, Counties, and Places: 2002." See http://factfinder.census.gov.
[6] Data provided by the United States Steel Corporation, Procurement Services.

When the size of the steel production and technology industries in Pittsburgh are considered together, it becomes even clearer that steel is still an important factor in the regional economy. Directly and indirectly, steel provides nearly 25,000 regional jobs. In terms of wages and revenue, the regional income received from just *one* steel company, US Steel, is nearly $2 billion.

Although the collective impact of these jobs and income may not be readily apparent, the role of some of the cluster's key participants is well known. The Pittsburgh Regional Alliance of the Allegheny Conference periodically publishes a list of the largest employers in the region. Nearly 60% of the employment in the 2006 list of Large Advanced Manufacturing and Materials firms is located at either cluster firms or their customers in the steel industry. Similarly, about 40% of employment at the 2006 Leading Engineering and Environmental Companies was in cluster firms.[7]

Members of the Steel Technology Cluster

The Steel Technology Cluster is made up of firms that provide a diverse array of products and services, ranging from large steel-making equipment to engineering services and from high tech devices to basic refractory brick. This diversity is a source of resilience and strength for both the cluster and the region, but also makes identifying the cluster with published government statistics very difficult. Intermediate suppliers typically represent a diverse group of firms that do not fall into a single or even small number of industrial codes. Recent changes in the structure of industrial statistics have further complicated the statistical identification of the cluster. Attachment A includes a more detailed discussion of how this issue affects the identification of the cluster.

Without the ability to rely on published statistics, it is critical for researchers to engage in a direct conversation with industry participants in order to bridge the gap between statistical abstractions and the reality of industrial structure. For cities such as Pittsburgh, which have transitioned from an economy based on production to one based on skills and knowledge, this information bridge is especially important.

As a result, this report will base its description of types of firms in the Steel Technology Cluster on the firms' role in the supply chain of the steel industry rather than the industry code in which it is categorized. This supply chain can be divided into four main components: the production equipment used by steel mills; the engineering services that assist mills in the selection, design, and upgrading of that equipment; the parts and supplies needed to keep that equipment operational; and, finally, the inputs of the production process itself. Each of these four categories is detailed below.

Although all of the firms in the cluster sell their output to the steel industry, it is important to note that only rarely do they sell exclusively to the steel industry. Cluster firms report sales to markets for nuclear power; the automotive industry; the health care industry; and other materials industries, such as aluminum and glass.

[7] Regional lists of firms by sector can be found on the website of the Pittsburgh Regional Alliance, available at http://www.alleghenyconference.org/PRA/RegionalData.asp.

Equipment

Large scale steel-making equipment includes major production equipment such as furnaces, casters, rolling mills, pickling lines, and other steel finishing equipment. The scale and complexity of this equipment should not be underestimated. Costs for new equipment range from millions for a single machine to billions for a new production line or facility.

Over the past twenty years, the producers of steel-making equipment have consolidated into a few "mill builders," or companies with the capability to build an entirely new mill. The four largest mill builders have their North American steel headquarters in the Pittsburgh region as shown in Table 2.[8] Typically, the Pittsburgh location of the mill builder firms houses the engineering, marketing, and sales staff that manage new construction in North America as well as provide service for previous sales. In addition, the mill builder firms may also bring in subcontractors for part of the job or to make a repair part. In those cases, the network of firms in the Pittsburgh Steel Technology Cluster is an important factor in both locating the North American steel headquarters in the Pittsburgh region and in attracting additional suppliers to the cluster.

Table 2: Top Global Steel Equipment Makers

Mill Builder	International Headquarters	North American Headquarters	North American Steel HQ	Merged or Acquired Firms
Danieli Wean United	Italy	Cranberry	Cranberry	Wean (1993), United Engineering (1995)
Mitsubishi-Hitachi Metals Machinery	Japan	Chicago	Pittsburgh	JV in 2000. Also acquired Mesta's technology
Siemens VAI	Austria	Alpharetta, Georgia	Canonsburg	Voest Alpine (2005)
SMS Demag	Germany	Pittsburgh	Pittsburgh	Demag (1999), Millcraft (2006), Tippins (2007)

With the global reach of these firms, their decision to locate in Pittsburgh both reflects the strength of the Pittsburgh Steel Technology Cluster and has reinforced it. Danieli, for example, began its U.S. operations with a headquarters in Charlotte, North Carolina, after purchasing a furnace company there. However, after purchasing two major U.S. equipment makers—Wean of Youngstown in 1993 and United Engineering of Pittsburgh in 1995—Danieli moved its headquarters to Pittsburgh. Although more steel-making was located in the South and in Ohio, Pittsburgh was chosen as the U.S. headquarters because the company felt that the Pittsburgh area offered better access to engineers and to customers.[9] Similarly, Mitsubishi moved its steel equipment operations

[8] As this table also clearly indicates, the consolidation of the major mill builders was led by non-American firms. In interviews with industry, participants have indicated that the construction boom in Europe and Japan after World War II provided manufacturers in those regions with more buying power during the consolidation period than the U.S. manufacturers, who were experiencing a construction slow down.
[9] Eric Thokar, Sales Manager, Danieli Wean United. Personal Interview. May 31, 2007.

from its Chicago headquarters, which is near several large steel-making plants, to Pittsburgh in order to participate in the advantages of the cluster.[10]

In addition to the mill builders, the Steel Technology Cluster includes firms that manufacture individual types of equipment, such as coil processing equipment at Herr-Voss Stamco, furnaces at Bricmont, and injection lances at Berry Metal. The presence of these firms in the Pittsburgh region forms a critical component of the Steel Technology Cluster. Although the four largest mill builder firms have production locations elsewhere, usually China and Eastern Europe, smaller equipment manufacturers often have production facilities in Pittsburgh.

Engineering Services

Pittsburgh has a long tradition as a region with deep base of engineering knowledge, particularly in areas of use to traditional manufacturing, such as mechanical engineering and metallurgical engineering. Engineering services provide technical expertise to steel producers as well as many of the firms in the cluster, particularly the major mill builders. Some engineering service firms, such as Core Technologies, were formed directly by the former engineering staff of US Steel. Others, such as R.T. Patterson, have been in existence for nearly 60 years. Still others, such as Fluor Corporation (see Illustration A), have been attracted to Pittsburgh by the current benefits of the Steel Technology Cluster. Of the top 24 engineering firms in the Pittsburgh region, firms in the Steel Technology Cluster represent over one-third of the companies, employing approximately 1500 people.[11]

Illustration A: Fluor Corporation

Fluor Corporation is one of the world's largest engineering, procurement, construction, maintenance (EPCM) firms in the business. Headquartered in Texas, it has offices in 25 countries and employs 46,000 people. According to Michael Hughes, Director of the Pittsburgh office, Fluor decided to open a Pittsburgh office in 2008 in order to capitalize on the market and the skill set located in Pittsburgh. After working on a project with Allegheny Ludlum, Fluor began to realize the potential of the expanding steel market as well as the advantages of the Pittsburgh region to meeting that market's needs. Specifically, Fluor identified Pittsburgh as the location with the "core competency" necessary as well as the opportunity to partner with the four large mill builders headquartered here. As Michael Hughes put it during an interview with Sabina Deitrick of the University of Pittsburgh (June 2008), "the skill set in this town is uncanny." Fluor plans to hire approximately 200 people by 2009.

[10] Kenneth W. Moots and Dave Brown of Mitsubishi. Personal Interview. May 8, 2008.
[11] Regional lists of firms by sector can be found on the website of the Pittsburgh Regional Alliance, available at http://www.alleghenyconference.org/PRA/RegionalData.asp.

Operating Parts and Supplies

Because of the complexity and size of steel-making equipment, numerous parts require repair, replacement or upgrading. For example, one of the largest expenses for a replacement part is the relining of steel furnaces and ladles with new refractory brick. Several large refractory brick suppliers are located in the Pittsburgh area, such as Resco Products, which moved its headquarters from Norristown (near Philadelphia) to Pittsburgh in 2001 to take advantage of the benefits of the Steel Technology Cluster.

In addition, there are local companies that specialize in making other replacement parts for steel equipment, such as rollers (Penna Flame Industries in Zelienople) and cutting tools (Asko in Homestead). In many cases, the customers of these firms are the mill builders rather than the steel mills. Close proximity to the North American headquarters of those firms can be an important part of making sales to both the equipment manufacturers and, ultimately, the mills.

Raw Materials

Most raw materials, such as iron ore and coal, are tied to the locations where they occur naturally. Pittsburgh's Steel Technology Cluster, however, includes brokers of these materials as well as headquarters for their production. Raw materials firms in the cluster include Crown Coal and Coke, Carmeuse Lime and Stone, and Horsehead Corporation (a zinc producer). In addition, the cluster includes providers of other raw materials that are not as geographically limited, such as the scrap metal that is recycled into new steel in electric arc furnaces. Based in Glassport, Pennsylvania, Tube City IMS is an international supplier of scrap metal with 69 locations worldwide.

For all of these firms, globalization and changes in steel production technology has led to the bundling of services with their raw materials. Tube City, for example, also offers scrap handling and management services as well as scrap optimization software to improve production and lower costs.

The Development of the Steel Technology Cluster

Because the decline of the size of steel-making capacity in Pittsburgh was so dramatic, there is a common assumption in the Pittsburgh region that all ties to steel-making were diminished to the same extent. Contrary to this assumption, the intermediate suppliers to the steel industry have managed to not only survive the loss of steel capacity in the region, but to transition successfully into an integral part of the global steel supply chain. The transition from steel-making to steel technology is an important part of the story of the Steel Technology Cluster.

Decline of Steel Production in Pittsburgh

During the peak of steel production in the region in the 1970s, Pittsburgh had about 20 operating steel mills with capacity of over 22 million tons of steel per year, of which 19 million tons of capacity was in large "integrated" mills, which integrate the production of iron and steel into one facility. This represented about 15% of the U.S. steel-making capacity.[12] By 1985, most of these mills had closed, leaving only one integrated steel mill operating in the region—the Edgar Thompson Works of US Steel in Braddock—and a handful of smaller specialty mills. By 2003, steel capacity in the Pittsburgh region had dropped to less than one-fifth of its peak capacity, representing only 3% of the nation's total capacity.

The decline in employment was even more startling as productivity gains in steel making combined with mill closures to drastically reduce the number of steel-making jobs. Over 70,000 jobs in the primary metals sector were lost between 1978 and 1988 in the Pittsburgh region, resulting in a corresponding drop in importance to the regional economy from 10% of all jobs to less than 2%.[13]

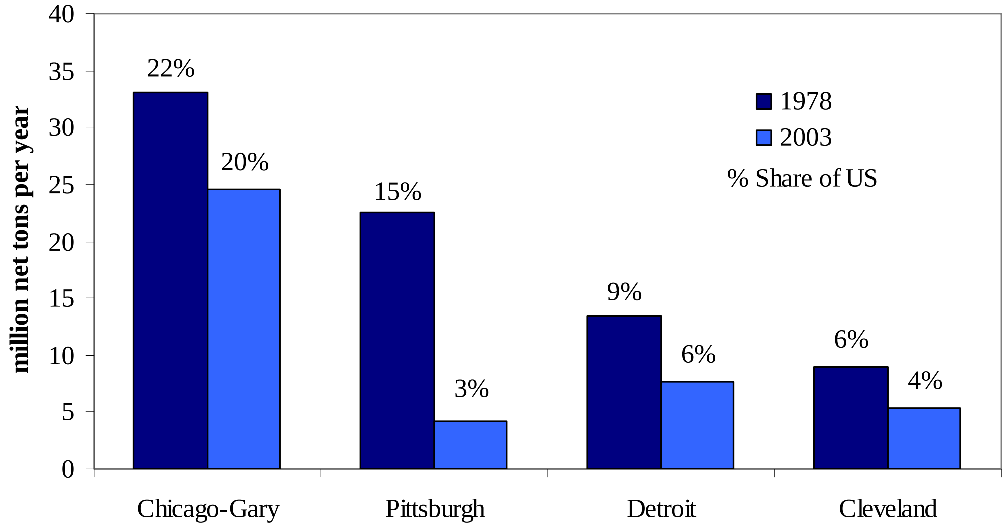
Not only was the decline in steel-making in Pittsburgh particularly dramatic, but it was also the steepest decline experienced by any of the major steel-making cities. Figure 4 shows the operating steel-making capacity in the four top steel cities for both 1978 and 2003. Pittsburgh experienced both the largest absolute and relative decline in operational capacity. The current steel-making capacity of the Chicago metropolitan area (which includes the Gary, Indiana, region) remains larger than Pittsburgh's steel-making capacity during the peak years of the 1970s.[14]

Given the relative position of Pittsburgh's current steel-making capacity to other major steel regions, it is particularly impressive that Pittsburgh has maintained such a large cluster of steel technology providers. As shown in Figure 5, the contrast between the relative size of Pittsburgh's Steel Technology Cluster and its steel-making capacity is sharp. Although Chicago, Detroit, and Cleveland have maintained a much larger share of U.S. steel-making capacity than Pittsburgh, their share of the number of firms who supply the steel industry is noticeably smaller.

The following sections describe some of the major economic forces that have led to the development of Pittsburgh's Steel Technology Cluster. These forces include the geography of new steel technology, the rise of steel production globally, and the restructuring of steel production domestically.

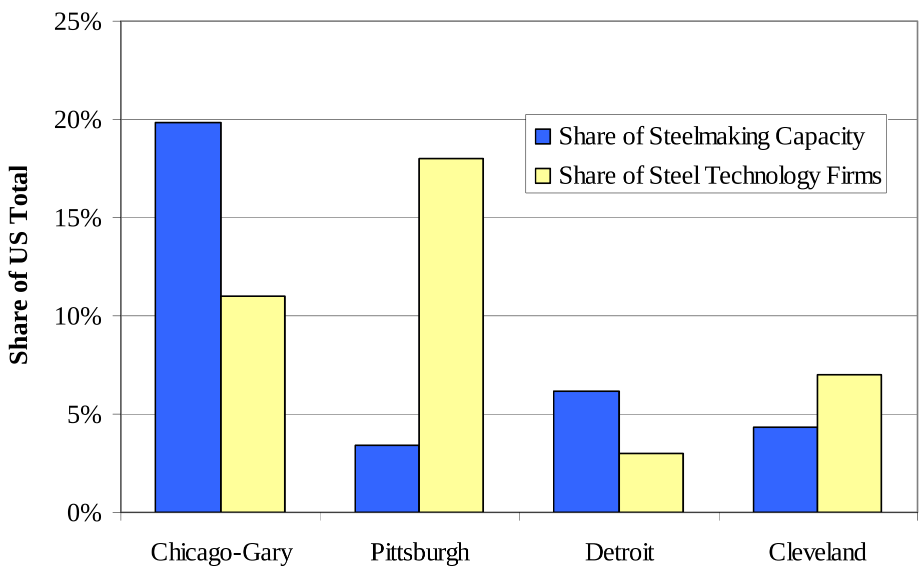
[12] Steel Plant Database, Center for Industry Studies, University of Pittsburgh. See http://www.industrystudies.pitt.edu/database.html.
[13] U.S. Bureau of the Census, *County business patterns*, 1978 and 1988. Archived data is available from Geospatial and Statistical Data Center of the University of Virginia. See http://fisher.lib.virginia.edu/collections/stats/cbp.
[14] Steel Plant Database, Center for Industry Studies, University of Pittsburgh.

Figure 4: Steel Production Capacity by Metro Area, 1978-2003



Source: Steel Plant Database, Center for Industry Studies

Figure 5: Share of US Steel Production and Technology by Metro Area, 2003



Source: AIST and Center for Industry Studies

Geography of U.S. Steel Production and Technology

While steel mills were closing in Pittsburgh and other traditional steel cities, new mills based on advances in steel technology were opening. This technology used recycled scrap steel instead of iron ore as the key raw material. Mills based on this type of production, which links electric arc furnace output with continuous casters, are commonly referred to as "minimills" and represent an alternative to traditional steel production. In the 1990s, minimill technology developed to the point that it could produce flat steel shapes, which had to meet higher metallurgical standards, as well as long steel shapes.

The traditional method of steel production involves the production of iron in blast furnaces and the transformation of that iron into steel in basic oxygen furnaces (or open hearth furnaces in previous decades). Mills based on the traditional production method are commonly referred to as "integrated mills."

All of the steel mills built in the United States during the 1980s and 1990s were minimills and most were opened in regions without any tradition of steel production. Since minimills are not dependent on iron ore as a production input, their location is more flexible than the location of integrated mills. Several minimills have been built in southern states that offer low unionization rates, proximity to new auto plants and regional construction booms. In addition, a few of the new minimills were also built in areas close to Chicago and Detroit.

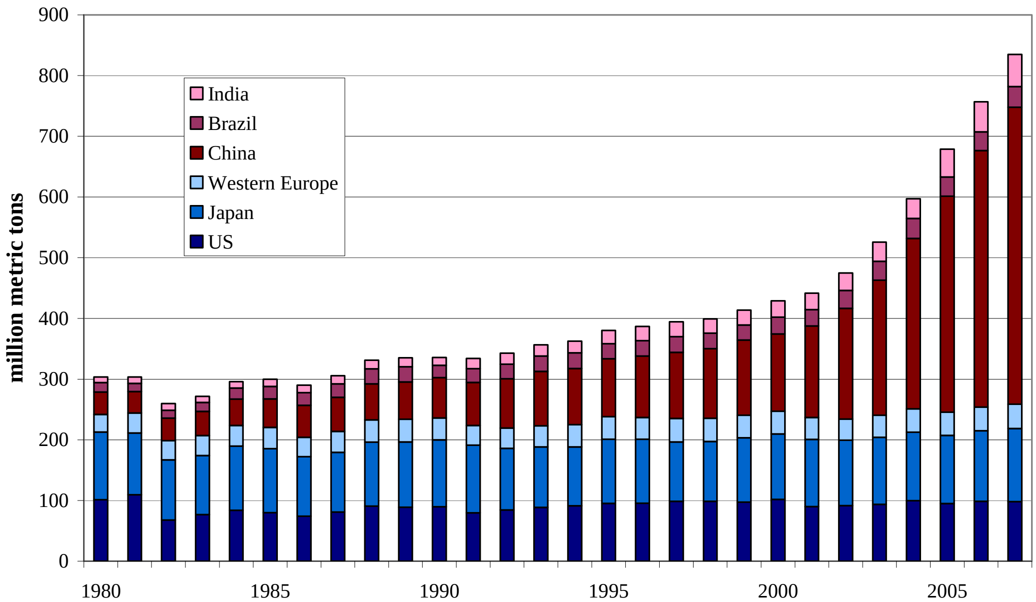
The combination of the closure of large integrated mills in traditional steel states and the opening of new minimills across a variety of regions resulted in a geographic dispersal of production, preventing the development of a new center of steel production. It is impressive that during this transformation of the geography of steel production, Pittsburgh was able to maintain its position as the largest supplier of steel technology, particularly since the Chicago-Gary area held onto more integrated steel production and also attracted new minimill construction.

Expansion of Global Steel Production

World steel production has more than doubled from record lows in 1982 to reach over 1.3 billion metric tons of production in 2007. Figure 6 shows production levels for the world's major centers of steel production. While U.S. steel production has increased by 45%, much of the recent growth in the industry has been driven by China and the other BRIC (Brazil, Russia, India, and China) countries. [15] These nations have been rapidly expanding their infrastructure and industry, driving up their demand for steel. As shown in Table 3, the Chinese steel industry tripled output and doubled the number of firms between 2000 and 2006. Over the same period, India's consumption of steel grew 64%.[16]

[15] International Iron and Steel Institute, Crude Steel Production. See http://www.worldsteel.org.
[16] International Iron and Steel Institute, Apparent Steel Use. See http://www.worldsteel.org.

Figure 6: Steel Production by Major Producing Nations, 1980-2007



Source: International Iron and Steel Institute

Table 3: The Growing Steel Industry of China

Year	Number of Firms	Crude Steel Output (m tons)
1978		31.8
1980	1332	37.1
1985	1318	46.8
1990	1589	66.4
1995	1639	95.4
2000	2997	128.5
2001	3176	151.6
2002	3333	182.4
2003	4119	222.3
2004	4992	282.9
2005	6604	353.2
2006	6639	418.8

Source: China's Great Economic Transformation, edited by Loren Brandt and Thomas G. Rawski, 2008, table 15.5, p. 594.

Rapid increases in demand have translated quickly into rapid growth in prices. The price of a ton of flat-rolled steel has risen from $422 in 2003 to $642 in 2007—a price increase of over 50% in current dollar terms.[17] In addition, the iron and steel sector has outperformed the S&P 500 over the past three years, growing by 166% in comparison to growth of 2 % for the S&P index and 3.5% for the technology sector over the same period.[18]

According to the American Iron and Steel Institute (AISI), net income as a share of net sales reached +8.3% in 2004, a significant improvement over the previous year's return of –20.8% and the average return of –3.4% in the previous nine years.[19] According to John Goodish, Chief Operating Officer of US Steel, the last four years have been the most profitable in US Steel's 107 year history.[20]

As a result of this growth in the steel industry, the demand for the products and services of the Steel Technology Cluster is also growing. Several new mills and expansion projects in the United States are detailed below. In addition, export opportunities are increasing as nations without a strong supplier base, such as China and India, seek to expand their steel industries with the help of suppliers from North America and Europe. For the Pittsburgh region, these trends call attention to the growth potential that the cluster offers to the regional economy.

Restructuring of Steel Production and Technology

Despite the opportunities that global steel growth presents to the Pittsburgh regional economy, many Pittsburghers mistakenly assume that their region has missed the steel boom. However, that assumption reflects outdated concepts of the industrial structure of steel production. The global structure of industrial production is currently in flux, changing from one of vertically-integrated and nationally-bound entities to one of de-integrated and globally-dispersed facilities.[21]

The steel industry is no exception to this pattern. Before shuttering mills, steel corporations first laid off large numbers of workers—sometimes entire departments or classes of workers were terminated. These workers included mill production workers as well as repair specialists, engineering staff, researchers, lab technicians, marketing staff, accountants, landscapers, firemen, and food service workers.

Although the impact on individual workers and on steel towns was devastating, some former steel industry employees were able to form small companies to provide the same skills and services that they had previously provided as employees. Others were hired by existing suppliers who expanded the range of products and services that they

[17] Price data taken from "2008 Pocket Facts" of the United States Steel Corporation. See http://www.ussteel.com/corp/investors/historical_data/Pocket%20Facts%202008.pdf.
[18] Data summarizes results from September 2005 to July 2008 for the Iron and Steel subsector of the Basic Materials Sector of Google Finance. See http://finance.google.com/finance?catid=59337585.
[19] American Iron and Steel Institute, *Annual Statistical Report*, 2004 and 2005.
[20] John Goodish, Chief Operating Officer, US Steel. Speech to the Economics Club of Pittsburgh. April 16, 2008.
[21] "Vertical integration" refers to an industrial structure in which a single entity controls several steps of the production process. This term should not be confused with "integrated mills," which refers to a particular steel-making technology that integrates the production of iron and steel.

offered the mills. Since the mills were still in operation, they continued to need repairs, lab work, engineering services, landscaping, and fire prevention. Soon, newly opened minimills would need both steel equipment and these related services.

The shift from employees to outside contractors—or de-verticalization—is also reflected in the industry's financial data. Between 1977 and 1997, U.S. steel mills more than doubled their expenditures on contract work. At the fully integrated mills, the rise in expenditure on contract work was even more pronounced, rising from 2% to 12% of value-added. For many regional steel-industry suppliers, the rise in contract work at local mills provided an opportunity to start a new business or expand the products and services of a current business. By the time the mills had closed in the Pittsburgh region, many of these suppliers were also able to expand their markets to reach steel producers in other areas as well as other end-use markets. In this way, the de-verticalization of the steel industry enabled steel-making expertise to remain in the Pittsburgh region in a different format.

Table 4: Expenditures on Contract Work by the Steel Industry, 1977-1997

($ million)	**1977**	**1982**	**1987**	**1992**	**1997**
Iron and Steel Mills (331111-NAICS, 3312-SIC)					
Value Added	15,332	11,763	15,820	16,569	24,629
Contract Work	548	420	1,013	1,551	2,062
As a share of Value Added	3.6%	3.6%	6.4%	9.4%	8.4%
Iron and Steel Mills, fully integrated (3311111-NAICS, 331211-SIC)					
Value Added	8,335	6,418	7,916	7,297	13,090
Contract Work	204	215	n/a	1,003	1,593
As a share of Value Added	2.4%	3.3%	n/a	13.7%	12.2%

Source: Economic Census of Manufacturing, Industry Series, Iron and Steel Mills.

The following organizational charts offer a simplified illustration of the process of de-verticalization that has occurred in the steel industry over the past thirty years. Figure 7 illustrates the structure of the vertically-integrated steel industry of the 1960s and 1970s, in which suppliers offered steel-making equipment, parts, or raw materials—generally as stand alone inputs to the steel producers. Most of the coordination, technical planning, repair, and services associated with these inputs were handled internally by the steel producers, as shown by their placement within the box containing steel mill production. University research programs were generally only involved with the steel producers and not with the suppliers. In addition, regional development efforts were able to assist the entire process by supporting the local steel producers.

Today, many of the activities previously performed within steel mills by mill employees, such as engineering services, are now performed by outside vendors, who coordinate their activities and output with each other as well as with the steel producer. As Figure 8 illustrates, the de-verticalization of steel production has had two main effects on the role of intermediate suppliers.

Figure 7: Vertically-Integrated, Domestically-Based Steel Production

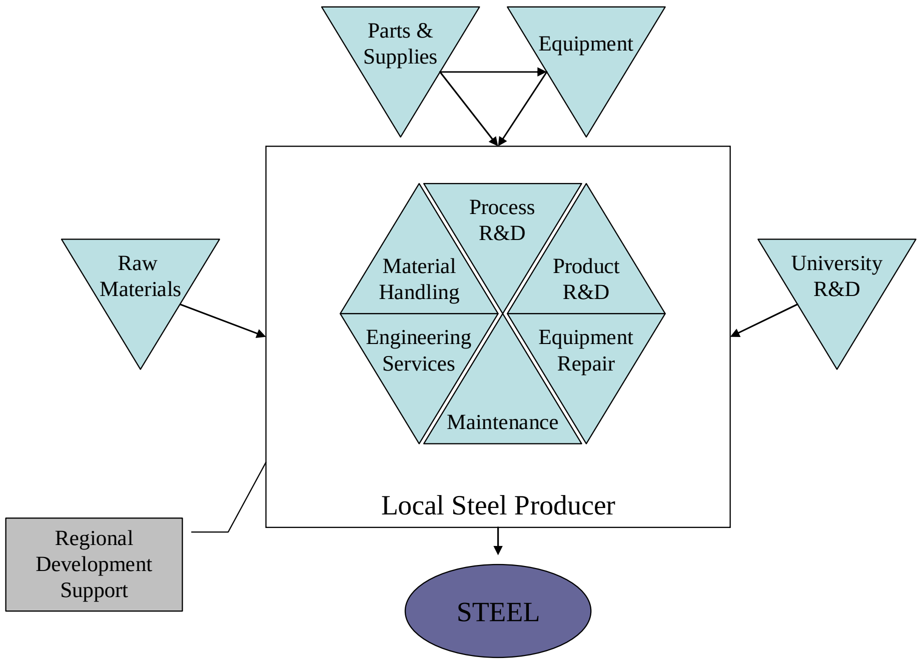
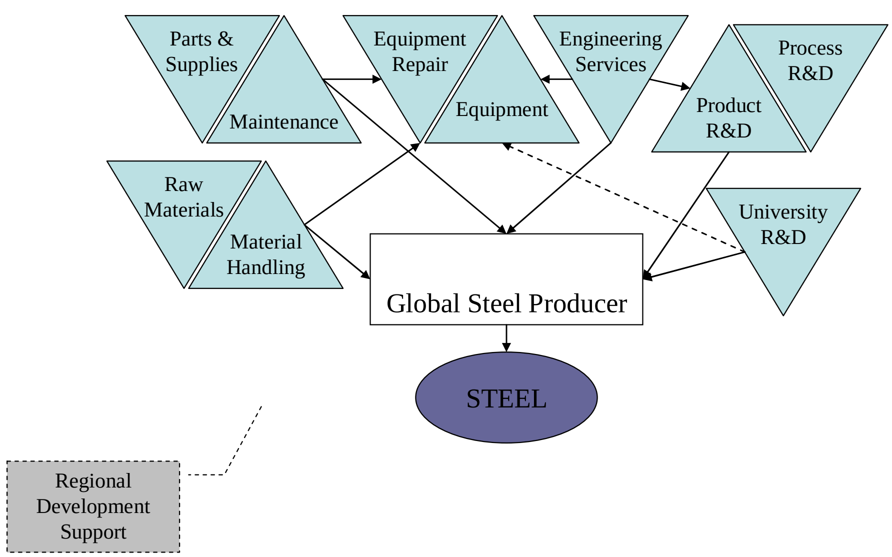


Figure 8: The Steel Technology Cluster and Global Production



First, they have expanded their role in the supply chain to include services as well as products, such as the bundling of material handling with the supply of raw materials and equipment repair with equipment sales. Second, they have developed a network of relationships with each other in order to coordinate the supply of products and services to a global (rather than local) industry. Although geographic proximity to the customer is no longer as critical to the suppliers, geographic proximity to other suppliers has risen in importance.

This structural transformation forms the basis for the development of the Steel Technology Cluster. With the development of the cluster, the relationship between other regional organizations and steel production has also changed. University research programs have begun to work with suppliers as well as producers, although collaboration is generally with the major equipment producers. As the chart also illustrates, the connection between the cluster of suppliers and the regional development community has been weakened during the transition process. This issue will be discussed further in the section on the "Weaknesses of the Cluster" below.

Markets and Innovation: Growth of the Steel Technology

Table 5: Current Projects to Build or Expand Steel Production in the United States

Buyer	Project	Cost	Date	Steel Technology Cluster
SeverCorr Columbus, MS	New flat product steel mill (1.7m tons of capacity)	$1B	October 2007 – 2010	Bricmont (tunnel furnace) SMS Demag (mill builder) Wheelabrator (air pollution control)
ThyssenKrupp Calvert, AL	Steel processing facility (5m tons of steel from slabs)	$3.7B	November 2007 – 2010	SMS Demag (mill builder)
Gerdau Ameristeel Jacksonville, FL	Expansion of rolling capacity by 0.4m tons.	n/a	Jan 08 – 2010	R.T. Patterson (melt shop design)
Minnesota Steel Nashwauk, MN	New iron-mining, iron-processing, and steel-making complex (2.5m tons of slab)	$1.6B	Sept 08 – 2010	Danieli (mill builder)
Nucor New Orleans, LA	New blast furnace facility (3m tons of pig iron)	$2B	Planning stages	Danieli Corus (mill builder)
US Steel Clairton, PA	Upgrade cokemaking	$1B	Planning stages	Not yet determined
Allegheny Technologies Brackenridge, PA	New rolling mill	$1.2B	Plans announced Sept. 2008	Not yet determined

Expansion and Upgrading

The current expansion of the steel industry has translated into increased demand for the services and products of the Steel Technology Cluster. Pittsburgh-based firms, such as SMS Demag, Bricmont, Wheelabrator, and RT Patterson, have been involved in the expansion of U.S. steel-making capacity at several recent projects, totaling over $10 billion, which are listed in Table 5 and detailed below.

SeverCorr: A major new steel-making facility was completed in October 2007 by SeverCorr—a joint venture between several American steel executives and the majority-owner, Severstal of Russia. The facility was built in Columbus, Mississippi, at the cost of approximately $1 billion and is expected to produce 1.7 million tons of flat-rolled steel using an electric arc furnace and an advanced finishing process. Pittsburgh area suppliers include SMS Demag, who had the major equipment contract; Bricmont, who provided the tunnel furnace; and Wheelabrator, who provided air pollution control equipment. The facility is strategically placed to serve the auto plants in the Southern states and in Mexico. Phase II is expected to increase production to 3.4 million tons and be completed by 2010.

ThyssenKrupp: The largest new steel facility built in the United States in at least a decade is a ThyssenKrupp processing facility, which began construction in November 2007 in Calvert, Alabama. With a cost of $3.7 billion, the plant is expected to employ 2700 people and produce over 5 million tons of steel from slab imported from Brazil.[22] Much of the large steel-making equipment will be built by SMS Demag.

Gerdau Ameristeel: This Brazilian-based company is expanding production capacity by 400,000 tons to reach a total of 1 million tons at its Jacksonville steel mill in Baldwin, Florida. Key improvements are being made to the melt shop and the rolling mill capacity. RT Patterson of Pittsburgh is developing the melt shop.

Minnesota Steel: Owned by Essar of Russia, Minnesota Steel is due to break ground in 2008 on a complex in Northern Minnesota that will include iron ore mining and the processing of the iron into direct reduced iron (DRI) for use in an on-site minimill that will be able to produce 2.5 million tons of slab each year. It will be the first minimill in the United States that is directly connected to an iron-processing facility.

Nucor: Nucor, the largest U.S. minimill producer, applied for a permit in June 2008 to build a new blast furnace facility in Louisiana near New Orleans. If the project is completed, it will represent the first new blast furnace facility built in the United States in over 30 years. The first phase of the project is expected to cost $2 billion and create 250 permanent jobs. The facility would enable Nucor to produce 3 million tons of pig iron, gaining a greater measure of control over its input costs and reduce its reliance on purchased scrap.[23] The joint venture of Danieli Corus has won the bid to build the facility.

[22] Press release from ThyssenKrupp, November 2, 2007. See http://www.thyssenkruppnewusplant.com/news.aspx?NewsId=19.
[23] Press release from Nucor, May 15, 2008. See http://www.nucor.com/indexinner.aspx?finpage=newsreleases.

US Steel: Closer to home, US Steel has announced a $1 billion upgrade of the Clairton cokemaking facility that supplies coke to blast furnaces at several US Steel integrated mills. According to US Steel's estimates, the upgrade will reduce air pollution emissions by 39% and will reduce airborne particle emissions (soot) by almost 58%.[24]

Allegheny Technologies: On September 17, 2008, Allegheny Technologies announced its intention to build a new rolling mill with advanced production technology at its Brackenridge, pending approval of necessary permits. Recent high levels of profitability will enable the company to finance the new mill with internal funds.[25]

New Steel Technology

Along with expanded and newly built steel-making facilities, advances in steel grades and the technology to produce steel have been an important source of market growth for the Steel Technology Cluster. Many of these innovations are led by the need to decrease the environmental impact of both steel-making and steel-based products, such as automobiles. Another major factor driving innovation is the need to reduce costs and improve efficiency in order to stay competitive within a globally changing industry. Key technological developments can be divided into advances in the metallurgy of steel; improvements in the production process; and environmental controls.

Metallurgy: Materials-based innovation includes new steel grades, dual phase strip steels, new light weight steels designed to meet CAFE requirements, and improvements in galvanizing of steel. Much of the funding for research in this area is supported by the U.S. Department of Energy. According to the US Steel Research and Technology Center, located in Munhall, there have been 50 new steel grades created just for auto use between 2000 and 2008 in order to improve safety and fuel economy.

Advances are also being made in the methods used to design new materials. According to TMS, the frontier of materials technology is the development of an Integrated Computational Materials Engineering (ICME) system. ICME would enable the complete design of a material from chemical structure to final use, resulting in rapid design times and reductions in staff required to complete a project.[26]

Production: There have been numerous advances in the production process for making steel and for supplying and refining its raw materials, such as scrap, iron, and coke. In some cases, these developments have led to the construction of entirely new mills, as with the development of thin slab casting the late 1980s. Ten new minimills that were built during the 1990s are listed in Table 6 along with some of their Pittsburgh area suppliers.

[24] Don Hopey, "U.S. Steel takes a 'giant step' in the Mon Valley," *Pittsburgh Post Gazette*, June 2, 2008. http://www.post-gazette.com/pg/08154/886687-28.stm.
[25] Len Boselovic, "$1.2B mill in works for area," *Pittsburgh Post Gazette*, September 18, 2008.
[26] For more information on the economic and technological benefits of ICME, see the report published by the National Research Council of the National Academies entitled "Integrated Computational Materials Engineering: A Transformational Discipline for Improved Competitiveness and National Security," Washington, D.C.: National Academies Press, 2008. The report was supported by the Department of Defense and the Department of Energy.

Table 6: Flat Product Minimills and their Pittsburgh Suppliers

Mill	Year Built	Pittsburgh Area Suppliers
Nucor Crawfordsville, IN	1989	Cegelac Automation (caster upgrade) SMS Demag (caster) Voest-Alpine (reversing/temper mill)
Nucor Hickman, AR	1993	Danieli (caster molds) Insight Automation Systems (computer system) Isotope Measuring Systems (integrated measuring system) SMS Demag (caster molds)
Gallatin Ghent, KY	1995	IMS Systems Inc. (gauges)
North Star BHP Delta, OH	1996	Bricmont (tunnel furnace) Concast Standard America (redesigned billet caster) Danieli (rolling mill) Voest-Alpine (total service contract)
Nucor Berkeley, SC	1996	Bricmont (reheat furnace) Busch International (fume-shield exhaust system) Danieli (rolling mill) D&L Inc. (construction engineering) Kvaerner Metals (pickling line) MG Industries (oxygen) SMS Demag (degassing facility and caster) Voest-Alpine (second cold mill)
Steel Dynamics Butler, IN	1996	Bricmont (tunnel furnace) Busch International (fume-shield exhaust system)
IPSCO Montpelier, IA	1997	SMS Demag (turnkey facility)
Trico Decatur, AL	1997	Voest-Alpine (caster maintenance)
IPSCO Mobile, AL	2001	AG Industries (equipment and services for roll shop) Ansaldo Ross Hill (electrical equipment and plate finisher) Danieli (rolling mill) Kvaerner Metals (construction engineering and management) International Mill Services (material handling) Techint (reheat furnace) US Filter (water system) Voest-Alpine (caster)
Nucor Hertford, NC	2001	Danieli (rolling mill) JBS Cranes and Accessories (cranes)
Source: Interviews conducted by faculty of the Center for Industry Studies. See Giarratani, Gruver, and Jackson (2007).		

More recently, SMS Demag has continued to advance the technology through its Compact Strip Production (CSP) process, which enables liquid steel to be directly processed into thin or ultra-thin hot strip - significantly thinner than 1.0 mm. SMS Demag has installed the most recent version of this technology in the new SeverCorr plant in Mississippi.

Other steps in the production of steel have also been the target of innovation technology. Berry Metal, of Harmony, has developed a Laser Contouring System (LCS) for finding flaws in the refractory lining of a ladle or furnace. The LCS represents a joint effort between the Technology Roadmap Program (TRP) of the American Iron and Steel Institute (AISI), Berry Metal's expertise with furnace injection technology, and a California company that makes process controls called Process Metrix. By characterizing the lining of steel-making vessels with advanced laser-based technology, the LCS offers "extended ladle lifetime and reduced refractory costs."[27]

Environmental Controls: One of the most problematic aspects of steel production from an environmental perspective is the production of iron in the blast furnace. Led by AISI's Technology Roadmap Program, there is currently a team from academia and industry that is working to develop an alternative to the blast furnace, a form of production that is over 100 years old, by producing direct reduced iron (DRI). The alternative is called the Paired Straight Hearth (PSH) furnace, and its development is motivated by the steel industry's need to reduce carbon emissions. The project is the result of research conducted at McMaster University in Canada and the production of a demonstration unit by Bricmont of Canonsburg, Pennsylvania. The installation of the demo unit is planned for either INMETCO of Ellwood City or US Steel's Edgar Thompson Works.[28] The estimated cost of the demonstration project is $16.7 million. In addition to the reduction of several forms of emissions, the PSH is expected to completely eliminate the emission of carbon monoxide from the iron smelting process.[29]

Market Diversity

Although these innovations in steel-making technology are important to the vitality of the Steel Technology Cluster, innovations in other markets play a significant role as well. The cluster has survived and prospered by diversifying both geographic and product markets. While some cluster firms are dedicated suppliers to the steel industry, most cluster participants sell to both steel and non-steel customers. Cluster firms have adapted their product lines to supply new markets, particularly ones that have a Pittsburgh presence—such as nuclear power, glass, and aluminum.

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[27] Quote is taken from Berry Metal promotional materials for the Laser Contouring System. See http://www.berrymetal.com/partners/process_metrix.htm

[28] Joe Vehec, Director, Technology Roadmap Program of AISI. Personal Interview. May 8, 2008

[29] Wei-Kao Lu, "A New Process for Hot Metal Production at Low Fuel Rate." American Iron and Steel Institute, 2006.

RT Patterson, an engineering services firm, has expanded its engineering expertise from the design of steel mills to the design of glass factories for PPG, plasma TV production for Sony, and baby food jars for Heinz.[30]

Resco Products, a manufacturer of refractory brick, has expanded into the market for pizza stones for baking and is now one of the largest U.S. suppliers of pizza stones, with customers such as Williams-Sonoma and Crate & Barrel.[31]

Mecco Marking and Traceability, which started in 1889 as a producer of hammers for marking steel product, is an excellent example of both innovation and diversification. In response to contraction in the steel industry, the company developed new forms of marking technologies and merged with another firm to eventually produce advanced automated and laser-based marking systems. This technology has been sold to a wide variety of industries, including defense, automotive, construction, and industrial machinery.

Strengths of the Steel Technology Cluster

Our interviews with firms in the Steel Technology Cluster included a wide variety of businesses: product and service based; domestic and international; family-owned and publically-traded; multi-plant and single enterprises; and Pittsburgh institutions and new comers. We asked each firm what drew them to or kept them in the Pittsburgh region. The advantages mentioned in their responses included the low cost of living and the central location between the East Coast and Midwest.[32]

However, their top answer was surprisingly uniform and straightforward: the technical knowledge of Pittsburgh's people. Pittsburgh has a reputation within the steel industry for having a strong engineering and technically-proficient workforce. More than any other factor, the technical knowledge of local labor seemed to be the key to attracting and retaining the members of the Steel Technology Cluster.

Pittsburgh's strength in this area is not a recent phenomenon, nor is it completely dependent on the steel industry's presence in the region. Pittsburgh's rich and diverse industrial heritage in industries such as glass, aluminum, and nuclear power—as well as the steel industry—has contributed to a critical mass of technical knowledge in the region. In addition, this heritage has been supported by three other types of institutions: (1) educational institutions; (2) research organizations; and (3) trade associations. The role of these institutions is an important part of understanding the advantages that the Pittsburgh region offers to the Steel Technology Cluster. Of course, these advantages are not guaranteed. The sections below detail the role of each institution as well as potential future sources of vulnerability.

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[30] Thomas C. Cehelnik, Vice President, R.T. Patterson. Personal interview with Sabina Deitrick of the University of Pittsburgh. July 16, 2007.
[31] Lane Harvey Brown, "Pittsburgh-based Resco Products expanding for pizza stone kiln," *The Business Journal of the Greater Triad Area*, April 4, 2008.
[32] According to the Allegheny Conference, 45% of the population of the United States and Canada lives within a 90 minute flight or a one day's drive from Pittsburgh.

Educational Institutions

Pittsburgh's network of colleges and universities provide an excellent supply of technically proficient graduates to the Steel Technology Cluster. The Pittsburgh region is home to 35 colleges and universities, with a total enrollment of nearly 130,000 students. Of the 30,000 degrees awarded each year, over 5,000 are in engineering, science, and technical fields.[33]

Table 7: Graduate Student Enrollment by University and Degree, 1995-2005

	Carnegie Mellon University			**University of Pittsburgh**		
(full-time students only)	Fall 1995	Fall 2005	1995-2005	Fall 1995	Fall 2005	1995-2005
Science and engineering	1,219	2,280	87%	1,993	2,280	14%
Science	704	1,515	115%	1,561	1,874	20%
Engineering	515	765	49%	432	406	-6%
Chemical engineering	70	97	39%	53	46	-13%
Civil engineering	56	75	34%	51	41	-20%
Electrical engineering	213	278	31%	119	91	-24%
Industrial engineering	0	101	n/a	65	44	-32%
Mechanical engineering	56	78	39%	66	46	-30%
Metallurgical and materials engineering	55	59	7%	32	17	-47%
Other engineering	65	77	18%	46	121	163%

Source: National Science Foundation/Division of Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering, 2005.

The academic institutions of Pittsburgh also include two national leaders in steel-related engineering research—the University of Pittsburgh (Pitt) and Carnegie Mellon University (CMU). As shown in Table 7, graduate student enrollment in the science and engineering programs of both schools is on the rise, although enrollment in engineering programs at Pitt is declining over the past decade. Enrollment in metallurgical and materials engineering has experienced the steepest decline at Pitt of any engineering program and has grown the slowest at CMU.

This drop in metallurgical engineering enrollment is part of a national trend that can be tied to the contraction of the U.S. steel industry in the 1980s and 1990s. As the industry contracted, research funding and job offers decreased significantly. These reductions in corporate funding precipitated declines in government sponsored research as well. Without these research programs, fewer graduate students specialized in steel-related or metallurgical research. When these graduate students became professors, their course offerings did not focus on the latest research in steel technology or metallurgy, further reducing the scope of metallurgy programs.

[33] Data is provided by the Pennsylvania Department of Education and reported by the Allegheny Conference. See http://www.alleghenyconference.org/PRA/RegionalData.asp.

Anthony DeArdo, a professor of engineering at the University of Pittsburgh and director of The Basic Metals Processing Research Institute (BAMPRI), has witnessed these trends and says that the result is a "knowledge gap" in which steel technology is getting more complex as academic curricula move away from teaching steel technology. His response to this gap has been to introduce a new set of coursework for engineering undergraduates at the University of Pittsburgh (see Illustration B).[34]

Illustration B: Ferrous Metallurgy Undergraduate Stream

In the mid-1970s, Pitt's Metallurgy and Materials Science Department typically graduated about 25 undergraduate engineering students per year, half of which entered the steel industry. In the late 1980s, the department was reorganized into the Materials Science and Engineering Department, with a corresponding decrease in the number of metallurgical courses. Graduating seniors dropped to about 8 per year, none of whom typically entered the steel industry at graduation. In 2007, the department was merged with the larger department of mechanical engineering to form the Mechanical Engineering and Materials Science (MEMS) Department. The combined department now graduates about 90 students per year, but student enrollment is skewed toward mechanical engineering

This trend at the University of Pittsburgh mirrors the trend for metallurgical programs at universities across the country. Although the metallurgy program at Pitt is fortunate in that it has a strong and active research program in steel technology through BAMPRI, there is limited undergraduate coursework and declining participation in the field. To address this gap, the department has recently developed an undergraduate minor in Ferris Physical Metallurgy, which includes dedicated coursework as well as internship opportunities with steel producers and suppliers. This program has received funding from ArcelorMittal.

The combination of the recent upswing in steel demand and enrollment declines in steel-related fields has contributed to a shortage of qualified engineers who are interested in the field. This shortage is exacerbated by the rising average age of employees in the steel industry. Steel producers are so concerned about this shortage that they have recently devised large-scale programs to fund academic research once again and to recruit new graduates (see Illustration C). At the 41st International Iron and Steel Institute's conference, John Surma, CEO of US Steel, stressed that the steel industry "cannot afford to lose the battle for talent."[35]

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[34] Anthony Deardo, University of Pittsburgh. Personal Interview. February 26, 2008.
[35] Hans Mueller, "Steel's Global Success Story Continues," *Metal Producing and Processing*, November 26, 2007 (http://www.metalproducing.com/classes/article/articledraw.aspx?HBC=feature&CID=79014).

In contrast, the Steel Technology Cluster has not been a significant participant in direct recruiting. In part, this is due to the relatively smaller size of the firms in the cluster than the firms in the steel industry itself. However, the growing shortage of engineers and technical personnel is beginning to change that pattern. For example, in 2007, SMS Demag participated in the job fair at the University of Pittsburgh, and its President and CEO, Joseph Dzierzawski, gave a presentation to the engineering students.[36]

The ability of the region to maintain a technically skilled workforce is critical to the continued success of the Steel Technology Cluster in the region. As a result, it is in the interest of the cluster and the region to promote technical education as well as the relationship between regional educational institutions and cluster members.

Illustration C: Recruiting by the Steel Industry

ArcelorMittal has identified 16 colleges as focal points for both business and technical recruiting. From the list of focus schools, ArcelorMittal has also identified a top tier from which they draw approximately 30% of their new hires. This top tier includes Purdue University, Pennsylvania State University, Missouri University of Science and Technology, the Colorado School of Mines, and the University of Pittsburgh. CMU is among the top 16 schools. The goal of their recruitment efforts is to hire 200 interns and 200 new hires per year.

Their recruitment program includes both investment in engineering programs, budgeted at $100,000 per year, and an active relationship between academic and industry leaders. ArcelorMittal has assigned an executive Vice President to adopt each of the 16 schools and to meet personally with the university administration. In addition, managers and engineers are sent to recruit new graduates from their alma maters.

United States Steel has a similar program, in which they have targeted 21 universities as recipients of grants, fellowships, and personal visits from corporate vice presidents, including both the University of Pittsburgh and Carnegie Mellon University. US Steel’s recruiting goal is to hire 250 new graduates and 250 mid-level managers per year.

[36] Joseph Dzierzawski, President and CEO, SMS Demag. Personal Interview. May 24, 2007.

Research Institutions

According to representatives of The Minerals, Metals & Materials Society (TMS), it would be difficult to find another U.S. city that had a similar combination of industry and university knowledge in materials engineering.[37] As listed in Table 8, both major research universities in the Pittsburgh region have steel research centers that are housed within their engineering department. In addition, Bayer, Westinghouse, PPG, Alcoa, and US Steel all have major materials research labs based in Pittsburgh.

Table 8: Materials Research Centers in the Pittsburgh Region

Type	Name	Material	Start Year	Current Location	Size
Academic	Basic Metals Processing Research Institute (BAMPRI) at the University of Pittsburgh	Steel	1975	Pittsburgh	20 researchers
Academic	Center for Iron and Steel Research (CISR) at Carnegie Mellon University	Steel	1985	Pittsburgh	20 researchers
Corporate	US Steel Research and Technology Center	Steel	1956	Munhall	115 employees
Corporate	Alcoa Technical Center	Aluminum	1965	Upper Burrell	600 employees
Corporate	Allegheny Technologies Technical and Commercial Center	Specialty metals	1956	Brackenridge	n/a
Corporate	PPG Coatings Innovation Center	Coatings	1974	Allison Park	n/a
Corporate	PPG Glass Technology Center	Glass	1958	Harmarville	300 employees
Corporate	PPG Chemicals Technical Center	Silica	1989	Monroeville	400 employees
Corporate	George Westinghouse Research and Technology Park	Nuclear materials	1955	Churchill (Cranberry in 2009)	700 employees
Corporate	Bayer Americas Technical Center	Polymers	2003	Robinson	n/a
Consortium	Technology Roadmap (TRP) of the American Iron and Steel Institute (AISI)	Steel	1997	Pittsburgh	88 partner organizations
Consortium	PA Nanomaterials Commercialization Center	Nano-materials	2006	Pittsburgh	300 members

[37] Warren Hunt, Director, and Todd Osman, Technical Director, TMS. Personal Interview. January 18, 2008.

In 2006, four of these corporations collaborated on an effort to move materials research to the next generation of research questions. Bayer, PPG, Alcoa and US Steel collaborated to form the Pennsylvania Nanomaterials Commercialization Center, with the goal of "accelerating the commercialization of nanomaterials research for new and enhanced products."[38] Although this center does not include a working research lab as the other centers do, it works to bring together the necessary researchers and organizations to address nanomaterials research questions.

Similarly, the mission of the Technology Roadmap Program (TRP) of the American Iron and Steel Institute (AISI) is to coordinate research programs that address steel-related questions. The program is a public private partnership between AISI and the U.S. Department of Energy's Office of Industrial Technology, which is designed to "(1) increase energy efficiency, (2) increase the competitiveness of the North American steel industry, and (3) improve the environment."[39]

Although Pittsburgh has two major academic research centers on steel metallurgy, BAMPRI and CISR, the share of R&D expenditures on these centers is relatively low. Table 9 illustrates the distribution of R&D expenditures at both CMU and Pitt. With nearly 90% of expenditure on life science research (which includes medicine and biotech), Pitt's R&D pattern reflects a national focus on the life sciences. CMU, in contrast, has decreased its life science program and is focusing over half of its R&D funding on computer and math sciences. While these fields are also vital components of the region's research economy, it is important for Pittsburgh to maintain its national reputation as a center for excellence in steel technology.

Table 9: R&D Expenditures at Universities and Colleges by Field, 2006

	All Institutions		CMU		Pitt	
(dollars in thousands)	2006	Share	2006	Share	2006	Share
All R&D expenditures	$47,760,402		$212,506		$530,162	52%
Life sciences (including medical)	$28,831,208	60.4%	$5,767	2.7%	$458,627	86.5%
Computer and Math Sciences	$1,967,831	4.1%	$120,498	56.7%	$5,659*	1.1%
Engineering	$7,076,182	14.8%	$56,824	26.7%	$21,254	4.0%
Bioengineering/biomedical	$476,420	1.0%	$6,068	2.9%	$6,156	1.2%
Chemical	$547,426	1.1%	$3,939	1.9%	$4,629	0.9%
Civil	$858,005	1.8%	$2,894	1.4%	$1,852	0.3%
Electrical	$1,613,939	3.4%	$20,626	9.7%	$1,427	0.3%
Mechanical	$1,047,881	2.2%	$5,532	2.6%	$1,951	0.4%
Metallurgical/materials	$643,662	1.3%	$5,279	2.5%	$3,071	0.6%
Engineering, nec	$1,507,682	3.2%	$10,968	5.2%	$2,168	0.4%

*Data is for 2005

Source: National Science Foundation/Division of Science Resources Statistics, Survey of Research and Development Expenditures at Universities and Colleges.

[38] Quote taken from "About the Pennsylvania NanoMaterials Commercialization Center" on the Center's website. See http://www.pananocenter.org/nano-center-about.aspx.

[39] Quote taken from the website of the Technology Roadmap Program. See http://www.steel-trp.org.

Furthermore, over half of the respondents to the 2005 survey of steel-industry suppliers conducted by the Center for Industry Studies said that regional universities were "not at all important" for either product development or technical support.[40] Given the strength of local academic research on steel technology issues, there appears to be a communication gap between the Steel Technology Cluster and university community (see Illustration D).

The Pittsburgh region has an opportunity during the current period of talent shortage to both capitalize on and increase its reputation as a center for excellence in steel technology. This opportunity will depend on the region's ability to recognize the virtuous circle that can exist between its academic institutions and its local industry. As a result, Pittsburgh may reap the benefits of additional research dollars as well as increased job opportunities for its graduates—raising the national profile of area universities. Although graduate retention is an important goal for the Pittsburgh cluster, the region's ability to maintain its reputation as a center of steel technological skills is even more critical for the cluster's continued success.

Illustration D: CISR Funding

The Center for Iron and Steel Research (CISR) of Carnegie Mellon University developed its research program with the support of the National Science Foundation (NSF) and 25 dues-paying member companies. Member companies, who were mainly steel producers, had access to both research output and graduate students. Downturns in the steel industry have led to loss of membership support as well declining interest in steel industry employment among its students.

According to Richard Fruehan, Director of CISR, steel industry placement of recent PhD graduates from the program has dropped from about 40% in the 1980s to about 5-8% today. He recommends that the supplier firms in the Steel Technology Cluster that are facing labor shortages become involved with CISR and structure a career path program for incoming employees.

Trade Associations

Pittsburgh is the headquarters of several key trade associations and professional societies for engineers within the steel industry as well as several related industries, such as mining and automotive (see Table 10). Interestingly, three of these organizations relocated their headquarters from New York to Pittsburgh in the late 1970s, including the

[40] Center for Industry Studies of the University of Pittsburgh, "Survey of the Pittsburgh Cluster of Suppliers to the Steel Industry," 2005.

Society of Automotive Engineers, which chose Pittsburgh over Detroit as its new location. The presence of these organizations appears to be both the result of a strong engineering base in Pittsburgh as well as a factor in attracting additional engineers and engineering-based companies.

For both TMS and SAE, the choice of a Pittsburgh area location appears to be motivated by regional expertise in materials research. According to the description of the relocation to Pittsburgh on the SAE website, "Pittsburgh at that time was, however, the home to the headquarters of a large number of companies that were key material and technical suppliers to mobility industries."[41] Similarly, the Materials Research Society was founded at Penn State in 1973, but moved to Warrendale in 1983.

Table 10: Engineering Trade Associations and Professional Societies in the Pittsburgh Region

Organization	Location and Year Established	Membership Description	Notes
Association for Iron and Steel Technology (AIST)	Warrendale, 2004	10,000 professional members (40% producers and 60% suppliers)	Merger of the Association of Iron and Steel Engineers (AISE, 1907) and the Iron and Steel Society (ISS, 1974), both Pittsburgh organizations. ISS had moved to Pittsburgh from New York in 1978.
Engineers' Society of Western Pennsylvania (ESWP)	Pittsburgh, 1880	1,000 professional members	Runs the International Bridge Conference and the International Water Conference
Materials Research Society (MRS)	Warrendale, 1983	15,000 professional members	Founded at Penn State University in 1973.
The Refractories Institute (TRI)	Pittsburgh 1951	48 member companies	Supports manufacturers of refractory materials and related products in North America.
Society of Automotive Engineers (SAE)	Warrendale, 1978	90,000 individuals	Established in 1905 and moved to Warrendale from New York City in 1978.
The Minerals, Metals & Materials Society (TMS)	Warrendale, 1978	11,000 professional members	Established in 1957 and moved to Warrendale from New York City in 1978. Used to be called The Metallurgical Society.

The key representative of the Steel Technology Cluster among these organizations is the Association of Iron and Steel Technology (AIST). AIST is the result of the merger of two separate steel-related engineering societies in 2004, and it continues their tradition

[41] Quote taken from "An abridged history of SAE" found on SAE's website. See http://www.sae.org/about/general/history.

of providing a forum for the diffusion of technical information in the industry. As an indication of the changing structure of the steel industry, the chair position on AIST technical committees was recently opened to members from supplier firms as well as from steel producers. Ron Ashburn, Director of AIST, reports that 60% of their membership is currently drawn from supplier firms and 40% from producer firms.[42]

However, the same problem facing the steel industry more broadly is also facing these organizations: the high average age of members. Both AIST and TMS report an average age for members of approximately 51. Although this has declined somewhat in recent years, it remains high and worryingly close to retirement age. Both organizations have student outreach programs, including fellowships and curriculum development, to encourage younger members to become aware of and involved with the association and its related industries.

These organizations also serve as an important source of networking and exchange of technical information. Although most are national in scope, they also host local events that bring together the scientists and engineers of the Steel Technology Cluster. When the AIST held its national conference, AISTech, in Pittsburgh this year, it set record attendance numbers, with 470 companies on the exhibition floor and over 8300 members in attendance.[43]

Despite these local events, none of these organizations truly serve as a regional networking organization for the Steel Technology Cluster, resulting in a "representation gap." The industrial interests of AIST and TMS are aligned with the cluster's interests, but both organizations have a national membership and agenda to consider. ESWP is regionally focused, but has a broad-base of industry members. The absence of a regional voice is a contributing factor to the low visibility of the Steel Technology Cluster in the region.

Weaknesses of the Steel Technology Cluster

Within the previous description of the strengths of the Steel Technology Cluster, we have already begun to glimpse a few of the major weaknesses of the cluster. Chief among these is the growing shortage of engineers and technical personnel. In addition, the absence of a representative regional organization is a source of vulnerability for the cluster. A third problem for the cluster, although not tied to any of the previous issues, is the declining access to national and international destinations through air travel. This third issue was a frequent complaint made by cluster members during onsite interviews. Each of these weaknesses is discussed in greater detail below, beginning with concerns about the Pittsburgh International Airport.

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[42] Ron Ashburn, Director, AIST. Personal Interview. January 18, 2008.
[43] "AISTech 2008 Conference and Exhibition Review," *Iron & Steel Technology*, August 2008, 37-43.

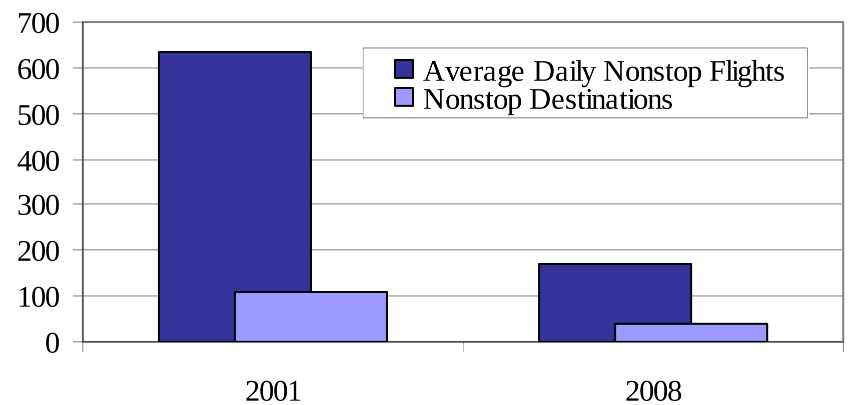
Pittsburgh International Airport

In interviews with members of the Steel Technology Cluster, the most common complaint about the Pittsburgh business environment was the declining number of flights at the airport. Anticipated concerns, such as businesses taxes or fragmented regional government, were not raised nearly as often or with as much vigor as the airport issue.

Although most residents are aware of the declining number of flights, the statistics are still surprising. Before September 2001, there were 633 daily nonstop flights leaving the Pittsburgh International Airport on average. The current number of nonstop flights has dropped by over 70%, averaging just 170 today. The situation continues to worsen as US Airways recently announced that it would end all direct flights between Pittsburgh and Florida in January 2009.[44]

The number of airports serviced from Pittsburgh has also declined. Currently, only 38 cities are reached by nonstop service, down from 110 in 2001.[45] Also important for the firms in the cluster, access to the top business destinations is limited. Of the top 30 business destinations, three have no nonstop service and another three have less than twice-daily service.[46]

Figure 9: Air Transportation Service at Pittsburgh International Airport



Source: Regional Air Service Partnership, Allegheny Conference

Currently, Pittsburgh is the largest market for U.S.-European travel without a direct flight, having lost its last flight to Europe in 2004. The absence of a Pittsburgh-European flight is particularly problematic for the three European mill builders that have their North American headquarters in Pittsburgh. As leaders in the Steel Technology Cluster, it is particularly important for the Pittsburgh region to avoid conditions that

[44] Mark Belko, "US Airways cuts nonstop flights to Florida," *Pittsburgh Post Gazette*, September 5, 2008.
[45] David Bear, "Nonstop flights from Pittsburgh drop sharply," *Pittsburgh Post Gazette*, April 6, 2008.
[46] Data has been provided by the Regional Air Service Partnership (RASP) of the Allegheny Conference.

would encourage their relocation. As one equipment supplier explained, steel industry customers prefer to fly to one location to bid a job.

The Regional Air Service Partnership (RASP) was formed in January 2004 by the Airport Authority, the Allegheny Conference, and the Allegheny County Executive in response to U.S. Airway's declaration of bankruptcy in 2003. RASP's mission is to maintain air transportation service regardless of U.S. Airway's plans. Although RASP has participated in several negotiations to return a direct flight to Europe from Pittsburgh, external issues in the airline industry, such as mergers and the price of fuel, have prevented a successful outcome. Continued efforts to improve air service to the Pittsburgh region are an important regional goal for the cluster.

Engineering Shortage

The availability of technically proficient labor in the Pittsburgh region is one of the key drivers behind the strength of the Steel Technology Cluster. Member firms in the cluster are drawn to the region by their need for a workforce that understands the technical aspects of steel making and its related equipment needs. Furthermore, the existence of alternative job opportunities locally is an important benefit to the technical workers themselves, attracting additional workers to the region. This mutually beneficial exchange—in which employers have access to many workers and workers have access to many job opportunities—helps to attract and retain both firms and people.

The exchange between cluster firms and technical workers is facilitated by several types of regional organizations. Trade and industry associations help to facilitate networking between firms as well as between firms and workers. The Pittsburgh Technology Council, for example, has an extensive job posting service that lists over 8000 jobs each year. As Figure 10 illustrates, job postings with the Tech Council have been growing steadily over the past five years, with particularly strong growth in computer and technical job positions, which represent about 60% of all job postings. Available engineering positions tripled between 2003 and 2006, growing from 445 over 1200 postings in 2006 before dropping slightly in 2007.[47] A representative of the Engineering Society of Western Pennsylvania described the current demand for engineers as the "reverse of a perfect storm—it's the perfect opportunity."[48]

This surge in demand for engineers and technical personnel has also been confirmed by another market bellwether—the temporary agency pool of labor. Although temp agencies are often seen as filling clerical and seasonal jobs, there are also temp agencies that specialize in filling industrial and technical positions as business cycles shift. There are several temp agencies in the Pittsburgh area that specialize in providing engineering staff to steel-related industries. One of these agencies, Contract Personnel Services, reports a shortage of engineers in the region that exceeds normal business

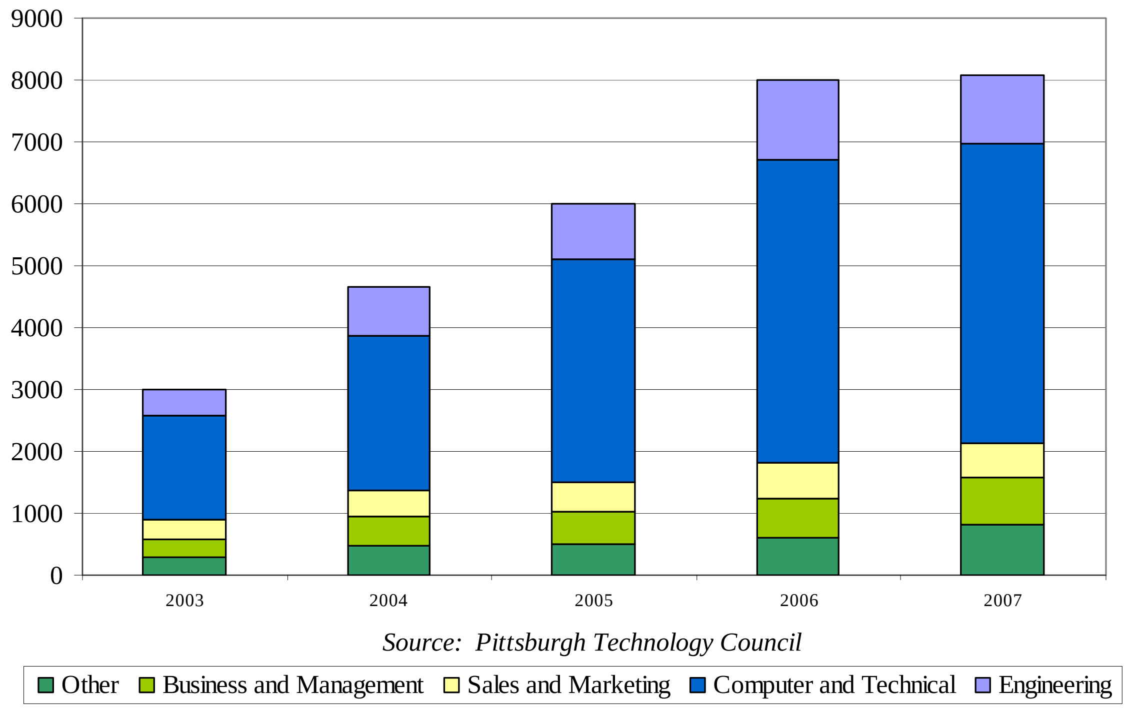
[47] Data has been provided by the Pittsburgh Technology Council.

[48] Dominick DeSalvo, Treasurer, Engineering Society of Western Pennsylvania. Personal Interview. April 23, 2008.

cycles. Following a slowdown between 2000 and 2003, the current surge of demand for engineers has reached a high point in the organization's recent memory.[49]

The shortage of engineers and technical labor is being fueled by both a surge in demand for steel and thus for steel-related technology as well as by a rising average age in the industry. If the retiring workforce is not replaced regionally, then Pittsburgh may lose its reputation for being home to a specialized, skilled workforce. Educational organizations, trade associations, and industry representatives are working to address this shortage by expanding educational programs and recruiting young workers. However, the concern for the Steel Technology Cluster is whether the Pittsburgh region can address the labor demand issues of the industry better and faster than other competing industrial regions. If so, the ties between the cluster and the region will be strengthened. If not, member firms may be drawn elsewhere in search of the technical skills that they require.

Figure 10: Job Postings with the Pittsburgh Technology Council



Source: Pittsburgh Technology Council

Visibility of the Cluster within the Region

The previous two issues are relatively concrete and specific in comparison to the issue of cluster visibility. Nevertheless, low visibility represents a critical weakness of the cluster with potentially far-reaching effects. Research on clusters in a variety of

[49] Mary Ann Fenters, Technical Recruiter, Contract Personnel Services. Personal Interview. April 21, 2008.

industries and locations has found that the supporting organizations of a region can be important to the growth and success of an industrial cluster. These supporting organizations include trade associations, economic development organizations, funding sources, universities, and community colleges among others. Through such organizations, cluster firms have greater access to capital, labor, policy-makers, and each other.

With the exception of the steel-related trade associations and research centers, there was little awareness among the Pittsburgh regional organizations of the size and national relevance of the Steel Technology Cluster. In fact, several major reports on clusters of economic activity in the Pittsburgh region have failed to identify the importance of suppliers to the steel industry to the regional economy.[50] In large part, this omission is due to the reliance of these reports on government industrial statistics, which are increasingly unable to identify a diverse, market-based cluster of firms such as the Steel Technology Cluster as discussed in Attachment A.

However, many of the organizations contacted for this study were interested in learning more about the cluster and incorporating the cluster's needs into their organization's goals. The Pittsburgh region is already home to a number of economic development organizations that could provide the type support needed by the cluster. Access to several of these organizations has been facilitated in recent years by their consolidation under the umbrella of the Allegheny Conference, which could thus serve as a forum to disseminate information about the cluster. In addition, the establishment of the Advanced Manufacturing Network by the Pittsburgh Technology Council offers a potential avenue for cluster networking and a forum for discussion of shared concerns.

There are also several sources of capitol that are prepared to support the financial needs of the cluster. Innovation Works and Bridgeway Capital (formerly CL Fund) offer financing that is targeted toward job creation and economic development goals. Members of the cluster have benefited from the programs offered at both of these organizations. In addition, a more traditional source of financing, PNC Bank, has begun to recognize the potential return on investment in the Steel Technology Cluster and, as a result, participated in the recent AISTech conference as both a sponsor and an exhibitor.

Although low visibility may have hampered regional recognition of the Steel Technology Cluster in the past, the economic development and financial community of the Pittsburgh region is poised to support the cluster in the future. As the community becomes better informed of the role that the cluster plays in regional resilience and economic growth, synergies between these organizations and the cluster should be easier to discover.

[50] See for example, *Manufacturing Pennsylvania's Future: Regional Strategies That Build From Current Strengths and Address Competitive Challenges*, prepared by Deloitte Consulting for the Team PA Foundation, January 2004 and the annual *State of the Industry Report*, prepared by the Pittsburgh Technology Council.

Future Prospects and Policy Recommendations

In making the transition from a traditional industrial economy to a high tech economy, the Pittsburgh region has sought to build expertise in technology-based industries with global growth potential. Toward this goal, it has supported the development of clusters in areas such as medical equipment, robotics, and tissue engineering. At the same time, a technology-based cluster with a global reputation for excellence has quietly established a Pittsburgh base with only limited regional recognition.

Part of the reason that the Steel Technology Cluster has been relatively unrecognized is that it arose from the ruins of the traditional industry, which was assumed to be lost. However, the cluster's roots in the steel heritage of Pittsburgh are a key source of its strength. In the words of Joseph Defilippi, Director of Product Technology for US Steel, the Pittsburgh Steel Technology Cluster is "creating a better future by building on traditions of the past."[51]

Although the cluster has done well thus far, it does face challenges that could be better addressed with improved regional support. Opportunities to improve metallurgical education, attract research funding, encourage local steel technology firms, supply non-U.S. mills, or increase air travel access may be missed if their relevance to the cluster is not fully understood. If Pittsburgh continues to see the steel industry as part of its past rather than an asset for the future, it may miss these critical support opportunities.

Therefore, more than any specific policies, the most important regional goal for the Steel Technology Cluster is to improve its ties to regional support organizations. Most importantly, the cluster needs to improve its connections to two main groups: (1) regional colleges and universities and (2) the regional economic development community, which includes governmental, non-profit, and financial organizations. In order to address the visibility issues that have thus far prevented these types of ties from forming, a concerted effort may be needed to bring the appropriate stakeholders together for a mutually beneficial discussion of their shared concerns. This effort may involve the identification of a coordinating organization or, more simply, the arrangement of a one-day stakeholders' workshop.

The Steel Technology Cluster offers the Pittsburgh region the opportunity to continue to play a vital role in the global steel value chain. The steel industry is expanding rapidly, creating skilled jobs and revenue growth throughout that value chain. By maintaining its reputation as place that "understands how steel is made," Pittsburgh can participate in the economic benefits of a high-growth and high-tech global industry. It can attract and retain a technically proficient workforce; offer high wage jobs; and bring revenue from other regions of the country and the world into the Pittsburgh economy.

[5151] Joseph Defilippi, Director of Product Technology, United States Steel Corporation. Personal Interview. February 21, 2008.

Attachment A

Identifying the Cluster with Government Statistics

In addition to the product diversity of participating firms, the changing structure of industrial production and revisions to industrial classification systems have created conditions that make it difficult to identify the cluster through traditional analytical techniques. As the factors needed for industrial production transition from vertically-integrated and nationally-bound entities to de-integrated and globally-dispersed facilities, it becomes increasingly difficult to identify how they link together to produce a final good. A concurrent change in the statistical codes used by the U.S. government data agencies to track industrial development that took place in 1997 has complicated this structural shift.[52]

Although there are analytical benefits to the 1997 reclassification, it makes the identification of industrial activity by markets even more difficult and overstates the extent to which some services are independent of other industries, such as manufacturing. As the following table illustrates, four of the top five industries in the Steel Technology Cluster are categorized as service industries.

Table 11: Industrial Codes of the Pittsburgh Steel Technology Cluster

NAICS*	Industry Description	Establishment Count	Share of Identified Industries
54133	Engineering Services	33	14.0%
42383	Industrial Machinery and Equipment Merchant Wholesalers	21	8.9%
42512	Wholesale Trade Agents and Brokers	17	7.2%
33351	Metalworking Machinery	10	4.2%
55111	Management of companies and enterprises	7	3.0%
	Total Pittsburgh Establishments with Identified Industry Code	263	37.3%

*North American Industrial Classification System (NAICS)
Source: AIST Directory Steel and Iron Plants, 2003, and U.S. Bureau of Labor Statistics.

Although firm classification may seem like a minor issue or a purely academic topic, it can have tremendous bearing on the ability of a region to recognize the major forces at work in its economy. One of the most significant issues for the Steel Technology Cluster is the shift to identifying individual establishments by activity rather than by end product. Under the new system, for example, the US Steel headquarters is

[52] In 1997, the product-based industrial groups of the Standard Industrial Classification (SIC) system were revised to correspond with the North American Industry Classification System (NAICS). These codes are used to identify business establishments by industry and then to group these industries into categories. Not only were the category groups changed during the transition, but the assignment of industries to individual establishments was also changed.

now classified part of a service industry called “Management of Companies and Enterprises” and is no longer classified as a manufacturing company.[53]

Using establishment-level data from the U. S. Bureau of Labor Statistics (2003), we were able to identify the primary industry code of 263 of the steel-industry suppliers identified in the *AIST Directory Iron and Steel Plants.*[54] Pittsburgh regional suppliers represent over 80 separate industries at the five-digit NAICS code level. The top 5 industries are identified in Table 11 and represent less than 40% of the intermediate supplier firms with an identified industry code.

[53] This category was created in 1997 by reclassifying over 35,000 establishments nationally from end-use categories such as Construction or Retail Trade into the activity category of Management. Of these reclassified establishments, 15% came from manufacturing. A similar reclassification occurred for other support facilities such as warehouses and computer services.

[54] U.S. Bureau of Labor Statistics, *Quarterly census of employment and wages (ES202)*, 2003.

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