Innovation in Manufacturing: Needs, Practices, and Performance in Georgia 2016-2018

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OPEN AND COLLABORATIVE INNOVATION: THE 2016 GEORGIA MANUFACTURING SURVEY EXECUTIVE SUMMARY

The Georgia Manufacturing Survey (GMS) is a statewide study conducted every 2-3 years by Georgia Tech's Enterprise Innovation Institute and School of Public Policy to assess the business and technological conditions of Georgia's manufacturers. The theme of GMS 2016 is smart manufacturing.

Technical and Basic Skill Needs Increase in 2016

Marketing and sales are the most common problem or need among Georgia manufacturers in 2016. Lean manufacturing priorities are still prevalent and the need for technical skills is also important. Needs for technical and basic skills rose substantially in 2016 compared to 2014 levels. Expansion planning needs also rose in the 2016 survey. In contrast, energy management needs declined to their lowest levels.

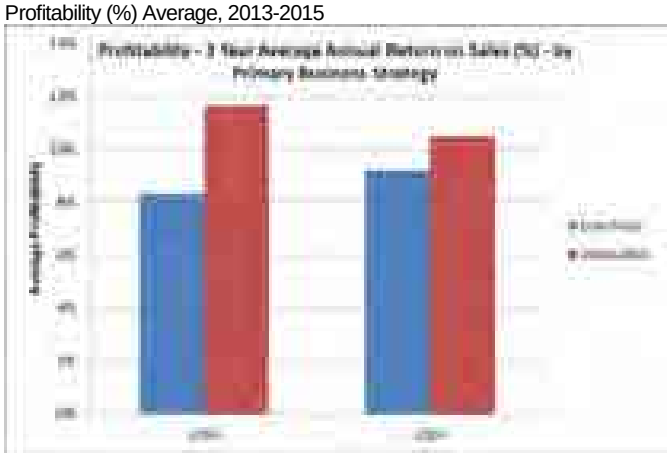
Outsourcing Rates Stabilize

Twelve percent of manufacturers were affected by outsourcing in 2016, just up from 2014 survey levels. The percentage of manufacturers benefitted from in-sourcing was about the same as 2014 levels, at 13 percent. A slight increase in in-sourcing opportunities from Europe was evidenced in the 2016 survey. In-sourcing was most prevalent among manufacturers in chemicals, medical devices and other science-based industries.

Profitability Rises for Georgia Manufacturers

Nearly 90 percent of Georgia manufacturers reported positive profitability returns from 2013 to 2015. Profitability grew by an average of 13% during the period. Profitability is associated with the strategies that manufacturers use to compete in the marketplace for sales. Eighteen percent of Georgia manufacturers compete primarily based on low price compared to only eight percent that compete through being innovative or using new technology. Manufacturers that prioritize innovation have 40% higher profitability than those that prioritize low prices.

Profitability (%) Average, 2013-2015



Open and Collaborative Innovation Not Much Used

Forty-five percent of Georgia manufacturers introduced a new product. Most of these developed this product by themselves. Only 21% who introduced a new product developed it cooperatively with another company, university, research institute or laboratory.

Resources for Innovation Not Widely Used

Nearly half of manufacturers have introduced a new product and 37 percent of manufacturers conduct in-house R&D. However, only 2 percent use public loans or grants, and 16 percent claimed an R&D tax credit.

Smart Manufacturing

Nearly half of Georgia manufacturers electronically collect and analyze data for improvement. The most common uses are for customer order monitoring, supplier monitoring, process improvement, and design specifications. Less than 40 percent use it for cybersecurity even though seven of 10 manufacturers production workers using the Internet at daily as part of their job.

About the Survey

- Mail surveys were sent to nearly than 4,000 manufacturers with 10 or more employees from January to May 2016. Completed surveys from 552 manufacturers were weighted to reflect employment and industry distributions in the Georgia Department of Labor database. Small manufacturers are those with 10-249 employees; large manufacturers are those with 250 or more employees.
- Survey results are used to improve manufacturing assistance programs and regional innovation initiatives in Georgia.
- Survey web site: http://www.gms-ei2.org

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Introduction: The 2016 Georgia Manufacturing Survey

The Georgia Manufacturing Survey 2016 is the 10th in a series of statewide manufacturing surveys conducted since 1994.[1] The survey benchmarks manufacturing performance in the state and identifies needs, issues, challenges, capabilities, and opportunities facing Georgia manufacturers so that strategies for enhancing their competitive advantages can be developed and improved. The 2016 survey focuses on how manufacturers are using smart manufacturing technologies. The survey also includes questions about trends in product, process, and organizational innovation; use of manufacturing technologies and techniques; operational performance; and the impact and effectiveness of Georgia's manufacturing assistance programs.

The 2016 survey went to all Georgia manufacturing firms with 10 or more employees. Of the 552 responses received, 526 surveys met the criteria of manufacturers with 10 or more employees. These 526 surveys were weighted to reflect the actual distribution of manufacturers by industry and employment size in Georgia and form the basis for the results described in this report.

This report is divided into eight sections. Chapter 2 examines manufacturer problems and needs. Chapter 3 looks at manufacturing strategies. Chapter 4 focuses on innovation practices, benefits, and barriers. Chapter 5 examines use of manufacturing technologies and techniques. Chapter 6 examines workforce training and organizational approaches. Chapter 7 reports manufacturing performance metrics. Chapter 8 summarizes survey responses about use of information and assistance sources, including Georgia Tech. For more information about the survey, see Appendix 1.

Definitions

Throughout this report, information will be broken down by employee size, industry group, and Georgia Tech service delivery region in 2012. Industry groupings and their North American Industrial Classification System (NAICS) are described in Box 1. These breakdowns are based on Pavitt's technology trajectories sectoral model.[2] Results will also be presented terms of Georgia major geographic service areas—

[1] Jan Youtie and Philip Shapira, "Manufacturing Needs, Practices and Performance in Georgia: 1994 Georgia Manufacturing Technology Survey," GMEA Evaluation Working Paper E9501, Revised, March 1995; Jan Youtie and Philip Shapira, "Manufacturing Needs, Practices and Performance in Georgia, 1994-1998," GMEA Evaluation Working Paper E9703, May 1997.

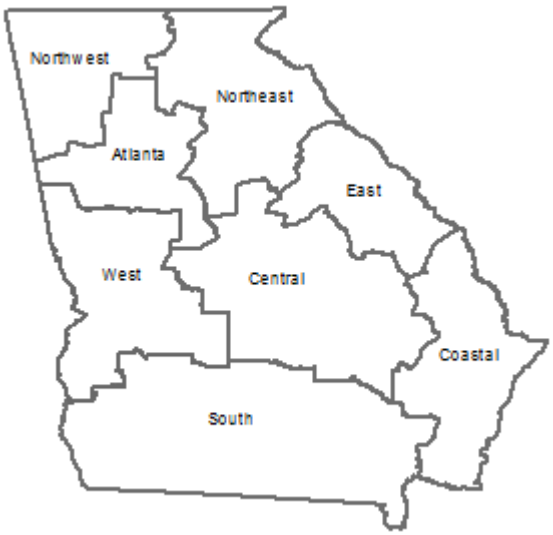
[2] Keith Pavitt. (1984) 'Sectoral patterns of technical change: towards a taxonomy and a theory', Research Policy, Vol. 13, pp. 343–373

Northwest (Dalton, Rome, Cartersville), Northeast (Gainesville, Athens), Atlanta (North Metro, South Metro), West (Columbus, LaGrange), East (Augusta), Central (Macon, Dublin, Warner Robins), South, (Albany, Douglas), and Coastal (Savannah, Brunswick). (See Figure 1.)

Table 1.1. Industry Group Definitions

Industry Group	Abbreviation	NAICS	Description
Supplier sectors	Food-Text	311	Food Manufacturing
		312	Beverage and tobacco product manufacturing
		313	Textile mills
		314	Textile product mills
		315	Apparel manufacturing
		316	Leather and allied product manufacturing
Scale intensive	Material	321	Wood product manufacturing
		322	Paper manufacturing
		323	Printing and related support activities
		326	Plastics and rubber products manufacturing
		327	Non-metallic mineral product manufacturing
		337	Furniture & related product manufacturing
Specialized suppliers	Mach	331	Primary metal manufacturing
		332	Fabricated metal product manufacturing
		333	Machinery manufacturing
Specialized suppliers	Elec-Trans	336	Transportation equipment
		334	Computer and electronic product manufacturing
		335	Electrical equipment, appliance & component manuf.
Science-based	Science	324	Petroleum & coal products manufacturing
		325	Chemical manufacturing
		3391	Medical equipment and supplies manufacturing

Figure 1. Georgia Regions Used in Analysis



Chapter
2

Problems and Needs

We start by examining the most significant problems or needs of Georgia manufacturers. The Georgia Manufacturing Survey 2016 asked a question that has been posed in all six manufacturing surveys, including those conducted in 1994, 1996, 1999, 2002, 2005, 2008, 2010, 2012, and 2014: "In which of the following areas does your facility have the most significant problems or needs?"

Nearly all of the respondents (95 percent) indicated that they had at least one significant problem or need at their facility. The average respondent checked 2.4 problem areas. Although 27 percent noted only one problem, a handful (2%) reported seven or more problems.

Manufacturers' Problems – Search for Basic, Technical Skills

Although manufacturer's priorities have maintained marked stability over time, the 2016 survey underscores several important changes (Table 2.1). First, marketing and sales were a significant need of 35 percent of respondents. This percentage is above 2014 levels.

Second, the frequency of human resource problems has increased dramatically since 2014. Fifty-three percent of manufacturers have one or more human resource needs. Needs for workers with technical skills are more common than the need for workers with basic skills. Nearly 35 percent of manufacturers have a need for technical workers and 29 percent with a need for basic skills. These percentages are 7 percent higher respectively than in the 2014 survey. Management and leadership needs in the 2016 survey are at roughly the same levels as they were in the 2014 survey.

Third, lean manufacturing is still a prevalent manufacturing concern, with 31 percent indicating a need in this area. Likewise, the survey shows rising concerns with facility layout and quality assurance, suggesting greater attention to good manufacturing practices.

Fourth, the 2016 survey showed a considerable decline in the percentage of respondents with worries about energy cost management. Only 9 percent of Georgia manufacturers reported a significant problem with energy cost management versus 12 percent in 2014 and 21 percent of in 2012. This decline reflects the continued drop in energy prices that has occurred in the last two years. Environmental, health, and safety compliance also attracted fewer responses than in the 2014 survey, with 11% of respondents indicating this as an area of concern.

Fourteen percent of manufacturers reported an IT problem or need. The same percentage of respondents to the 2014 survey registered a need in the product development and design area. Business and finance needs garnered an 12 percent response.

Table 2.1. Manufacturing Problems and Needs: 2016, 2014, 2012, 2010, 2008, 2005, 2002, 1999, 1996, 1994

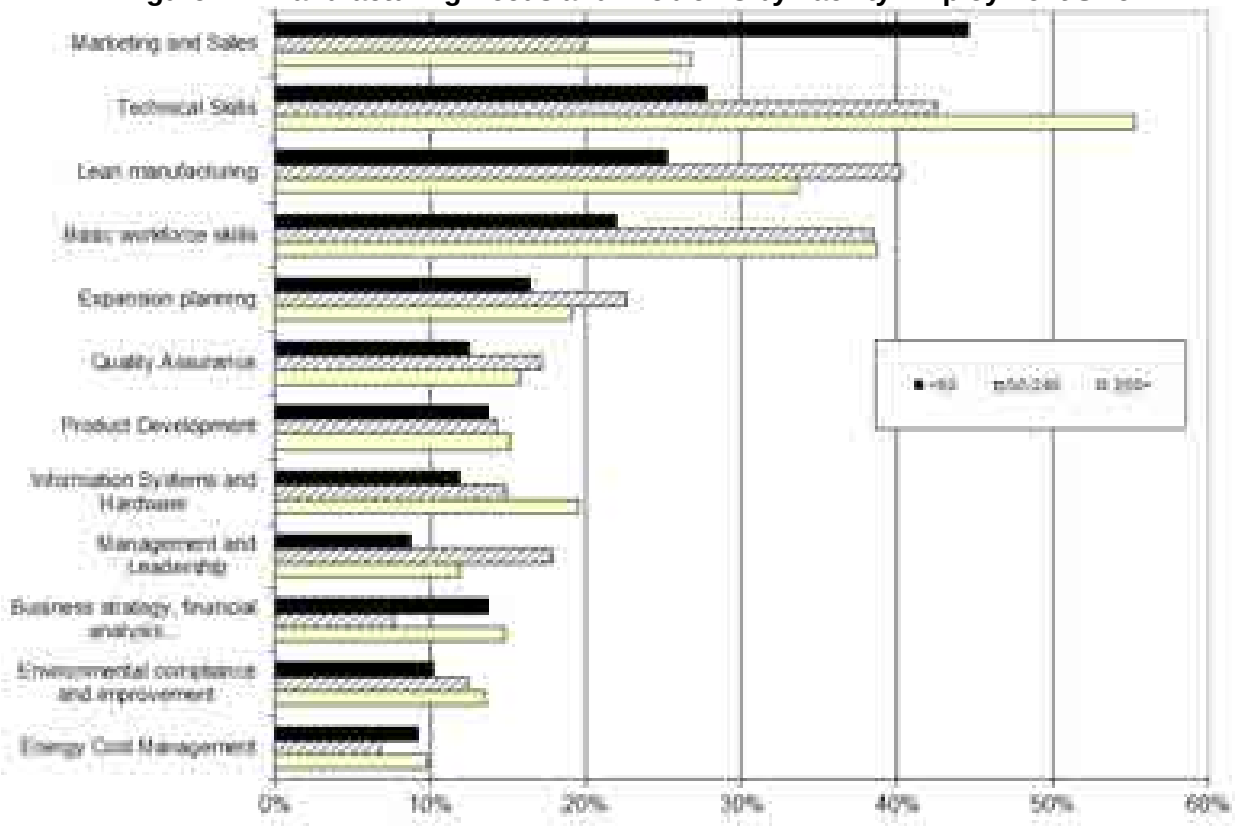
Problems/Needs	2016	2014	2012	2010	2008	2005	2002	1999	1996	1994	Diff. 2016-2014
Marketing and sales	35.3%	32.3%	36.0%	39.1%	32.9%	25.2%	36.9%	25.0%	17.0%	15.0%	3.0%
Technical skills	34.7%	27.5%	23.5%	18.8%	23.8%	23.3%	26.6%	25.0%	31.0%	n/a	7.2%
Manufacturing process/lean	30.8%	27.9%	31.6%	31.6%	32.3%	38.9%	34.4%	29.0%	27.0%	37.0%	2.9%
Basic skills	28.6%	21.8%	16.4%	13.9%	21.9%	25.6%	10.6%	13.0%	16.0%	n/a	6.8%
Expansion planning, facility layout	18.6%	16.3%	13.8%	13.5%	17.6%	20.6%	24.0%	22.0%	22.0%	25.0%	2.3%
Quality assurance	14.3%	10.4%	13.6%	11.5%	17.1%	14.7%	17.2%	17.0%	19.0%	22.0%	3.9%
Product development, design	14.0%	12.2%	11.4%	15.4%	15.5%	12.5%	19.0%	13.0%	13.0%	12.0%	1.8%
Information systems & hardware	13.5%	11.2%	12.2%	11.1%	10.7%	14.3%	20.1%	27.0%	17.0%	13.0%	2.3%
Management and leadership	12.0%	12.9%	12.2%	12.8%	12.6%	15.6%	26.2%	21.0%	33.0%	n/a	-0.9%
Business, Finance	11.9%	11.1%	11.4%	13.5%	13.0%	15.8%	19.7%	n/a	n/a	n/a	0.8%
Environmental, safety compliance, health, workplace	11.1%	12.1%	13.5%	12.3%	13.3%	15.0%	17.6%	15.0%	17.0%	29.0%	-1.0%
Energy costs management	8.5%	11.4%	21.4%	18.9%	23.2%	19.1%	15.3%	10.0%	13.0%	16.0%	-2.9%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 surveys; Georgia Manufacturing Survey 2014, weighted responses of 504 surveys; Georgia Manufacturing Survey 2012, weighted responses of 528 surveys; Georgia Manufacturing Survey 2010, weighted responses of 494 surveys; Georgia Manufacturing Survey 2008, weighted responses of 677 surveys; Georgia Manufacturing Survey 2005, weighted responses of 648 surveys; Georgia Manufacturing Survey 2002, weighted responses of 636 surveys; Georgia Manufacturing Survey 1999, weighted responses of 727 manufacturers; Georgia Manufacturing Survey 1996, weighted responses of 1,002 manufacturers; Georgia Manufacturing Technology Survey 1994, weighted responses of 1,180.

Problems and Needs by Size, Industry, and Region

Large manufacturers with 250 or more employees were more likely to have a higher level of concern about finding employees with technical skills than were their smaller counterparts (Figure 2.1, yellow bar). Managing information technology was also more prominent among large manufacturers. Medium-sized firms with 50 to 249 employees were most likely to express a need for lean manufacturing, expansion planning, and quality assurance (cross-hatched bars). They also frequently indicated problems finding employees with basic skills, almost as much as did large manufacturers. Small businesses with 10 to 49 employees were more apt to indicate marketing was a great need compared to their larger-firm counterparts.

Figure 2.1. Manufacturing Needs and Problems by Facility Employment Size



Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

The emphasis given to specific problems differed by industry groups. The need for technical skills was most prevalent for machinery industries (43%), while those in the food-textiles and materials group were more likely to prioritize basic skills needs (33% and 34% respectively). Marketing needs were most common for machinery (39%), electronics/transportation (37%), and materials industries (36%). Lean manufacturing was a need for about one-third of the establishments in all but the food-textiles group (Table 2.2).

Table 2.2. Manufacturing Problems and Needs by Industry

Problems/Needs	Food-Text	Materials	Mach	Elec-Trans	Science
Marketing and Sales	27.5%	37.9%	40.1%	36.7%	27.1%
Technical Skills	26.5%	30.8%	42.7%	40.8%	39.6%
Lean manufacturing	26.1%	30.1%	32.7%	36.7%	31.2%
Basic workforce skills	32.3%	33.2%	18.5%	26.5%	29.2%
Expansion planning	22.4%	17.8%	19.9%	10.2%	20.8%
Quality Assurance	11.2%	11.3%	17.8%	18.4%	18.7%
Product Development	12.2%	9.7%	16.0%	26.5%	16.7%
Information Systems and Hardware	13.0%	10.9%	16.4%	12.2%	18.7%
Management and Leadership	12.4%	10.0%	9.9%	18.4%	16.7%
Business strategy, financial analysis...	5.6%	16.0%	7.6%	16.3%	12.5%
Environmental compliance and improvement	12.6%	9.3%	11.0%	4.1%	22.9%
Energy Cost Management	10.1%	9.5%	7.5%	4.1%	8.3%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Marketing and sales needs were the most widespread concern for manufacturers in the Atlanta region. Lean manufacturing needs were most commonly expressed by respondents in the East region, along basic workforce skills needs. The West region was distinctive in that manufacturers in this region were more likely to mention problems and needs with technical skills than with any other area. The second most common concern among respondents in the South region, after marketing and sales, was basic workforce skill needs. Expansion was most pressing for manufacturers in the Northeast region. Energy cost management was most often a concern of respondents in the Coastal region. (Table 2.3).

Table 2.3. Manufacturing Problems and Needs by Region

Problems/Needs	North -west	North -east	Atlan- ta	West	Cen- tral	East	South	Coast -al
Marketing and Sales	29.4%	29.9%	42.0%	30.9%	35.0%	16.5%	36.4%	35.5%
Technical Skills	33.4%	33.8%	35.1%	44.2%	30.3%	34.8%	29.8%	40.6%
Lean manufacturing	23.5%	32.9%	35.0%	31.7%	36.4%	38.1%	19.3%	26.3%
Basic workforce skills	30.3%	25.3%	25.0%	41.3%	31.3%	53.1%	28.9%	25.2%
Expansion planning	17.7%	28.6%	18.5%	16.4%	9.9%	3.7%	20.3%	14.1%
Quality Assurance	10.5%	5.9%	21.2%	8.8%	16.9%	26.1%	8.7%	5.6%
Product Development	15.2%	6.5%	19.1%	6.8%	15.9%	10.5%	6.5%	16.5%
Information Systems and Hardware	19.4%	13.9%	10.7%	12.3%	13.2%	6.8%	12.2%	21.0%
Management and Leadership	7.2%	12.6%	15.0%	13.5%	7.9%	19.0%	13.6%	0.0%
Business strategy, financial analysis...	9.1%	7.1%	12.3%	13.2%	18.4%	17.0%	10.5%	20.6%
Environmental compliance and improvement	14.4%	9.5%	8.0%	8.7%	9.4%	25.3%	17.6%	12.5%
Energy Cost Management	12.7%	7.9%	6.0%	7.5%	0.0%	12.2%	18.7%	4.9%

Source: Georgia Manufacturing Survey 2014, weighted responses of 504 manufacturers.

Chapter
3

Manufacturing Strategy

This section explores the strategies that manufacturers chose to compete for customer sales. The analysis is based on a series of questions that ask manufacturers to rank six strategies from 1 (highest importance) to 6 (lowest importance) based on how important the strategies are to the firm in competing in the marketplace for sales. The six strategies are low price, high quality, innovation/new technology, quick delivery, adapting to customer needs, and sustainable or green manufacturing. The latter strategy was substituted for value-added services, which was the sixth response choice in prior years' surveys. The results reported in this chapter represent the percentage of manufacturers that chose each strategy as their highest choice. This series of questions was also asked in the 1999, 2002, 2005, 2008, 2010, 2012, and 2014 surveys which facilitates exploration of changes in primary manufacturing strategies over time.

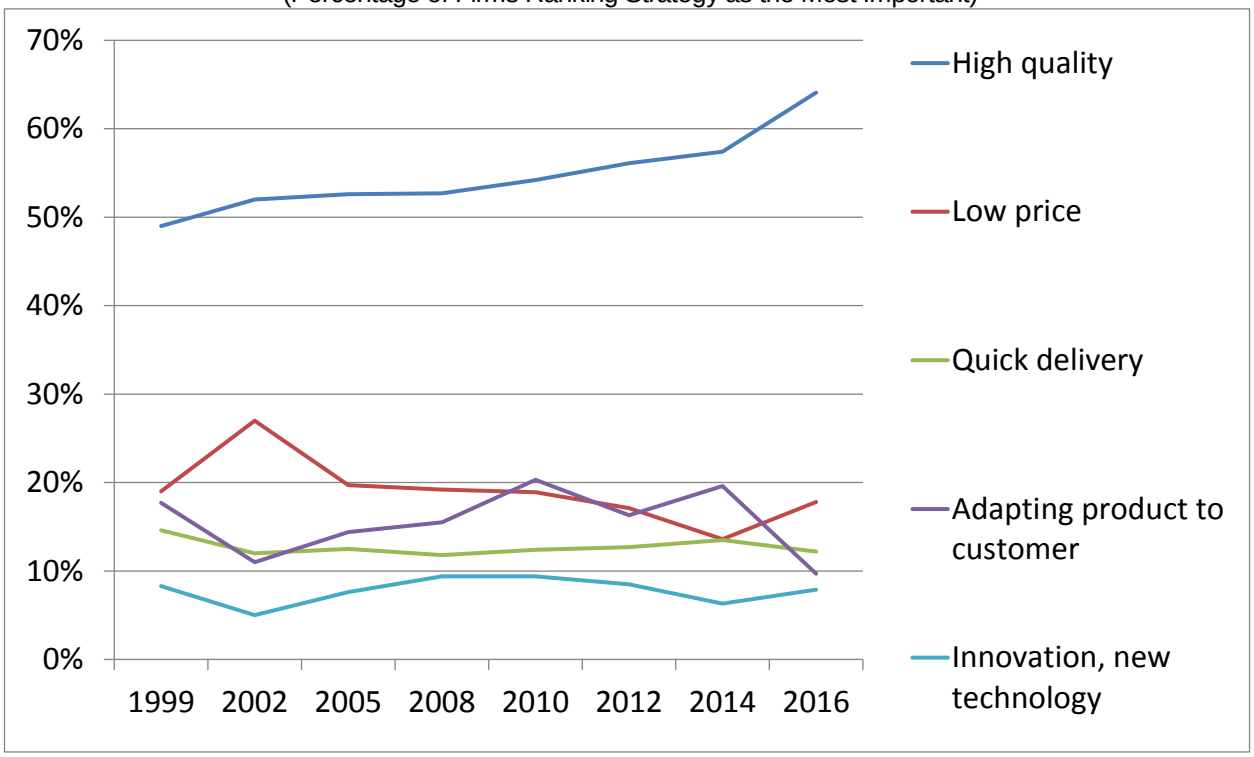
The 2016 survey found that 64% of Georgia manufacturers prioritize quality of service as their primary strategy in competing for customer sales. Low price was a primary strategy for 18 percent of Georgia manufacturers. Twelve percent of respondents prioritized quick delivery as a top strategy. Adapting to customers' needs was cited by only 10 percent of the manufacturers. Innovation/new techniques constituted a top strategy for only 8 percent of manufacturers. Only 2 percent of manufacturers indicated that sustainable or green manufacturing was their top strategy.

Since 2014, the percentage of respondents competing for sales primarily based on quality and low price has increased. The percentage of firms competing primarily on quick delivery and customization has dropped somewhat from 2014 levels (Figure 3.1).

Strategies by Firm Characteristics

Little difference by employment size is observed in prioritization of strategies for competing for sales (Table 3.1). Large manufacturers were less likely to compete based on quality and innovation. Adapting the product to customer needs was most important among small manufacturing establishments.

Figure 3.1. Top Manufacturing Strategies: 1999-2016
(Percentage of Firms Ranking Strategy as the Most Important)



Source: Georgia Manufacturing Survey 2016, weighted responses of 526 surveys; Georgia Manufacturing Survey 2014, weighted responses of 504 surveys; Georgia Manufacturing Survey 2012, weighted responses of 528 surveys; Georgia Manufacturing Survey 2010, weighted responses of 494 surveys; Georgia Manufacturing Survey 2008, weighted responses of 738 surveys; Georgia Manufacturing Survey 2005, weighted responses of 648 surveys; Georgia Manufacturing Survey 2002, weighted responses of 636 surveys; Georgia Manufacturing Survey 1999, weighted responses of 727 manufacturers.

All industries favored high quality as a primary sales strategy. Manufacturers in food/textiles/apparel/leather industries placed a particularly high priority on quality strategies. High quality was least important to electronics/transportation manufacturers, although still the most common top priority. Electronics/transportation manufacturers placed higher priority on low price than did any of the other groups. Low price was also important to food and textile firms firms. The importance of quick delivery was particularly prominent for materials and science-based manufacturers. Innovation strategies also were most important to the electronics and transportation group (Table 3.2).

Competition based on high quality was the most common strategy for respondents in all regions of the state. High quality was most likely to be prioritized by manufacturers in the East, Coastal, and Northeast, regions (88 percent, 76 percent, and 74 percent respectively). Low price, quick delivery, and adapting products to customer needs attracted the highest percentage of respondents prioritizing this strategy in the West region. Prioritization of innovation-oriented strategies accounted for 13 percent and 11 percent of respondents in the Central and Atlanta regions respectively (Table 3.3).

Table 3.1. Most Important Manufacturing Strategies by Facility Employment Size
(Percentage of firms indicating strategy is of highest importance)

Strategy	10-49	50-240	250+
High quality	60.7%	64.7%	88.7%
Low price	19.2%	19.4%	0.0%
Quick delivery	13.9%	11.6%	1.4%
Adapting product to customer	11.5%	6.8%	7.9%
Innovation, new technology	8.6%	7.4%	4.2%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 surveys

Table 3.2. Most Important Manufacturing Strategies by Industry Group
(Percentage of firms indicating strategy is of highest importance)

Strategy	Food-Text	Material	Mach	Elec-Trans	Science
High quality	65.0%	64.3%	69.0%	53.1%	62.5%
Low price	20.7%	17.2%	15.8%	22.5%	14.6%
Quick delivery	4.3%	16.1%	12.7%	8.2%	14.6%
Adapting product to customer	12.6%	11.4%	5.7%	12.2%	4.2%
Innovation, new technology	7.2%	5.7%	8.2%	14.3%	10.4%

Source: Georgia Manufacturing Survey 2016 weighted responses of 526 surveys

Table 3.3. Most Important Manufacturing Strategies by Region
(Percentage of firms indicating strategy is of highest importance)

Strategy	North-west	North-east	Atlanta	West	Central	East	South	Coast-al
High quality	62.7%	73.6%	65.3%	35.6%	56.9%	88.2%	56.9%	75.5%
Low price	21.7%	15.7%	13.4%	32.4%	22.2%	18.8%	19.1%	17.1%
Quick delivery	9.7%	12.3%	13.7%	20.0%	14.4%	6.9%	12.7%	0.0%
Adapting product to customer	11.1%	5.9%	8.0%	21.7%	18.1%	6.9%	10.6%	3.5%
Innovation, new technology	7.6%	2.7%	11.0%	7.1%	12.6%	6.9%	3.9%	3.9%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 surveys

Outcomes of Strategies

How have these strategies fared in generating sales returns, which manufacturers care about, and employee wages, which economic developers care about? Average return on sales over a three-year period is one measure of the profitability of an establishment. We found that there were more manufacturers with positive profitability and fewer with negative profitability than in the 2014 survey. In 2014, the mean (average) return on sales was 8.6 percent and the median (50th percentile) was 9.7 percent. By 2016, the mean

return on sales rose to 11 percent although the median was the same as in 2014 at 9 percent.

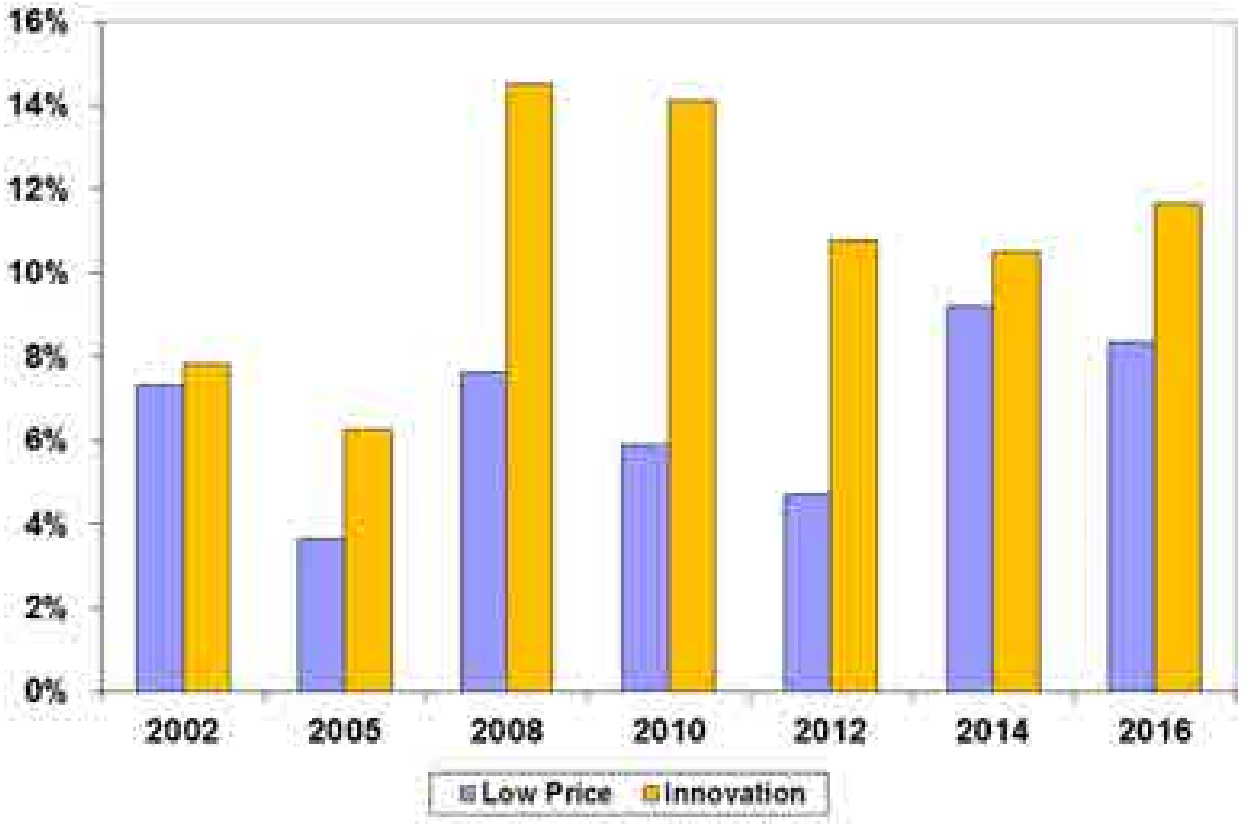
We found that the average return on sales for establishments that compete primarily on low price were pretty close to those of firms competing on innovation in 2002; only a half of a percentage point separated the two strategies. By 2005, these margins had widened. Establishments competing primarily through low price had margins that were two-and-a-half percentage points below those of firms competing primarily through innovation. In the 2008 survey, the margins had expanded yet again so that average return on sales for manufacturers prioritizing innovation strategies had profitability levels that were nearly twice that of those prioritizing low price. The 2010 survey showed that the profitability difference between manufacturers competing on low price and innovation widened even further, despite the drop in profitability. The 2012 survey also indicates a drop in profitability for both types of strategies. The 2014 survey indicated that profitability has doubled for manufacturers competing based on low price while it has stayed about the same for those prioritizing innovation strategies; the two strategies were very close in average returns on sales. But by 2016, the profitability difference between the two strategies widened once again, with manufacturers competing based on innovation being 40% more profitable on average than those competing based on low price (Figure 3.2).

Across all strategies, we found that strategies prioritizing innovation had the highest mean return on sales of 11.7%. Low price had the lowest mean return on sales of less than 9 percent. High quality strategies were associated with margins of 11.5 percent, quick delivery in the 11.2 percent range, and adapting to customer needs in the 10.7 percent range.

Average wages are calculated by dividing annual payroll by number of employees. Average wages can be viewed as a “return to the community,” since well-paid employees can generate further “induced” economic development impacts through the purchase of additional local goods and services. Average wages of respondents by strategy ranged from $38,000 to more than $63,000, with innovation strategies associated with an average wage of over $63,000.

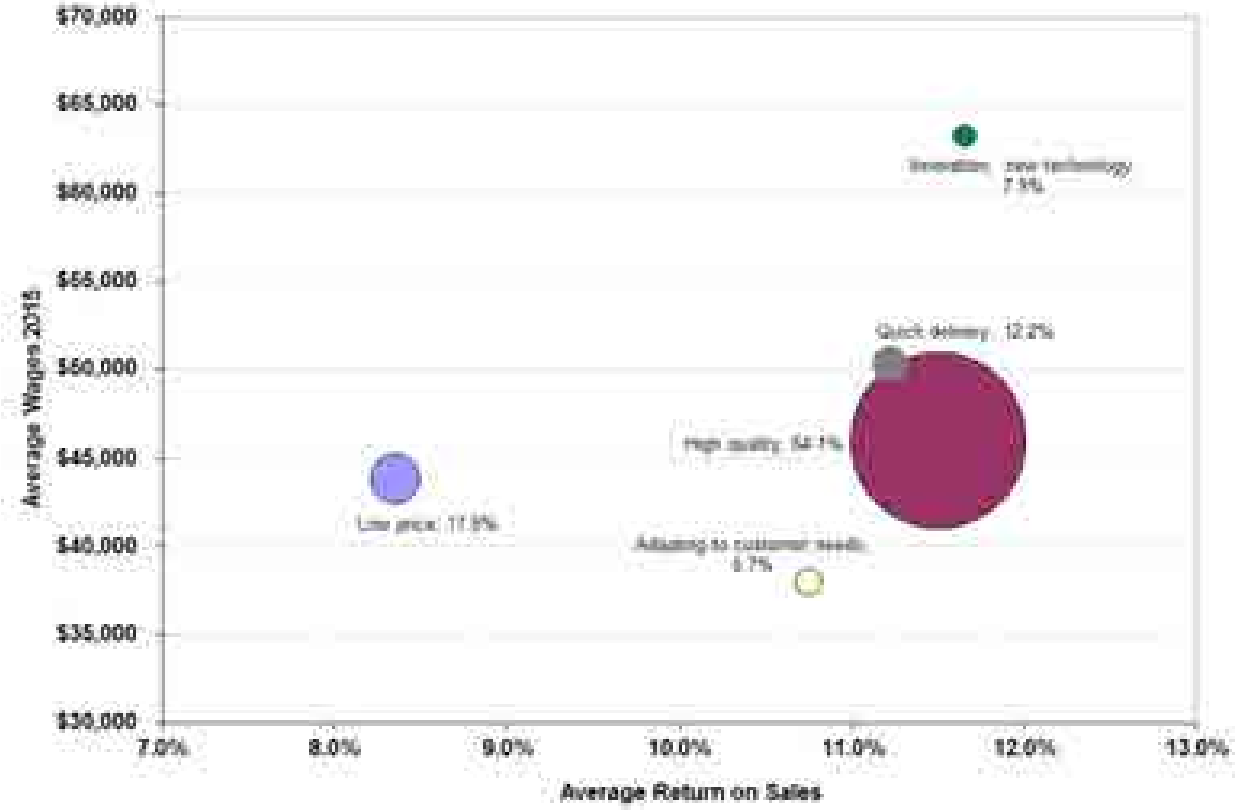
We can look at the relationship between the number of manufacturers that adopt various strategies to compete for customers, the “profitability” of these establishments, and the average wages they pay. The bubble chart (Figure 3.3) illustrates these findings graphically. The sizes of the bubbles represent the percentages of Georgia manufacturers that compete primarily through the various strategies. The vertical axis shows the average 20015 wages associated with these strategies. The horizontal axis shows average return on sales from 20013-2015 associated with these strategies. Manufacturers who compete primarily through innovation strategies have relatively higher returns on sales and higher employee wages, although as previously indicated, these differences between returns on strategies have narrowed considerably in the 2014 survey. Still, most Georgia manufacturers use strategies that are associated with lower wages and profitability levels.

Figure 3.2. Average Return on Sales for Manufacturers Competing Primarily Through Low Price vs. Innovation: 2002, 2005, 2008, 2010, 2012, and 2014 (mean return on sales shown on y axis)



Source: Georgia Manufacturing Survey 2016, weighted responses of 417 surveys; Georgia Manufacturing Survey 2014, weighted responses of 191 surveys; Georgia Manufacturing Survey 2012, weighted responses of 215 surveys; Georgia Manufacturing Survey 2010, weighted responses of 370 surveys; Georgia Manufacturing Survey 2008, weighted responses of 484 surveys; Georgia Manufacturing Survey 2005, weighted responses of 648 surveys; Georgia Manufacturing Survey 2002, weighted responses of 475 surveys.

Figure 3.3. Manufacturing Returns and Wages by Percentage of Respondents Ranking Strategies Highest in 2016



Source: See Figure 3.2.

Summary

This chapter showed that nearly two-thirds of the manufacturers compete for sales based on high quality strategies. There were increases in the percentages of manufacturers prioritizing high quality and low price declines in respondents prioritizing quick delivery and adapting to customer needs strategies. Returns on low price strategies declined such that manufacturers prioritizing innovation strategies had 40% higher profitability than those competing on low price.

Chapter
4

Innovation

The previous chapter indicated that only 8 percent of manufacturers employ innovation as their primary business strategy for competing for sales in the marketplace. However, there are many ways that a firm may be innovative or engage in innovative activities in addition to their business strategy. This chapter will examine innovation, beginning with the specification of a definition for it. We will then examine four general types of innovation and the extent to which these types are prominent among various types of Georgia manufacturers. Take-up rates of more explicit innovation activities will be gauged in the state's manufacturing base. We will consider the upside of innovation, including the types of impacts and benefits that manufacturing respondents report, as well as the downside factors that limit their ability to engage in innovation.

Innovation is the entire process through which new knowledge is created and disseminated into the market. [3] It contrasts with invention, which applies new knowledge often to patentable goods, and productivity, which applies conventional knowledge to existing commodity goods or services.

In the Georgia Manufacturing Survey, we define four types of innovation for innovation measurement and data gathering. Two are technological (product and process innovation) and two are considered non-technological (organizational and marketing innovation). In developing these definitions, we have sought consistency with the OECD's Oslo Manual and innovation surveys conducted by the European Community and other countries.[4] These four types are defined as:

1) Product innovation in goods or services—technologically new products or existing products that are significantly improved.

2) Process innovation—technologically new or significantly improved practices, technologies, or delivery.

3) Organizational innovation—new or significant changes in firm structure, management methods, or information exchange systems.

4) Marketing innovation—new or significant changes to design, packaging, sales methods, or distribution channels.

[3] J. Schumpeter, 1934. The Theory of Economic Development. Harvard University press, Cambridge, MA.
[4] OECD, 1997, Proposed Guidelines for Collecting and Interpreting Technological Innovation Data, Manual Oslo, Eurostat.

Innovation Types in Georgia Manufacturing

Product Innovation

We asked survey respondents to tell us whether their facility introduced any new or significantly improved goods or services during the period 2013 to 2015. Excluded were small changes to the color or look or resale of goods purchased elsewhere. Forty-five percent of the respondents had introduced a new or significantly improved good. This is down from 41 percent in the 2014 survey. Fifteen percent of the establishments had introduced a new or significantly improved service, about the same as the 2014 survey. In total, 51 percent of respondents had introduced either a product innovation involving either a new good or service.

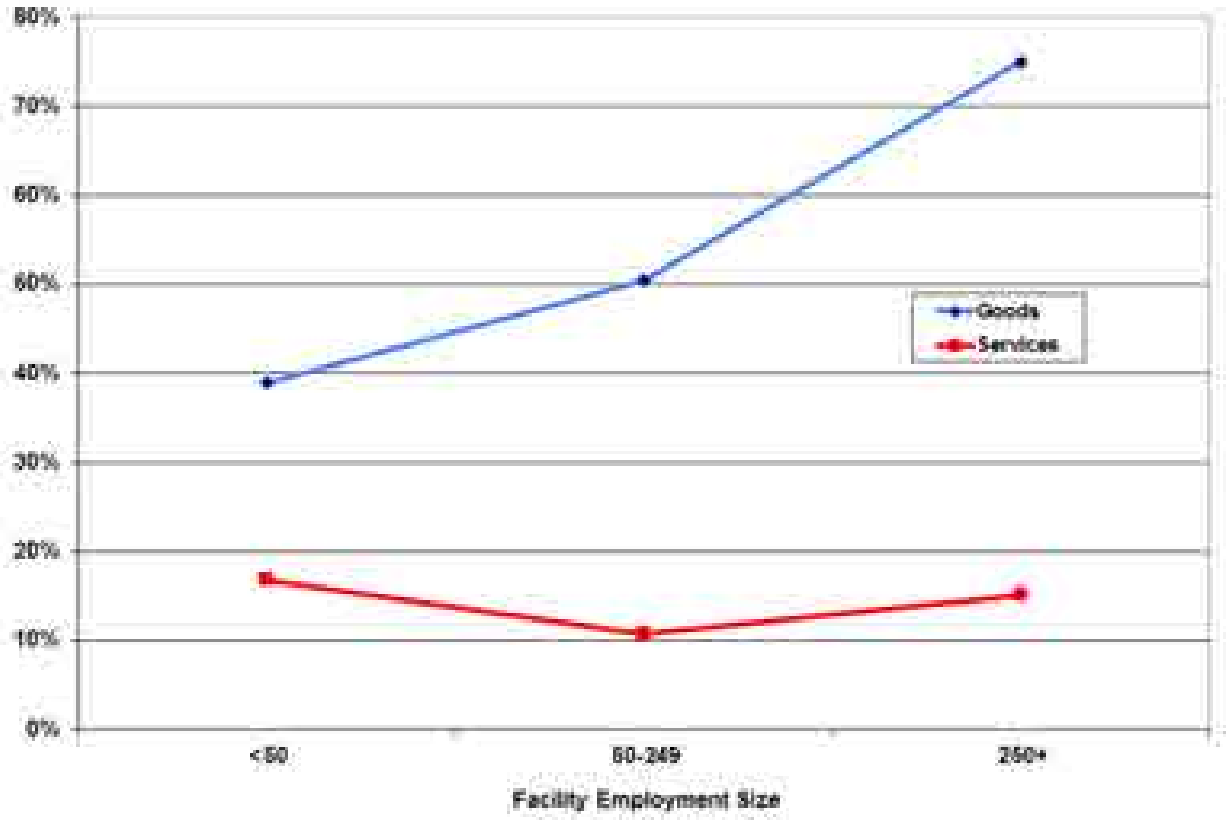
Introduction of new goods was most likely among larger manufacturing establishments. Larger manufacturers were also more likely to have introduced a new service than were their smaller manufacturing counterparts (Figure 4.1).

The electrical/electronic/ transportation and science-based industry groups had the highest percentage of establishments that had introduced a new good, followed by the food/textile/apparel/leather groups. Material and machinery manufacturers were least likely to have introduced a new good. However, machinery manufacturers were among the most likely to have introduced a new service (Figure 4.2).

By region, the Atlanta and West regions had the highest percentage of establishments that introduced new goods (55 and 50 percent respectively), with the East coming in at the lowest percentage (around 23 percent). This difference in range between regions with the highest and lowest incidence of introduction of new goods is greater than it was in the 2014 survey. New services were also more prevalent among establishments in the Atlanta and West regions, with roughly 20 percent of manufacturers in these regions having introduced new services. Georgia headquartered multi-facility plants are somewhat more likely to have introduced new products and services than are single establishment firms. Likewise, publicly traded firms were significantly more likely to have introduced new goods than were privately held firms, but no difference was observed in the percentage of public and private firms introducing new services. Because so few publicly traded or multi-facility establishments are small, this finding is not surprising. Indeed only 21 percent of publicly traded manufacturing respondents and 26 percent of Georgia-based multi-facility respondents have fewer than 50 employees.

Figure 4.1. Introduction of New or Significantly Improved Goods and Services by Facility Employment Size

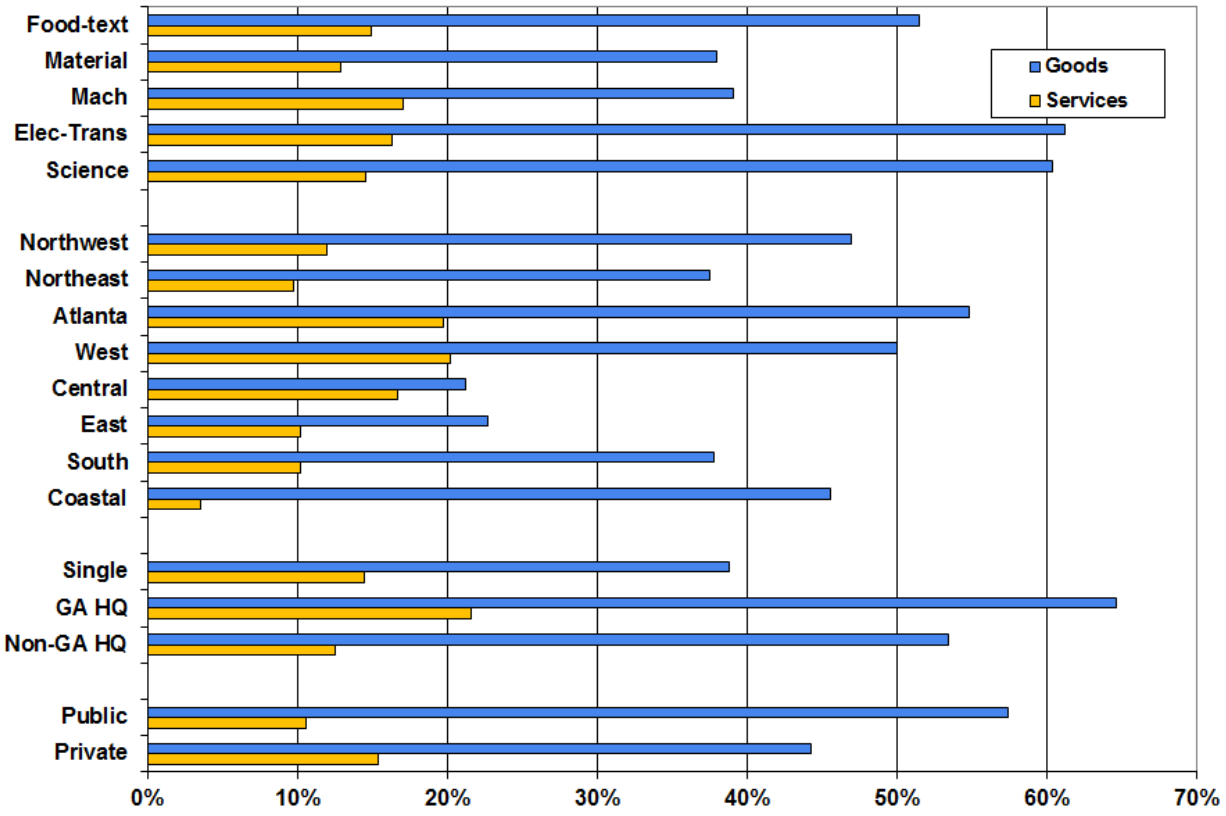
(Percentage of Establishments that Introduced New Goods or Services from 2013-2015)



Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Figure 4.2. Introduction of New or Significantly Improved Goods and Services by Industry Group, Region, Ownership

(Percentage of Establishments that Introduced New Goods or Services from 2013-2015)



Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Open and collaborative innovation has the potential to offer new sources of ideas for manufacturers beyond what is available internally. We asked respondents to tell us with whom they developed their product or service innovations. Eighty-three percent of Georgia manufacturers developed at least one of their products by themselves. Another 21 percent developed at least one product together with other companies, universities, research institutes, laboratories. Nineteen percent developed a product by adapting or modifying it from a product originally developed by other companies, universities, research institutes, or laboratories. Only 4 percent introduced products developed by companies, universities, research institutes, or laboratories. Medium-sized manufacturers were most apt to develop products by themselves (87 percent) while the other size classes were at 80 percent. Large manufacturers were slightly more likely (25 percent) to develop products with others, with medium-sized manufacturers at 22 percent and small manufacturers at 20 percent. Small manufacturers were slightly more likely to adapt products developed by others (22 percent), while medium-sized manufacturers were at 18 percent and large manufacturers at 16 percent. Food-text and machinery groups had the highest percentage of development of products by themselves (90 percent and 87 percent respectively). Electrical/electronics/transportation manufacturers had the highest percentage of

collaborative product development at 45 percent, followed by science-based firms at 37 percent. Electrical/electronics/transportation manufacturers also had the highest percentage of manufacturers which adapted products developed by others at 29 percent. Multi-establishment manufacturers headquartered in Georgia were also more apt to develop products either collaboratively (30 percent) or through adapting products developed by others (27 percent) than either single establishment manufacturers (at 19 percent and 22 percent respectively) or non-Georgia headquartered branch facilities (at 20 percent and 12 percent respectively).

We asked whether these product innovations were new to the market or new to the facility. New-to-the-market innovations were defined as those that were introduced before the competition, whereas new-only-to-the-facility innovations were defined as those already available from the competition.

Twenty-eight percent respondents reported that they had introduced a new-to-the-market product in the 2013 to 2015 timeframe. This percentage is higher than in the 2014 survey. The percentage of establishments introducing new-to-the-market and new to the facility innovations is about the same for small and medium-sized establishments, but markedly higher at 51% (new to the market) and 37% (new to the facility) for establishments with more than 250 employees. By industry, establishments in the science categories had the highest percentage of respondents reporting introduction of new-to-the-market product innovations. The lowest percentage of new-to-the-market product innovations is in the materials and machinery groups. By region, the Atlanta region had the highest percentage of establishments introducing new-to-the-market innovations, and the East region had the lowest. (See Table 4.1)

Table 4.1. New to Market vs. New to Facility Innovations
(Percentage of Establishments that Introduced the Innovations)

	New to Market	New to Facility
Total	27.6%	28.2%
Employment		
10-49	23.1%	27.1%
50-249	30.4%	28.1%
250+	50.6%	37.1%
Industry		
Food-text	31.3%	28.4%
Material	21.0%	25.9%
Mach	21.5%	25.6%
Elec-Trans	38.8%	36.7%
Science	47.9%	33.3%
Region		
Northwest	31.7%	21.8%
Northeast	18.7%	24.8%

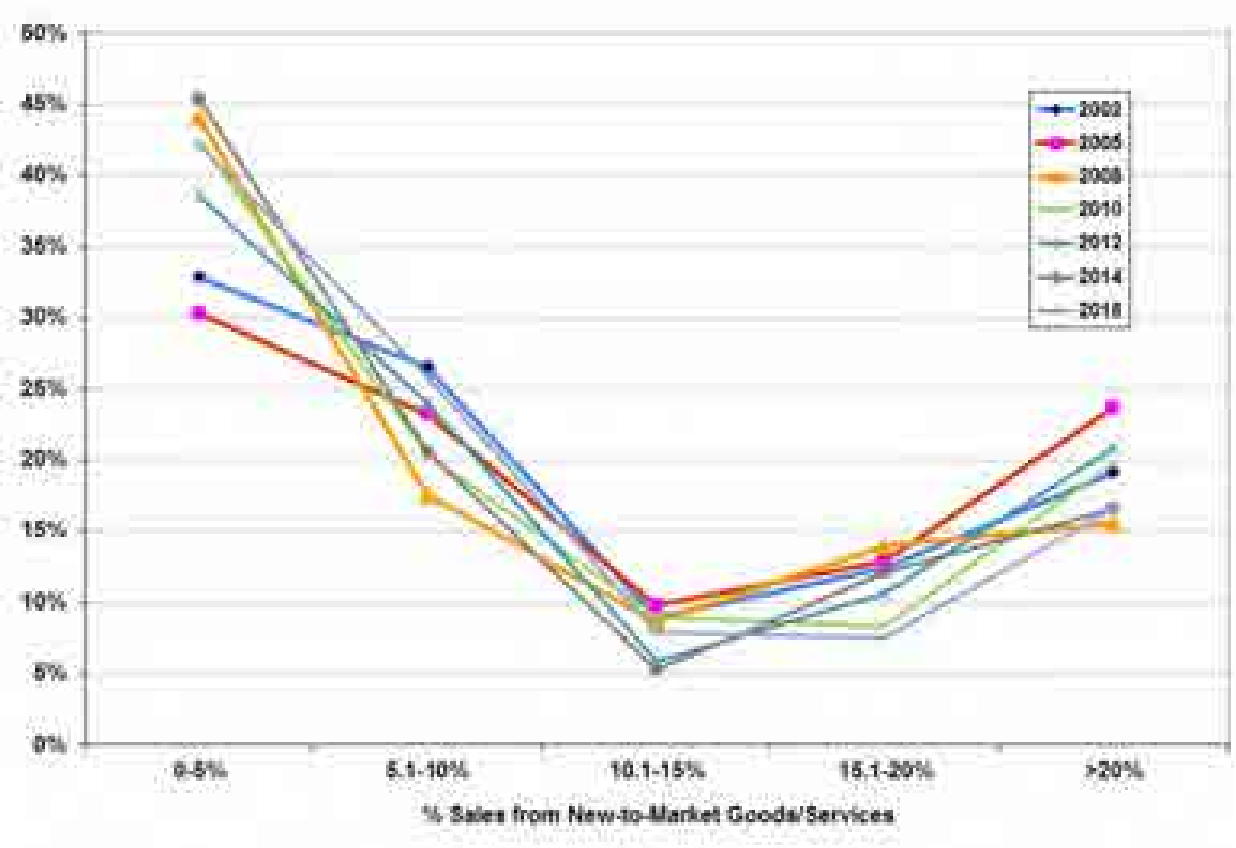
Atlanta	34.3%	34.5%
West	31.6%	28.8%
Central	16.0%	13.7%
East	3.7%	33.0%
South	22.3%	26.1%
Coastal	23.8%	30.5%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

New-to-the-market products rarely make up the lion's share of a manufacturing establishment's sales. The average respondent that introduced new-to-the-market goods or services reported that these goods and services accounted for 13 percent of the facility's sales. However, for 3 percent of the respondents with new-to-the-market products or services, these offerings comprised half or more of their sales. Figure 4.3 shows that the percentage of sales from new-to-the-market goods and services is below 2014 levels.

Figure 4.3. Percentage of Sales from New-to-the-Market Goods/Services: 2002, 2005, 2008, 2010, 2012, 2014, 2016

(Y-axis represents percentage of firms)



Source: Georgia Manufacturing Survey 20164, weighted responses of 206 manufacturers; 2014, weighted responses of 191 manufacturers; Georgia Manufacturing Survey 2012, weighted responses of 215 manufacturers; Georgia Manufacturing Survey 2010, weighted responses of 199 manufacturers; Georgia Manufacturing Survey 2008, weighted responses of 326 manufacturer; Georgia Manufacturing Survey 2005, weighted responses of 421 manufacturers; Georgia Manufacturing Survey 2002, weighted responses of 448 manufacturers.

Process Innovation

Over the last three years, 56 percent of the respondents introduced processes that were new to or significantly improved the firm. Of these processes, new manufacturing technologies and techniques on the shop floor were most common, introduced by 44 percent of respondents. Logistics and distribution innovations were introduced by 13 percent of respondents. Purchasing, accounting, maintenance, or other similar processes were introduced by 23 percent of respondents. Smaller establishments lagged larger ones in all process innovations. Shop floor innovations (i.e., techniques and technologies) were most common in electronics/transportation firms. Office innovations (i.e., purchasing and accounting) and logistics were more common in science-based firms. By region, establishments in the West areas had the highest rates of process innovation introduction, while the establishments in the East region had the lowest rates (Table 4.2).

Table 4.2. Process Innovations Introduced from 2013 to 2015
(Percentage of Establishments that Introduced the Innovations)

	Techniques, Technologies	Logistics, Distribution	Purchasing, Accounting	Materials	Any Process
Total	44.0%	12.8%	22.6%	16.0%	56.1%
10-49	34.6%	7.2%	16.8%	12.4%	46.9%
50-249	54.5%	16.5%	27.1%	19.2%	67.5%
250+	73.6%	41.0%	49.3%	30.9%	81.5%
Industry					
Food-text	45.4%	14.3%	27.6%	23.0%	55.9%
Material	39.1%	13.4%	16.0%	10.6%	51.9%
Mach	42.3%	6.2%	25.4%	13.4%	54.5%
Elec-Trans	61.2%	22.5%	20.4%	18.4%	71.4%
Science	45.8%	12.5%	35.4%	27.1%	60.4%
Region					
Northwest	39.7%	16.1%	23.3%	16.5%	52.6%
Northeast	34.6%	16.1%	18.1%	12.2%	48.4%
Atlanta	51.0%	14.5%	27.3%	19.2%	64.2%
West	60.2%	13.1%	19.1%	11.3%	74.0%
Central	37.6%	7.9%	17.1%	11.1%	43.6%
East	28.4%	14.3%	21.1%	6.8%	42.6%
South	41.0%	2.8%	18.6%	17.8%	49.9%
Coastal	36.4%	4.8%	18.6%	14.9%	45.2%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Organizational Innovations

Respondents were asked whether their facility had introduced any organizational innovation activities that involved improved strategic planning, management systems, restructuring of management or departmental configurations, or relationships with other firms (e.g., alliances, partnerships, outsourcing, subcontracting). Nearly 60 percent of all manufacturing establishments reported that they introduced at least one of these organizational activities (Table 4.3). Restructuring of management or departments was the most common organizational introduction, reported by 35 percent of respondents. New management systems and relationships with other firms were reported to have been introduced by 24 percent of respondents and new strategy was reported by 22 percent. Organizational innovations were much more common among medium-size and large manufacturing establishments with at least 50 employees, with two-thirds of respondents having introduced an organizational innovation over the 2013 to 2015 time period. By industry, respondents in the science-based group were most apt to have introduced organizational innovations, with more than 70 percent having introduced an organizational innovation over the 2013-to-2015 time period. This group had the highest proportion of new or improved

management systems introduced. The electronics/electrical/transportation organizational innovations introduced the highest percentage of organizational innovations in corporate strategy, internal restructuring, and relations with other firms. Regional differences highlighted the Atlanta region in its higher introduction of organizational innovations. Overall introduction of organizational innovations was lowest in the Central region.

Table 4.3. Organizational Innovations Introduced from 2013 to 2015
(Percentage of Establishments that Introduced the Innovations)

	Corporate Strategy	Improved Management System	Internal Restructuring	Relations with other Firms	Any Organizational Innovation
Total	21.9%	24.0%	35.1%	22.9%	58.6%
10-49	16.6%	21.4%	29.2%	21.7%	53.0%
50-249	28.5%	25.8%	42.7%	23.8%	67.0%
250+	36.2%	37.1%	49.8%	27.8%	67.6%
Industry					
Food-text	23.0%	27.1%	46.4%	19.1%	61.3%
Material	17.1%	20.1%	25.4%	19.9%	51.2%
Mach	18.2%	22.8%	32.3%	25.6%	58.7%
Elec-Trans	34.7%	28.6%	49.0%	32.7%	67.4%
Science	33.3%	31.3%	43.8%	25.0%	72.9%
Region					
Northwest	15.3%	25.3%	36.8%	21.7%	54.9%
Northeast	22.5%	24.4%	33.4%	21.5%	60.8%
Atlanta	25.4%	26.8%	40.1%	26.5%	65.7%
West	28.3%	29.0%	38.6%	22.9%	61.7%
Central	12.4%	8.7%	17.3%	22.6%	37.2%
East	19.5%	35.9%	43.7%	10.2%	60.2%
South	21.5%	17.3%	24.0%	25.2%	55.1%
Coastal	23.0%	17.4%	31.8%	8.7%	43.4%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Marketing Innovations

More than 30 percent of the manufacturers participating in the survey introduced at least one marketing innovation during the 2013 to 2015 time period. This suggests that marketing innovations are the least common improvement in manufacturing. Introduction of new sales and distribution channels was more slightly common than introduction of new designs or packaging – 22 percent versus 16 percent respectively. By size, the percentage of respondents introducing marketing innovations did not differ markedly by size class. However, in the case of design, large firms had twice the percentage of respondents introducing new design than small firms, while small firms made greater use of new sales channels. . Respondents in the food / textile / apparel / leather group

and in the electronics/transportation group were most likely to have introduced design or packaging innovations. The percentage of respondents introducing marketing innovations was highest in the East region and lowest in the Central region.

Table 4.4. Marketing Innovations Introduced from 2013 to 2015
(Percentage of Establishments that Introduced the Innovations)

	Design/ Packaging	Sales	Any Marketing Innovation
Total	16.4%	22.1%	33.7%
Employment Size			
10-49	14.4%	24.2%	34.4%
50-249	16.6%	19.8%	31.0%
250+	31.9%	14.9%	39.6%
Industry			
Food-text	30.7%	20.5%	41.6%
Material	11.5%	21.9%	32.0%
Mach	15.2%	24.1%	33.7%
Elec-Trans	14.3%	20.4%	28.6%
Science	14.6%	22.9%	31.3%
Region			
Northwest	15.0%	17.2%	27.8%
Northeast	23.1%	18.3%	35.2%
Atlanta	18.2%	26.4%	39.0%
West	18.0%	13.0%	27.5%
Central	8.2%	17.8%	22.0%
East	10.5%	31.3%	41.8%
South	14.5%	20.1%	28.5%
Coastal	5.6%	31.2%	36.8%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

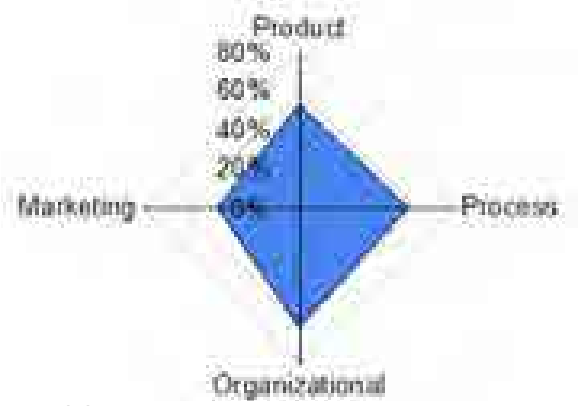
Industry Group Innovation Framework

We examined each of the four general innovation areas individually and found that they range from an overall take-up rate 30 percent for marketing innovations to around 60 percent for organizational innovations. Figure 4.4 brings the four types of innovation together and presents them on a “radar graph” to show the innovation framework in each industry group. Each axis on the radar graph represents one general innovation area. The proportion of respondents in an industry group that report using a particular innovation area is indicated in the shaded area on the scale of the axis, which ranges from 0 to 0.8. Where a measure is closer to the outside perimeter of the graph, this represents a stronger sector performance in terms of introducing the innovation. Conversely, where a measure is closer to the center of the graph, this represents a weaker

performance in that innovation area. The shaded area provides the basis for visual comparison of industry group performance by innovation component. Visually, the greater the total shaded area of the radar's octagon, the higher is the industry group's innovation content (Total Innovation Area chart).

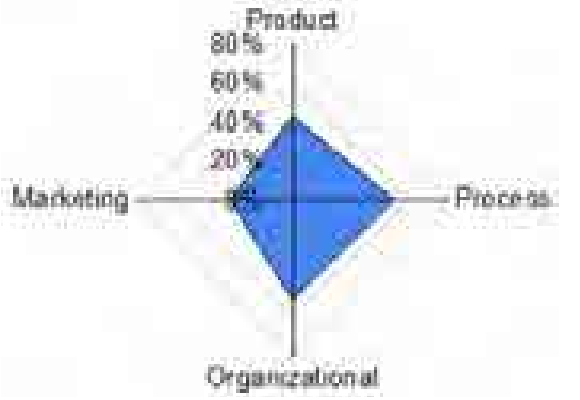
Figure 4.4. Radar Charts of Innovation Area Adoption by Industry

Food-text

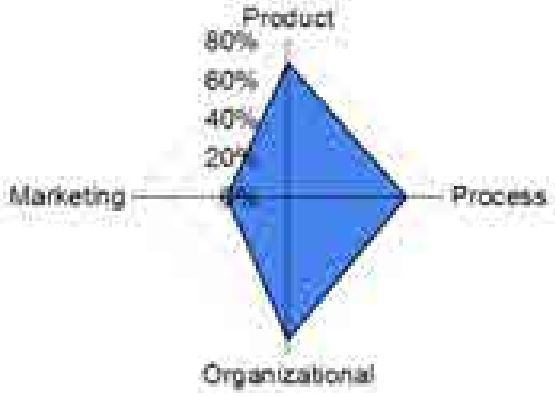


Elec-trans

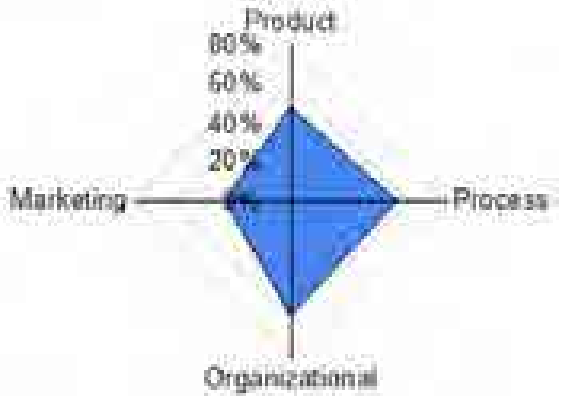
Material

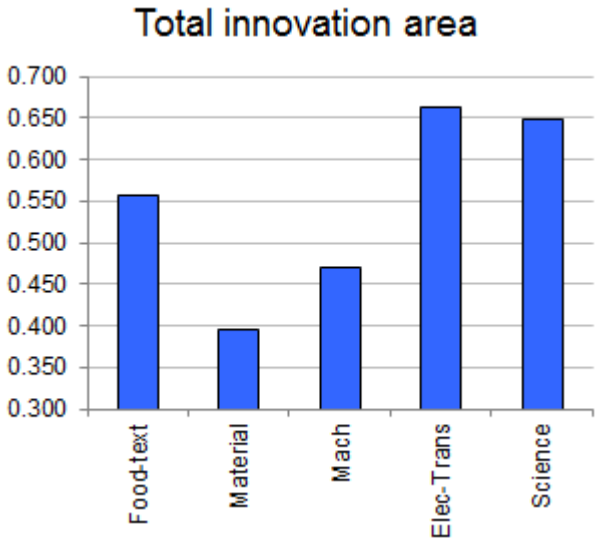


Science



Mach





Electronics/transportation establishments have the largest shaded area. These firms maximize product innovation, process and organizational innovations, with marketing innovation at the lower end. The science-based group has the next largest innovation area. The science-based group looks like a north-pointing diamond, with relatively higher levels of product innovation, medium levels of process and organizational innovation, and lower levels of marketing innovation. The food-text group has the most balanced innovation area with marketing being relatively more prominent in this group than in the others. The smallest innovation areas are associated with machinery and material groups, which also follow this right-pointing visual profile.

Specialized Innovation Activities

The four general areas of innovation can elicit a relatively high level of response. In this section, we follow up these general innovation areas with more explicit items that ask about the adoption of specific innovation-related practices, such as research and development (R&D), capital purchases, engineering, patents,[5] training, marketing research, inter-firm relationships, and the like.

We asked respondents to indicate the extent to which their facility engaged in any of a series of 13 innovation-related activities during the 2013-to-2015 time period. The average respondent implemented three of these activities. The most common activities, as shown in Figure 4.5, were:

- Working with customers to create an innovation – 61 percent
- Purchasing machinery, equipment, computers, or software to implement innovations – 52 percent.
- Signing a confidentiality agreement – 51 percent,

The least common activities were:

- Purchasing R&D from research organizations or other branches of the company (the latter applicable to facilities in a multi-establishment enterprise) – 4 percent.
- Purchasing or licensing patents, inventions, know-how, or other types of knowledge – 6 percent.
- Publishing papers or technical articles – 7 percent.

Nearly all of these activities were particularly affected by facility employment size (Table 4.5). The largest manufacturers were most apt to engage in these activities than their smaller counterparts. Working with customers to create an innovation is relatively equally prevalent across size classes. Medium-sized

[5] The patenting information is based on manufacturers' survey responses and has not been verified against patent database information.

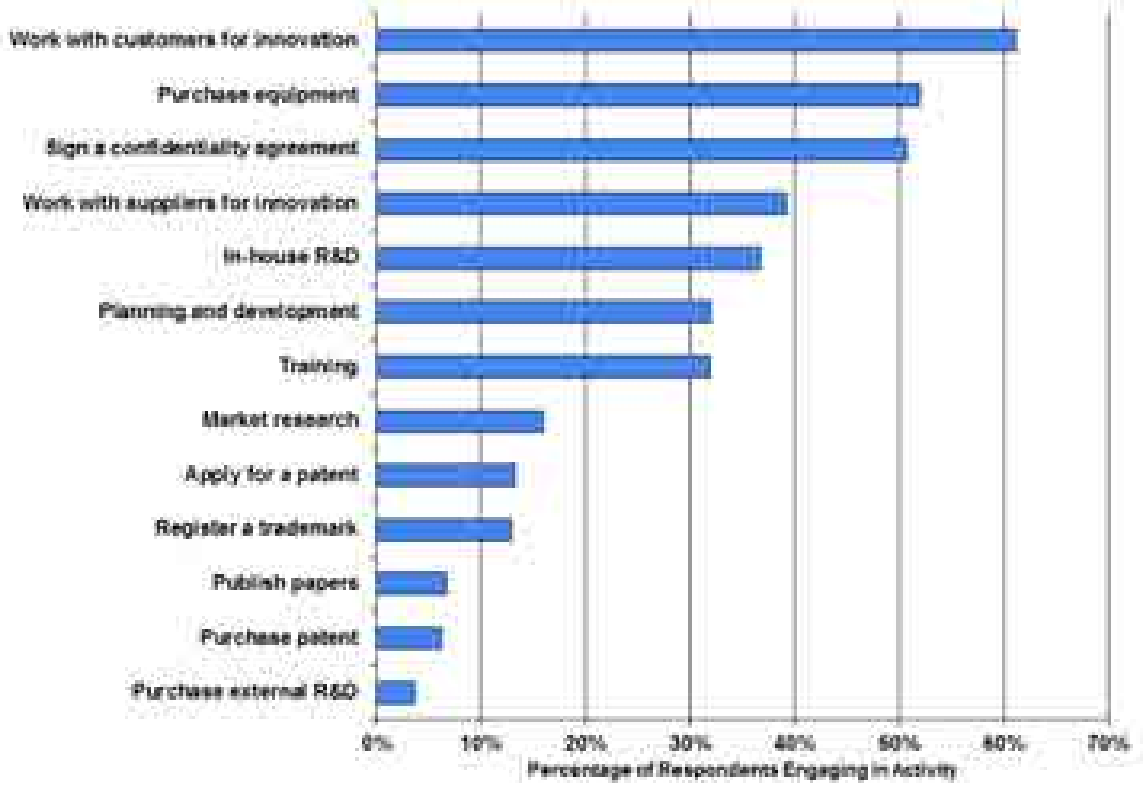
manufacturers (with 50-249 employees) also had a rate of purchasing equipment similar to that of large manufacturers. For other activities—such as market research and registering a trademark—medium-sized firms' usage was similar to that of smaller manufacturers (with 10 to 49 employees.).

By industry, the elec-trans and science-based industries have the highest take up rate for the 13 activities (Table 4.6). Science-based industries have the highest incidence of signing and confidentiality agreement, purchasing equipment, in-house R&D, and applying for a patent while the elec-trans group is highest or tied with science-based industries in the rest of the areas. Materials manufacturers had the lowest take-up of these activities, but they were distinctive in being more considerably likely to have purchased equipment than to have signed a confidentiality agreement.

The West and Atlanta regions have the highest take up of these activities while the East has the lowest take up (Table 4.7). Working with customers for innovation was highest in the Northwest, Atlanta, and Coastal regions. Purchasing equipment is similarly prevalent in all but the Central region. Signing a confidentiality agreement is most common in the Atlanta region. Training staff to introduce new innovations was particularly prevalent in the West region and least prevalent in the East region.

Figure 4.5 Adoption of Specialized Innovation Activities

(Percentage of Establishments that Engaged in the Activity)



Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Table 4.5. Adoption of Specialized Innovation Activities from 2013 to 2015 by Facility Employment Size

(Percentage of Establishments Engaged in Innovation Activities)

Innovation Activity	10-49	50-249	250+
Purchase equipment	60.2%	61.9%	64.8%
Sign a confidentiality agreement	45.1%	61.1%	67.6%
In-house R&D	44.7%	57.3%	71.0%
Planning and development	31.7%	48.1%	60.6%
Training	28.3%	47.3%	59.2%
Market research	22.4%	41.0%	70.4%
Work with suppliers for innovation	24.9%	39.1%	55.8%
Work with customers for innovation	13.4%	17.0%	32.8%
Register a trademark	7.1%	19.0%	38.5%
Apply for a patent	11.7%	12.3%	25.1%
Publish papers	4.3%	9.0%	16.5%
Purchase patent	2.8%	9.2%	22.2%
Purchase external R&D	1.9%	3.6%	18.5%
Mean # Innovation Activities	3.0	4.3	6.0

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Table 4.6. Adoption of Specialized Innovation Activities from 2013 to 2015 by Industry Group

(Percentage of Establishments Engaged in Innovation Activities)

Innovation Activity	Food-text	Material	Mach	Elec-Trans	Science
Purchase equipment	65.6%	54.9%	62.7%	69.4%	64.6%
Sign a confidentiality agreement	44.5%	49.5%	57.9%	53.1%	60.4%
In-house R&D	44.7%	34.4%	62.9%	69.4%	77.1%
Planning and development	51.6%	34.6%	32.5%	44.9%	43.8%
Training	41.6%	25.3%	35.3%	51.0%	60.4%
Market research	31.1%	25.7%	30.6%	49.0%	43.8%
Work with suppliers for innovation	35.0%	31.8%	25.6%	36.7%	35.4%
Work with customers for innovation	21.5%	13.5%	14.7%	20.4%	14.6%
Register a trademark	13.1%	10.0%	13.4%	16.3%	22.9%
Apply for a patent	18.9%	9.9%	10.1%	14.3%	18.8%
Publish papers	5.2%	2.4%	8.2%	16.3%	12.5%
Purchase patent	10.8%	2.2%	8.1%	4.1%	12.5%
Purchase external R&D	1.2%	1.4%	2.9%	14.3%	8.3%
Mean # Innovation Activities	3.8	3.0	3.6	4.6	4.8

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Table 4.7. Innovations Introduced from 2013 to 2015 by Region
(Percentage of Establishments Engaged in Innovation Activities)

Innovation Activity	North-west	North-east	Atlanta	West	Central	East	South	Coastal
Purchase equipment	63.7%	58.6%	68.4%	47.4%	49.8%	42.2%	52.1%	64.8%
Sign a confidentiality agreement	48.9%	50.7%	55.3%	54.0%	34.9%	48.2%	57.1%	52.9%
In-house R&D	46.2%	42.8%	63.5%	55.7%	34.9%	19.6%	41.8%	44.1%
Planning and development	42.8%	41.3%	39.0%	43.5%	32.2%	35.7%	25.4%	53.4%
Training	38.6%	32.2%	47.0%	34.7%	22.2%	24.5%	23.8%	22.0%
Market research	33.6%	28.1%	34.9%	46.9%	23.9%	12.7%	32.8%	20.6%
Work with suppliers for innovation	28.5%	35.1%	33.1%	47.9%	21.4%	12.1%	36.0%	23.4%
Work with customers for innovation	14.3%	9.0%	20.4%	26.9%	5.7%	13.9%	16.5%	10.5%
Register a trademark	17.2%	5.0%	15.2%	21.3%	8.2%	0.0%	8.6%	23.0%
Apply for a patent	15.1%	7.0%	16.7%	13.8%	2.5%	0.0%	10.8%	17.8%
Publish papers	10.4%	5.3%	8.5%	8.1%	2.5%	0.0%	2.2%	2.1%
Purchase patent	9.0%	4.6%	7.0%	10.8%	7.2%	0.0%	1.2%	4.8%
Purchase external R&D	2.6%	4.5%	3.8%	8.7%	3.2%	5.3%	2.2%	2.1%
Mean # Innovation Activities	3.7	3.2	4.1	4.2	2.5	2.1	3.1	3.4

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Sectoral Innovation Gaps Between Small and Large Firms

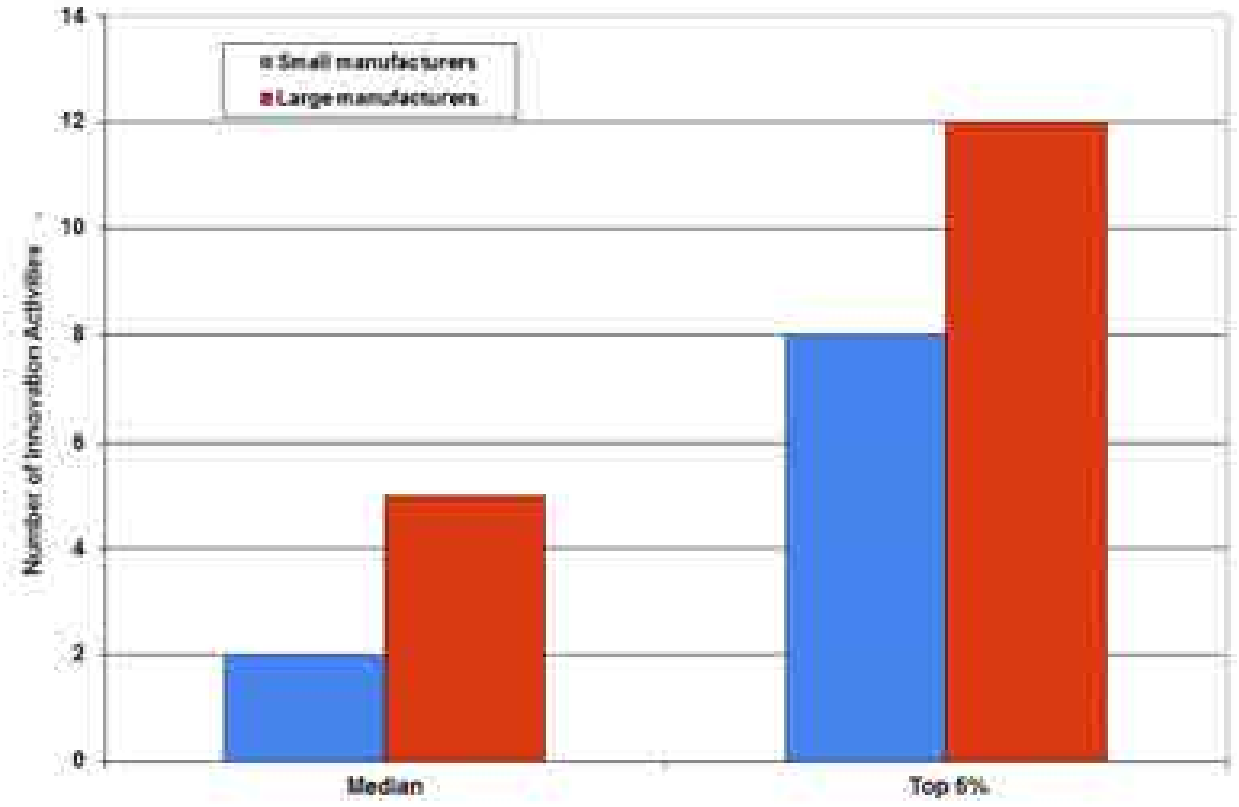
To further probe the patterns of industry group innovation across these 12 innovation activities, this section looks more closely at variations by establishment employment size. In general, our analysis shows that large establishments achieve higher levels of innovation activity than smaller ones. We find that median-sector innovation activity level for large establishments is 5, while for smaller firms the comparable median-sector innovation measure is 2. The "gap" between small and large establishments (by the median-sector knowledge content measures) is 3 innovation activities (Figure 4.6).

The observation that an innovation gap exists between small and large establishments is not unexpected. However, some small establishments do slightly better than their median counterparts. Indeed, we find that the top 5 percent of small Georgia establishments are engaged in eight innovation activities – an innovation activity profile that is much higher than median large establishment's average take-up of innovation. *Narrowing* the size of the innovation gap between SMEs and large establishments in Georgia is an important concern.

Moreover, while in overall terms we have established differences by employment size, we also find rather significant variations by industry group. We suggest that it is highly informative to track these industry group differences in innovation activities by employment size. In this analysis, Figure 4.7 presents the mean

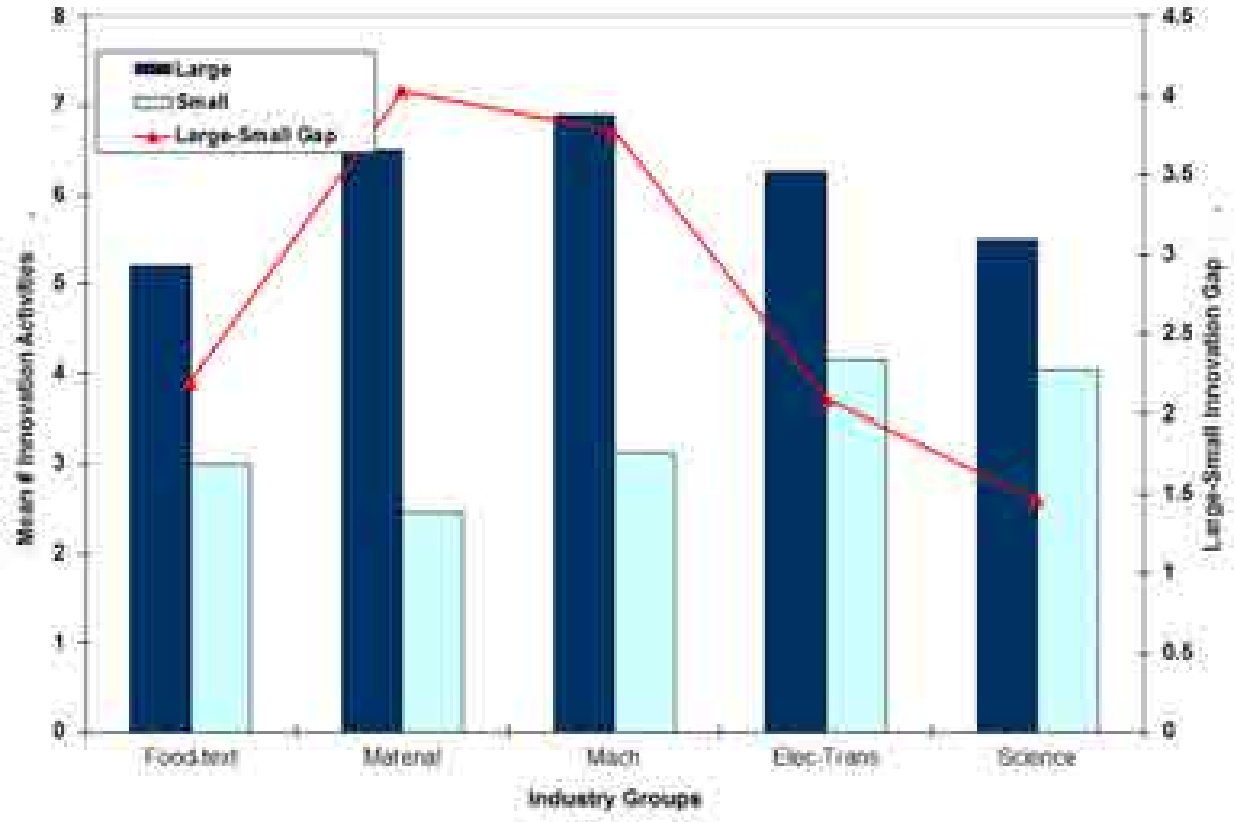
sector innovation measures for SMEs and large establishments (the bars of the graph) and then calculates the difference between these two measures (the line on the graph). The science-based group has the smallest gap between large and small establishments. The SME-large establishment innovation gap is greatest for machinery industries, followed by the material group. One way to interpret these findings is in terms of opportunities for transfer of innovation activities. Thus, it seems that there could be useful opportunities for exchange and learning by other SMEs on the innovation strategies used by SMEs in the material and machinery groups. Strategies to assist SMEs in science-based and materials groups with many less well-performing SMEs to catch up with the leading edge of innovation practices in their sectors could be helpful (Figure 4.7).

Figure 4.6. Number of Innovation Activities Used by Establishment Size



Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Figure 4.7. Number of Innovation Activities Used by Establishment Size within Industry Groups



Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Innovation Expenditures and Investments

Seventy percent of the manufacturers participating in the Georgia Manufacturing Survey furnished estimates of their expenditures total R&D expenditure. Total R&D expenditure is the sum of the following expenditures: (1) in-house R&D personnel; (2) acquisition of external R&D; (3) acquisition of machinery, equipment, and software; and (4) other development work for innovation. Expenditures for the average respondent, on a per employee basis show that the median establishment that made an investment in innovation spent only $3,752 per employee in innovation, mostly in R&D capital investments (Table 4.8). The distribution of innovation expenditures is skewed, with a small number of establishments investing substantially in innovation, while the majority invests little or nothing by comparison. After capital investments, in-house R&D garnered the next highest level of expenditures. Most respondents expended little or nothing in acquiring external R&D and other development work.

Table 4.8: Average Innovation Expenditures and Investments Per Employee
(medians and trimmed means are reported)

	Mean	Mean (trimmed)*	Median
In-house R&D	$6,169	$1,745	$1,176
Purchased R&D (from external sources)	$412	$0	$0
R&D capital investments	$9,963	$2,826	$2,240
Other R&D	$883	$64	$0
All R&D Expenditures	$13,540	$5,979	$3,752

*Trimmed mean is the mean that would be obtained if the upper and lower 2.5 percent of the distribution were excluded.

Source: Georgia Manufacturing Survey 2016, weighted responses of 390 manufacturers.

Medium-sized manufacturers with 10-249 employees have higher in-house R&D expenditures on a per employee basis than their large counterparts. Capital investments per employee for R&D increases by employment size, more than doubling between size classes. Innovation-related investments on average were highest for the science-based group, followed by the electronics/transportation group. By region, the East region had the highest average R&D expenditures, followed by the Atlanta and South regions (Table 4.9).

Table 4.9: Average Innovation Expenditures and Investments Per Employee
(Trimmed means are reported)

	In-house R&D	Purchased R&D	R&D Capital Investments	Other R&D	All R&D Expenditures
Total	$1,745	$0	$2,826	$64	$3,752
Employment					
10-49	1,546	0	1,907	25	4,303
50-249	2,468	2	4,255	204	8,715
250+	1,772	2	18,637	336	21,295
Industry					
Food-text	1,543	0	2,351	13	4,890
Material	1,388	0	3,034	41	5,666
Mach	1,085	1	2,310	16	4,657
Elec-Trans	1,719	239	3,652	550	7,026
Science	5,866	1	6,6173	2,214	17,072
Region					
Northwest	2,727	0	1,932	0	5,957
Northeast	1,070	0	2,416	8	4,813
Atlanta	1,938	3	5,313	170	8,158
West	1,608	n/a	3,354	467	6,239
Central	3,192	10	434	229	4,387

East	62	n/a	24,192	170	24,493
South	4,166	14	3,309	34	7,551
Coastal	672	n/a	1,901	116	2,840

n/a: insufficient responses to provide data

Source: Georgia Manufacturing Survey 2016, weighted responses of 390 manufacturers.

How do Georgia manufacturers' R&D expenditures compare with the manufacturers throughout the US? We can use the National Science Foundation's (NSF) Business R&D and Innovation Survey (BRDIS) to compare these results. This comparison is based on R&D intensity, which is calculated by dividing R&D expenditures by sales and reporting the results as a percentage. Georgia Manufacturing Survey respondents have an overall R&D intensity of 3.4. Industry group differences are minimal except that science-group firms tend to have lower R&D intensity. In comparing the Georgia results to that of BRDIS, it is not possible to review this comparison across the same years because the most recent BRDIS results are for 2013. Still the results are close enough in time to provide some insights in how the state's manufacturing R&D intensity matches up with that of the US. The results show that Georgia manufacturers below the US benchmark, though not substantially so (Table 4.10). By industry, Georgia's manufacturers have higher R&D intensity levels in traditional industries than the US benchmark and lower R&D intensity levels in high tech groups such as electrical/electronics/transportation and science-based industries.

Table 4.10: R&D Intensity: Georgia versus U.S.
(R&D intensity measured by R&D expenditures divided by sales, reported as a percentage of sales)

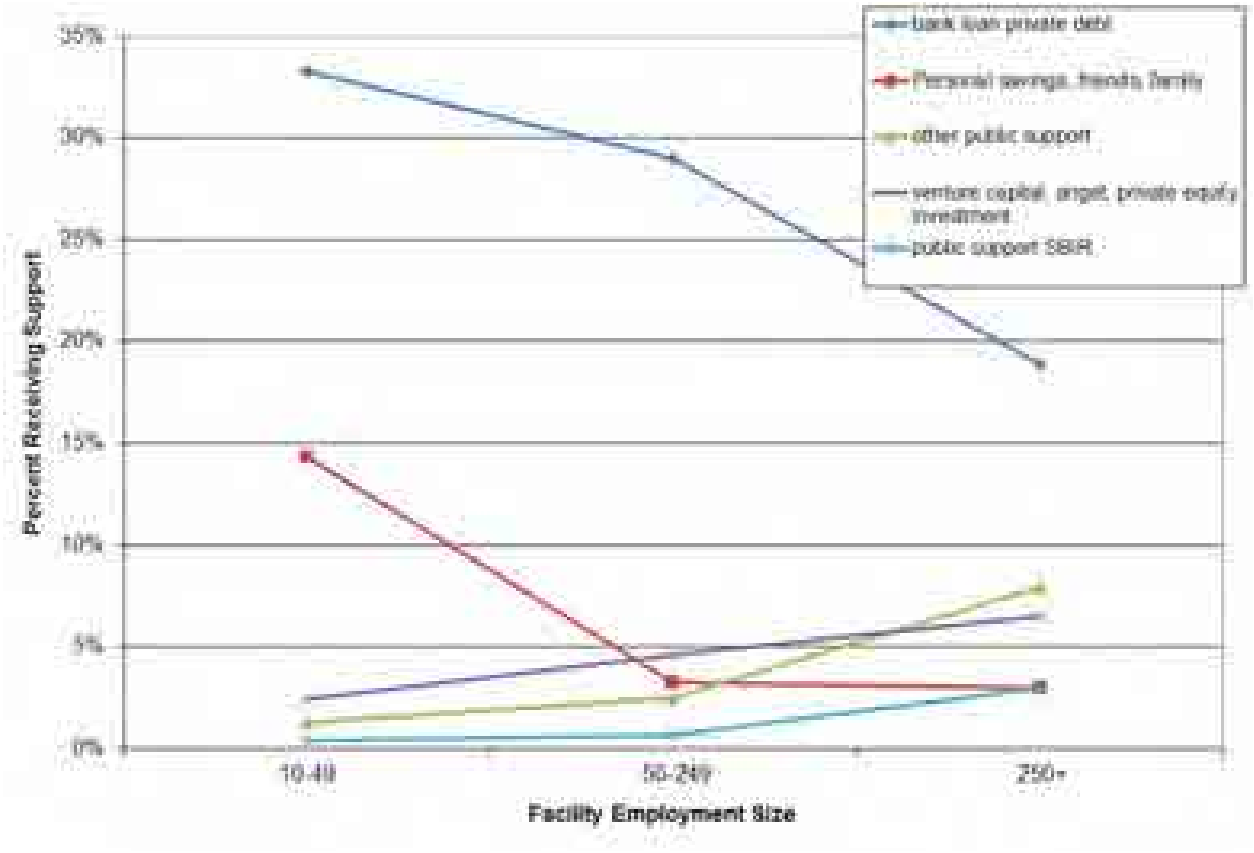
	R&D Intensity 2015 Georgia	R&D Intensity 2013 US Domestic*
Total	3.42%	3.75%
Industry Group		
Food-text	3.59%	0.70%
Material	3.90%	1.68%
Mach	3.47%	2.39%
Elec-Trans	3.49%	6.21%
Science	2.76%	3.75%

*5% trimmed means shown to control for outlying responses. **Domestic means R&D is conducted at any US location in the enterprise group. Sources: Georgia Manufacturing Survey 2016, weighted responses of 390 manufacturers; U.S. National Science Foundation/Division of Science Resources Statistics, Business R&D and Innovation Survey: 2013.

Access to financial resources is important for innovation. Manufacturers were asked if their facility received public or private financial support for innovation activities in the 2013 to 2015 time period. Only 2 percent of manufacturers said they received public support such as loans or government grants (local, state, or national level). Less than 1 percent of respondents reported using the Small

Business Innovation Research (SBIR) and related programs. Private equity was similarly rare, with less than 4 percent of respondents reporting receipt of venture capital, angel financing, or other private equity investment. Personal savings, friends, and family accounted for 10 percent of financial resources. Conventional loans were the most common, with 31 percent of respondents reporting receiving bank loans or other private debt to finance their innovation activities. Large manufacturers with 250 or more employees were somewhat more likely than small manufacturers to have received bank loans and public support, while the use of personal savings/friends/family was inversely associated with facility employment size (Figure 4.8).

Figure 4.8. Receipt of Public and Private Support by Facility Employment Size



Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Chapter
5

Manufacturing Technologies and Techniques

This chapter examines use of manufacturing technologies and techniques. Current and planned use of sustainability, information technologies, quality management, and production practices are profiled.

Manufacturing Technologies and Techniques

This section examines current and planned use of a set of 19 information technologies, quality management and continuous improvement techniques, and manufacturing production technologies. These technologies include:

- Bar code readers for data collection
- Computer aided design
- Software for scheduling, inventory control, or purchasing (e.g., ERP)
- RFID for inventory and warehouse tracking
- Supply chain management systems
- Cloud-based design and manufacturing
- ISO 9000, TS16949 certification
- ISO 14000 environmental management certification
- ISO 50001, Energy Management System
- Carbon footprint, greenhouse gas estimate
- Quality systems (e.g., Six Sigma)
- Lean manufacturing
- Preventive/predictive machine maintenance program
- Life cycle analysis
- Computer-integrated manufacturing (CIM)
- Sensors, visioning, other monitoring
- Rapid prototyping
- Additive manufacturing, printed manufacturing
- Robots
- Advanced materials (e.g., nano-materials, bio-materials, composites)

Eighty-eight percent of respondents used at least one of these technologies and techniques. The median respondent used four of these technologies, while 8 percent of respondents used 10 or more. Software for scheduling, inventory control of purchasing such as enterprise resource planning (ERP) is the most commonly used (71 percent), followed by computer aided design (67 percent),

preventive and predictive maintenance (57 percent), and lean manufacturing (43 percent). Plans for acquiring new technologies are most common for bar code readers (21 percent) and radio frequency identification (RFID) for inventory and warehouse tracking (17 percent) (Figure 5.4).

Eighty-six percent of respondents used at least one of these technologies and techniques. Use of technologies and techniques is slightly higher than in 2014, particularly of robots. Planned use of technologies was higher in the 2016 survey than the 2014 survey particularly for bar code readers (Table 5.1).

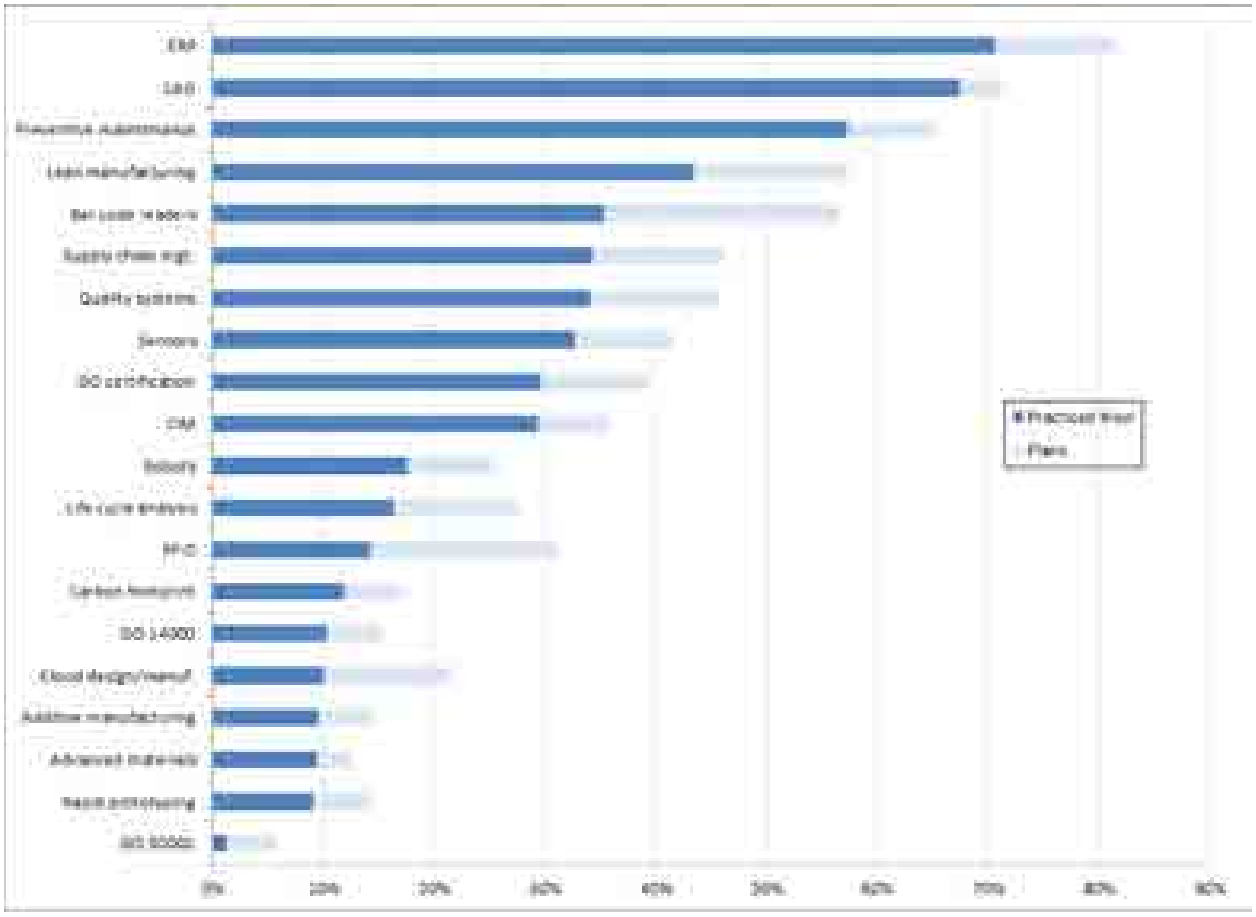
Table 5.1. Current and Planned Use of Technologies and Techniques: 2014 and 2016 Surveys

(Percentage of Establishments Using Technology)

Technology/Technique	2016 Currently Use	2016 Planned Use	2014 Current Use	2014 Planned Use
ERP	70.7%	10.9%	67.7%	12.2%
CAD	67.4%	3.9%	62.9%	2.0%
Preventive maintenance	57.3%	8.1%	56.0%	8.2%
Lean manufacturing	43.4%	14.0%	44.0%	11.7%
Bar code readers	35.3%	21.3%	35.1%	14.7%
Supply chain mgt.	34.3%	11.8%	30.2%	10.4%
Quality systems	34.0%	11.7%	32.5%	9.2%
Sensors	32.7%	8.8%		
ISO certification	29.6%	9.9%	26.9%	7.1%
CIM	29.3%	6.6%	28.7%	4.8%
Robots	17.6%	7.7%	9.7%	6.1%
Life cycle analysis	16.3%	11.3%	13.2%	9.1%
RFID	14.2%	17.0%	14.4%	12.3%
Carbon footprint	11.9%	5.3%	8.8%	3.8%
ISO 14000	10.3%	5.1%	9.3%	2.8%
Cloud design/manuf.	10.0%	11.6%	7.3%	10.0%
Additive manufacturing	9.5%	5.2%	5.8%	3.8%
Advanced materials	9.4%	3.2%	8.1%	2.6%
Rapid prototyping	9.1%	5.1%	10.1%	4.0%
ISO 50001	1.3%	4.4%	1.3%	3.1%

Source: Georgia Manufacturing Survey 2016, weighted responses of 503 manufacturers; Georgia Manufacturing Survey 2014, weighted responses of 480 manufacturers.

Figure 5.4. Technologies and Techniques Manufacturers Use and Plan to Use



Source: Georgia Manufacturing Survey 2016, weighted responses of 503 manufacturers.

In general, use of technologies and techniques increases with facility employment size. This is particularly true for use of supply chain management, quality systems, lean manufacturing, robots, and bar code readers. Nearly 60 percent of manufacturers with 250 or more employees have estimated their carbon footprint which is more than three times higher than in the medium-size class; this higher adoption is likely driven by regulatory requirements. Rapid prototyping, advanced materials and additive manufacturing have about the same percentage in small and medium-size employment categories using these technologies. By industry, the electronics/electrical/transportation group had the highest use of these technologies and techniques. However, RFID was most prevalent in the food/textile/apparel/leather group (used by 26% of these respondents) and CAD in the machinery and electronics/electrical/transportation groups (used by 76% of respondents in these groups). The West region is the most likely to have users of these technologies and techniques, while the Central and Coastal are least likely (Tables 5.2, 5.3, 5.4).

Table 5.2. Current Use of Technologies and Techniques by Facility Employment Size
(Percentage of Establishments Using Technology)

Technology/Technique	10-49	50-249	250+
ERP	58.8%	86.9%	92.4%
CAD	59.3%	76.2%	92.2%
Preventive maintenance	45.4%	72.5%	84.3%
Lean manufacturing	30.7%	57.3%	81.8%
Bar code readers	18.2%	56.3%	79.3%
Supply chain mgt.	19.2%	49.6%	82.2%
Quality systems	17.0%	55.4%	70.0%
Sensors for monitoring	18.7%	48.4%	75.9%
ISO 9000	16.9%	43.8%	70.1%
CIM	19.6%	41.0%	58.3%
Robots	7.5%	26.2%	59.7%
Life cycle analysis	8.0%	25.9%	47.8%
RFID	5.1%	20.5%	55.9%
Carbon footprint	3.8%	16.8%	57.2%
ISO 14000	1.8%	15.3%	59.4%
Cloud-based design manuf	7.4%	13.3%	17.1%
Additive manufacturing	6.6%	10.8%	29.5%
Advanced materials	6.4%	9.9%	33.6%
Rapid prototyping	7.9%	8.0%	25.6%

Source: Georgia Manufacturing Survey 2016, weighted responses of 503 manufacturers.

Table 5.3. Current Use of Technologies and Techniques by Industry Group
(Percentage of Establishments Using Technology)

Technology/Technique	Food-text	Material	Mach	Elec-Trans	Science
ERP	61.5%	65.4%	70.7%	87.0%	87.2%
CAD	51.1%	66.7%	80.3%	87.2%	45.5%
Preventive maintenance	49.8%	58.3%	54.5%	60.5%	68.2%
Lean manufacturing	43.3%	35.6%	43.1%	67.4%	46.5%
Bar code readers	43.1%	29.4%	30.4%	60.0%	29.8%
Supply chain mgt.	27.7%	29.2%	29.6%	56.5%	48.9%
Quality systems	31.2%	27.6%	29.8%	59.5%	42.9%
Sensors for monitoring	38.3%	31.5%	21.1%	35.7%	48.9%
ISO 9000	20.7%	17.7%	32.5%	60.5%	44.2%
CIM	34.8%	25.5%	33.9%	26.8%	25.0%
Robots	17.2%	13.6%	14.3%	28.6%	27.3%
Life cycle analysis	21.7%	12.5%	11.1%	30.0%	18.4%
RFID	25.5%	12.8%	7.6%	15.0%	13.3%
Carbon footprint	10.7%	10.7%	3.5%	26.8%	20.5%
ISO 14000	9.1%	6.1%	2.9%	32.5%	19.5%
Cloud-based design manuf	12.0%	8.5%	10.8%	4.8%	15.2%
Additive manufacturing	1.9%	6.0%	12.9%	23.8%	9.5%
Advanced materials	5.8%	7.4%	5.8%	25.6%	11.6%
Rapid prototyping	3.6%	5.5%	13.6%	20.5%	7.0%

Source: Georgia Manufacturing Survey 2016, weighted responses of 503 manufacturers.

Table 5.4. Current Use of Technologies and Techniques by Region
(Percentage of Establishments Using Technology)

Technology/ Technique	North-west	North-east	Atlanta	West	Central	East	South	Coastal
ERP	66.5%	77.3%	72.4%	71.8%	64.1%	87.0%	59.4%	70.5%
CAD	51.5%	74.7%	70.8%	61.1%	78.3%	83.4%	55.5%	78.2%
Preventive maintenance	52.7%	68.9%	53.1%	61.5%	58.0%	53.2%	66.8%	50.1%
Lean manufacturing	38.8%	51.0%	43.9%	58.5%	44.0%	24.2%	36.5%	37.1%
Bar code readers	37.8%	36.5%	41.6%	55.8%	22.2%	34.3%	10.4%	14.9%
Supply chain mgt.	30.0%	35.6%	36.5%	50.3%	21.7%	51.8%	29.0%	23.3%
Quality systems	36.8%	34.1%	31.8%	45.5%	33.7%	43.5%	31.0%	27.3%
Sensors for monitoring	38.2%	31.7%	30.2%	38.7%	35.7%	40.6%	31.9%	23.2%
ISO 9000	31.7%	32.5%	27.2%	54.8%	19.0%	30.1%	20.2%	33.4%
CIM	38.7%	33.0%	31.9%	21.7%	19.6%	36.7%	19.1%	4.4%
Robots	16.1%	23.5%	17.8%	38.9%	7.6%	0.0%	13.5%	7.5%
Life cycle analysis	15.8%	21.8%	14.9%	14.4%	16.7%	10.6%	17.8%	16.7%
RFID	20.4%	12.1%	9.4%	20.9%	14.4%	26.7%	16.2%	14.7%
Carbon footprint	17.2%	15.5%	6.9%	23.0%	7.4%	25.0%	15.3%	5.1%
ISO 14000	15.7%	10.3%	8.0%	17.7%	4.6%	8.2%	6.3%	15.5%
Cloud-based design manuf	10.9%	12.8%	12.1%	7.5%	5.9%	7.0%	2.1%	7.8%
Additive manufacturing	9.9%	10.9%	11.4%	11.0%	2.2%	0.0%	8.4%	4.9%
Advanced materials	7.3%	11.0%	10.5%	17.4%	4.3%	0.0%	10.5%	4.4%
Rapid prototyping	8.9%	12.1%	11.9%	6.9%	4.3%	0.0%	5.7%	0.0%

Source: Georgia Manufacturing Survey 2016, weighted responses of 503 manufacturers.

In this analysis, we distinguish (1) base entry use and (2) competitive or advanced entry use. These two categories are assessed along 11 dimensions:

- State of the art equipment
- Highly skilled people
- High levels of design
- Information technologies
- Product development
- New materials and processes
- Supplier engagement
- Customer engagement
- Life-cycle sustainability
- High quality and reliability
- Automation

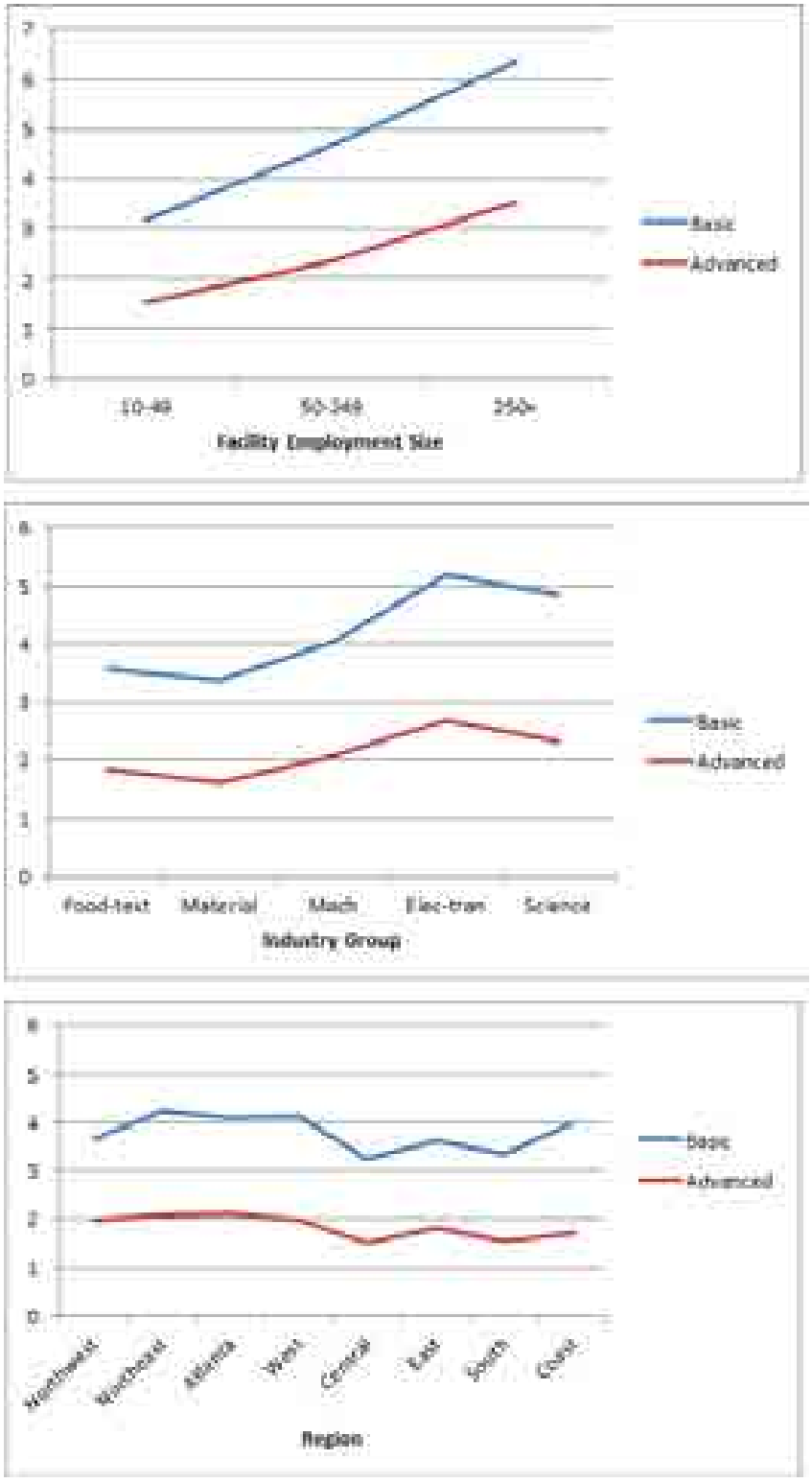
For each dimension, there is a base entry and a competitive/advanced entry (Table 5.5). A simple sum of each technology for basic and advanced entry shows the difference between levels of basic use of technology versus those of advanced use (Figure 5.5). Ninety-three percent of respondents used at least one base entry technology, while 75 percent used at least one advanced entry technology. Technology use differs by size, but medium-sized establishments are closer to small establishments in their use of basic technologies and

advanced technologies. By industry group, the elect-trans group is the largest user of basic and advanced technology, followed by the science and machinery groups. However, the food-text and materials manufacturers are closer to these leading groups in their use of advanced technologies. Regional differences are more pronounced in terms of use of basic technologies than advanced technologies, with Northeast and West region respondents more likely to use these technologies and those in the Central less likely to use them.

Table 5.5. Base Entry and Competitive/Advanced Entry: Manufacturing Technologies, Techniques

Component	Base entry measure	Competitive/advanced entry measure
State of the art equipment	Preventive/predictive machine maintenance program	Percentage of workers using computers 75 percent or more.
Highly skilled people	More than $100 spent on all training activities in fiscal year 2011	Percentage of training that is non-routine of 50 percent or more
High levels of design	Use of CAD	Use of cloud-based design systems
Information technologies	Use of ERP	Use of RFID
Product development	Use of Rapid prototyping	Use of additive manufacturing, printed manufacturing
New materials and processes	Use of higher performing materials	Use of new materials (e.g., nano-materials, bio-materials, advanced composites)
Supplier engagement	Work with suppliers for innovation	Use of supply chain management systems
Customer engagement	Any marketing innovation	Work with customers for innovation
Life-cycle sustainability	Use of environmental (ISO 14000), energy (ISO 50001) management	Use of life-cycle analysis
High quality and reliability	Use of ISO 9000, QS-9000 certification	Use of lean manufacturing
Automation	Use of robots	Use of CIM

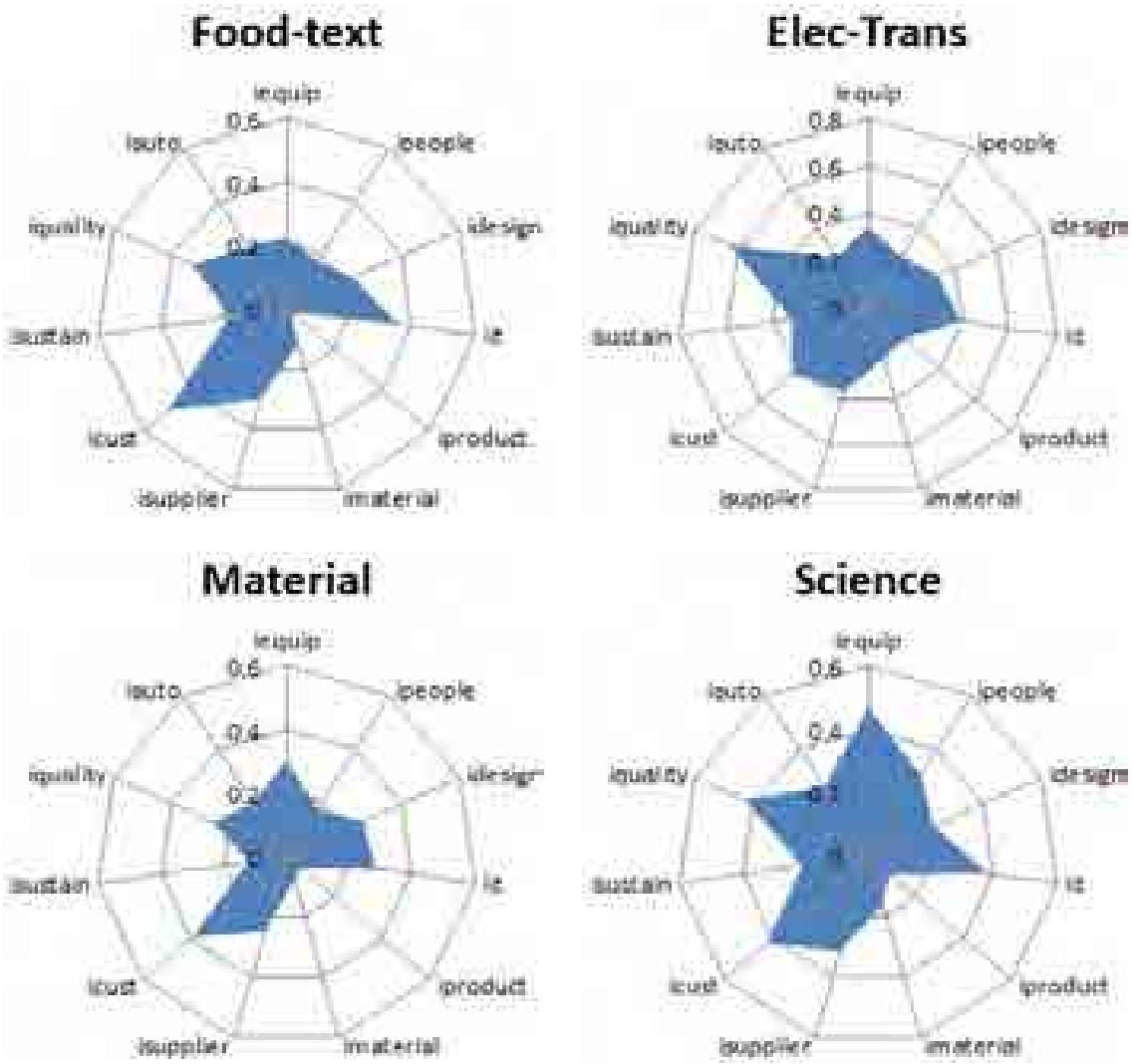
Figure 5.5. Usage of Basic and Advanced Technologies and Techniques by Size, Industry, Region (y-axis=mean number technologies used)



Source: Georgia Manufacturing Survey 2016, weighted responses of 503 manufacturers.

Differences are also apparent when considering each dimension separately. This can be done through an examination of radar charts showing an index score on each of the 11 dimensions. In this analysis, the basic entry technologies are given a score of "1" and the competitive/advanced, a score of "2". The results are normalized to a 0-1 scale (Figure 5.6). Most of the industries have significant usage of quality and supplier entry techniques, owing to the widespread work with suppliers on innovation and prioritization of high quality strategies for competing in the market for sales. The science group tends to have the greatest usage along the 11 dimensions of analysis. The quality, equipment, customer and information technology dimensions were particularly prevalent in the science group. The elec-trans group tended to be distinctively strong along the quality dimension. The machinery group was also strong along the customer, quality, and equipment dimensions. The food-textile group had customer scores that were higher than all the other industry groups.

Figure 5.6. Usage of Basic and Advanced Technologies and Techniques



Source: Georgia Manufacturing Survey 2016, weighted responses of 503 manufacturers.

Smart Manufacturing

Smart manufacturing concerns the use of data to drive manufacturing performance improvement. Half of Georgia manufacturers electronically collect and analyze data for improvement. Just over 30 percent of small manufacturers collect and analyze data, but this percentage rises to 69 percent for medium-sized manufacturers and 90 percent for large manufacturers. Manufacturers in science-based industries are most likely to collect and use data (69 percent), followed by electronics/transportation manufacturers (60 percent). Nearly all manufacturers that electronically collect and analyze data for improvement use it for customer order monitoring (90 percent), followed by process improvement (84 percent), supplier monitoring (81 percent), and design specifications (58 percent). Less common are uses for cybersecurity (38 percent), and energy management (37 percent). Energy management is the area with the largest percentage of respondents planning to use a smart manufacturing application (23 percent) followed by cybersecurity (16 percent). Smart manufacturing usage is highest in the Coastal, West, and Northeast region, on average (Table 5.6).

Table 5.6. Use of Smart Manufacturing by Facility Employment Size, Industry Group, and Region

	Customer order monitor-ing	Supplier ordering and monitoring	Process improve-ment	Design specifica-tions	Energy manage-ment	Cyber-security issues
Total	90.9%	81.6%	84.3%	56.6%	37.2%	37.9%
Facility employee Size						
10-49	89.7%	86.2%	74.9%	51.5%	21.2%	27.3%
50-249	90.7%	77.5%	89.4%	55.9%	36.9%	39.5%
250+	93.0%	81.3%	92.1%	73.6%	77.1%	63.7%
Industry group						
Food-text	96.6%	84.4%	82.4%	64.8%	40.1%	42.6%
Material	92.3%	83.4%	81.6%	57.1%	43.3%	29.1%
Mach	95.3%	87.5%	80.4%	67.9%	27.4%	47.3%
Elec-tran	88.5%	84.6%	92.3%	68.0%	40.0%	44.0%
Science	75.8%	63.6%	90.9%	20.7%	31.3%	33.3%
Region						
Northwest	89.7%	79.6%	80.8%	53.1%	26.6%	45.1%
Northeast	92.6%	86.6%	87.6%	68.8%	36.0%	33.7%
Atlanta	89.0%	80.5%	82.6%	63.0%	32.6%	38.1%
West	100.0%	92.0%	81.9%	45.0%	43.2%	46.7%
Central	81.9%	80.3%	100.0%	41.0%	53.6%	21.3%
East	100.0%	79.2%	92.7%	35.6%	45.5%	23.1%
South	90.2%	80.9%	77.4%	43.6%	53.3%	29.8%
Coastal	89.1%	69.6%	100.0%	53.7%	54.7%	50.1%

Source: Georgia Manufacturing Survey 2016, weighted responses of 503 manufacturers.

Manufacturing Technologies and Employment

Technology use is often assessed relative to employment. Some contend that technology is used to substitute for workers. Others contend that the most efficient and effective firms use technology, which enables greater productivity and consequently more workers hired. Although results from this survey cannot address these points of view causally (due to the cross-sectional nature of the survey data), we can examine these perspectives as an association without attributing causal relationships. Across the technologies in this survey, 60 percent are used by manufacturers with job gains, 22 percent are used by manufacturers with job losses, and 18 percent are used by manufacturers with neither job losses nor gains.

Drawing on the work of Haltiwanger and colleagues[6], we estimate change in employment from 2013 to 2015 as a function of: whether significant changes occurred in the facility in the last two years; change in sales per employee from 2013 to 2015; change in capital investment per employee from 2013 to 2015; year manufacturing began at the facility; and number of technologies used at the facility. Because the employment estimates were highly heterogeneous, we are treating the changes as categories in the models. Logit models are used for these specifications. The results indicate that greater technology use is positively and significantly associated with higher employment; it is also significantly associated with lower employment (Table 5.7). In addition, capital investment increases are positively associated with both higher and lower employment while sales increases are only associated with higher employment; major change positively associated with higher employment and positively associated with lower employment; year established is positively associated with higher employment and negatively associated with lower employment (i.e., newer firms are less likely to have employment declines than older firms are); there are some industry relationships, with non-durable industries and electronics/transportation industries that are negatively associated with employment growth and positively associated with employment declines. The odds of an employment increase from 2013-2015 is 106% higher with a unit increase in technology use, holding the rest of the variables constant; a similar result applies to the job loss regression.

What are the implications of this model for the relationship between technology use and employment? The results indicate that technology is associated with job gains but also associated with job losses suggesting that how technologies are acquired and implemented can make a difference in the addition or reduction of employees. One caveat is that the model does not represent manufacturers that went out of business due to technological and other factors. That said, technology substitution-related job losses may have been offset by employment gains due to greater competitiveness.

[6] Dunne, T, Haltiwanger, J., Troske, K (1996). Technology and Jobs: Secular Changes and Cyclical Dynamics, Working paper 5656. Cambridge, MA: National Bureau of Economic Research.

Table 5.7. Employment and Technology Use

Variables	Employment Higher 2013-15	Employment Lower 2013-15
major change	0.269 (0.107)**	0.282 (0.114)**
sales diff. 2013-15	0.000 (0.000)***	0.000 (0.000)
capital diff. 2013-15	0.000 (0.000)***	0.000 (0.000)***
year established	0.016 (0.002)***	-0.009 (0.003)***
number tech. used (0-6+ technologies)	0.055 (0.021)***	0.056 (0.024)**
food-text	-.481 (0.183)***	1.133 (0.247)***
materials	-0.028 (0.169)***	1.006 (0.237)***
machinery	-0.229 (0.174)**	1.099 (0.243)***
elec-trans	-0.530 (0.199)	1.385 (0.260)***
Constant	-31.460 (4.643)	15.830 (4.992)***
Pseudo R2	0.151	0.054
Log Likelihood	2956.099***	2492.218***
Observations	352	352

Standard errors in parentheses, parameters are log odds (logit models).
* significant at 10%; ** significant at 5%; *** significant at 1%
Percentages predicted correctly: 67% (Employment Higher), 78% (Employment Lower)
Standard errors in parentheses, parameters are log odds (logit models).
* significant at 10%; ** significant at 5%; *** significant at 1%

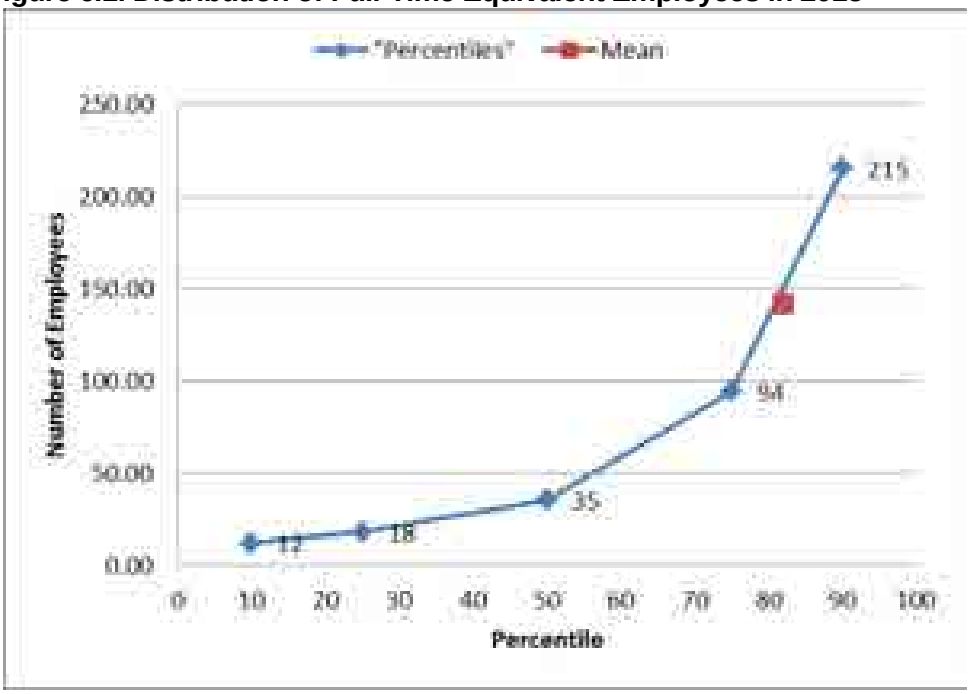
Chapter
6

Workforce and Training Practices

Workforce

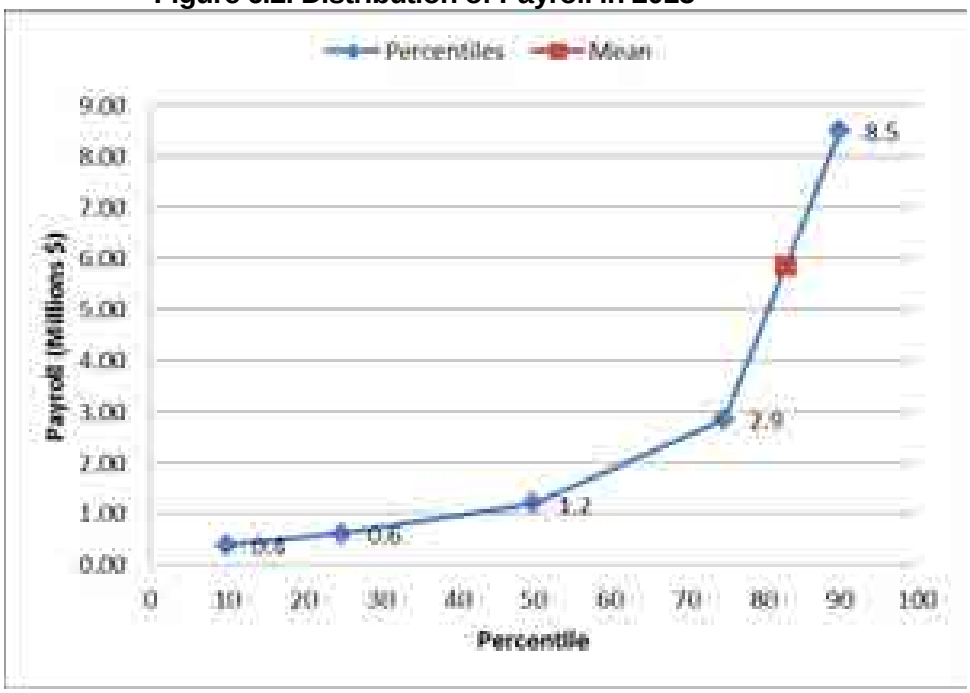
The median number of full-time employees for the sample of manufacturers is 35, a slight increase compared to the 2013 reading of 32 employees. The median annual compensation for a full-time employee in the manufacturing sector for 2015 increased 10% since 2013 to $41,509. Figures 6.1 and 6.2 show the employment and payroll distribution for manufacturers in Georgia.

Figure 6.1. Distribution of Full-Time Equivalent Employees in 2015



Source: Georgia Manufacturing Survey 2016, weighted results of 503 manufacturers

Figure 6.2. Distribution of Payroll in 2015



Source: Georgia Manufacturing Survey 2016, weighted results of 503 manufacturers

Similar to the 2014 survey, this year the data shows some positive correlation between employment size and annual compensation; manufacturers with 250+ employees paid a median of $48,060 while manufacturers with less than 50 employees paid only $38,461.

Compensation also varied by industry; Science was the industry with the highest payroll per employee ($58,949), followed by Electrical-Transportation and Machinery. In the 2014 and 2016 surveys, the Material industry reported the lowest payroll per employee.

The data revealed a higher variability of compensation by geographic location, compared to the 2014 survey. Atlanta manufacturers reported the highest pay per employee compared to other Georgia regions.

Table 6.1. 2015 Median Number of Employees and Payroll per Employee by Employment Size, Industry, and Location

	Employees	Pay ($)
<50	20	38,461
50-249	95	47,907
250+	430	48,060
Food-text	49	37,939
Material	30	35,769
Mach	25	46,667
Elec-Trans	86	51,250
Science	40	58,949
NW	47	38,563
NE	31	39,118
ATL	34	46,671
West	52	40,455
Central	38	37,755
East	88	44,616
South	30	37,625
Coast	35	44,934
All	35	41,509

Source: Georgia Manufacturing Survey 2016, weighted results of 503 manufacturers

As a result of the continued economic uncertainty observed in 2015, many companies opted for a higher number of temporary employees. Temporary workers accounted for 10% of total full-time equivalent employees in 2015, a 1-point increase since 2013 (Table 6.2).

Manufacturers in the Electrical-Transportation industry is the group with the highest percentage of temporary employees and also the group with the highest increase between 2013 and 2015.

Companies located in North East, Atlanta, and South Georgia experienced a temporary labor increase of 3 basis points between 2013 and 2015, as opposed to a decrease of temporary workers between the two years for the West, East, and Coastal Georgia.

Table 6.2. 2015 Mean Percent Number of Temporary Employees over Full Time Employees by Employment Size, Industry, and Location

	2015	2013
<50	10%	9%
50-249	9%	8%
250+	11%	8%
Food-text	11%	10%
Material	5%	5%
Mach	6%	5%
Elec-Trans	27%	19%
Science	10%	7%
NW	8%	8%
NE	7%	4%
ATL	12%	9%
West	19%	20%
Central	5%	5%
East	2%	3%
South	8%	5%
Coast	1%	3%
All	10%	9%

Source: Georgia Manufacturing Survey 2016, weighted results of 440 manufacturers

Employee Education and Training

The 2016 survey showed a slight increase in the education of the workforce. Twenty percent of the force received a 2-year technical training and 10% have a 4-year non-technical degree (Table 6.3). These two figures represent a 2-point increase compared to their corresponding readings recorded for 2014.

The exceptions are the 4-year non-technical and graduate degrees, which was the case in the 2014 study. This year all other categories revealed a relationship of larger employment size to a less educated workforce.

Employee Education and training is related to the type of industry. Electrical-Transportation has the highest percentages for 4-year and graduate degrees; Machinery has the highest percentage for 2-year technical degrees.

The relationship between education and type of industry illustrates another determinant of the educational relationship; East Georgia experienced the

highest percentage of 2-year technical degrees. Education and training opportunities play a major role as was the case for Atlanta manufacturers with the highest ratios for 4-year degrees.

Table 6.3. Employee Education by Employment Size, Industry, and Location

	HS Diploma or GED	2-year Technical Training	4-year Technical Degree	4-year non Technical Degree	Graduate Degree
<50	81%	23%	9%	11%	2%
50-249	79%	15%	9%	8%	2%
250+	75%	18%	10%	5%	2%
Food-text	76%	18%	6%	10%	1%
Material	76%	18%	7%	9%	2%
Mach	86%	27%	8%	8%	1%
Elec-Trans	83%	21%	18%	12%	3%
Science	84%	15%	13%	12%	4%
NW	75%	17%	6%	7%	1%
NE	79%	18%	7%	10%	1%
ATL	82%	22%	13%	12%	2%
West	84%	19%	7%	7%	2%
Central	84%	18%	4%	7%	3%
East	83%	29%	13%	11%	2%
South	76%	20%	6%	8%	2%
Coast	83%	19%	10%	9%	2%
All	80%	20%	9%	10%	2%

Source: Georgia Manufacturing Survey 2016, weighted results of 429 manufacturers

Computer, Mobile Device, and Internet Use

Thirty seven percent, 8% and 22% of all manufacturers workforce utilize computers, mobile devices, and the Internet at least once a day as part of their job, respectively (Table 6.4). Larger employers have a higher percentage of employees utilizing computer technology, while they have a lower percentage of employees accessing the internet.

Technology usage has a wide variation based on industry and location. The Science industry is the highest user for all three technology categories. The Food-Textile industry recorded the lowest levels for Computer usage.

Usage also varied with location. The Coast of Georgia ranks as the top user for Computer and Internet usage. The East has the highest Internet use of 33 percent.

Table 6.4. Computer, Mobile Device, and Internet Usage of Production Workers At Least Once a Day By Employment Size and Industry

	Computer	Mobile Device	Internet
<50	34	7	22
50-249	39	11	22
250+	44	7	17
Food-text	28	7	18
Material	31	9	20
Mach	45	8	25
Elec-Trans	42	4	25
Science	52	16	26
NW	37	8	16
NE	38	10	21
ATL	38	8	24
West	38	1	29
Central	34	5	25
East	38	10	33
South	26	8	17
Coast	39	13	19
All	37	8	22

Source: Georgia Manufacturing Survey 2016, weighted results of 443 manufacturers

Training Expenses

Georgia manufacturers' training expenses per employee increased in 2015 to $549 from $423 in 2013. Part of the increase is explained by an increase in training on new tasks, accounting for 29% of total training expenses in 2015, compared to 27% in 2013.

Manufacturers with less than 50 employees was the group that experienced the highest training increase (Table 6.5); they spent $607 per employee in 2015, a 55% increase compared to 2013. Manufacturers with 250+ employees spent $188 per employee for new tasks, a 49% increase between 2013 and 2015.

Material was the industry that spent the most in training per employee in 2015 ($699); this group remarkably doubled its budget between 2013 and 2015. The Electrical-Transportation and Science industries, the top two in 2013, reported the greatest training cuts in 2015 spending only $391 and $628, respectively.

Companies that use Sustainability and Innovation as their main competitive strategy reported the highest training expenses per employee in 2015, $714 and $400, respectively. Companies in the Innovation group spent the most in training for new tasks, $132 or 33% of total training, while the ones in the Low Price group spent the least, only $3 or 3% of total training.

Table 6.5. Median Training Expenses per Employee By Employment Size, Industry, and Top Competitive Strategy

	Training Expenses per Employee ($)	Training Expenses for New Tasks ($)	Training New Tasks/Total Training (%)
<50	607	162	27
50-249	435	132	30
250+	522	188	36
Food-text	479	94	20
Material	699	168	24
Mach	385	127	33
Elec-Trans	391	165	42
Science	628	223	36
Low price	114	3	3
High quality	143	18	13
Innovation	400	132	33
Quick delivery	83	8	10
Customization	67	20	30
Sustainability	714	143	20
All	549	157	29

Source: Georgia Manufacturing Survey 2016, weighted results of 368 manufacturers

Employee Incentives

More Georgia manufacturers rewarded their employees for new skills, education, productivity increases or generation of new ideas in 2015, compared to 2013. In 2015, 20% of surveyed manufacturers provided incentives or bonuses based on new skills or education, 42% of the companies rewarded their employees for productivity increases, and 19% of the companies offered incentives for new ideas (Table 6.6).

The 2016 data suggests that incentives seem to be directly related to employment size, consistent with the 2014 study. In 2015, for example 39% of the companies in the 250+ group offered incentives for new skills or education, while only 17% of the <50 group offered similar incentives.

Among industries, Electrical-Transportation ranked first by percentage of companies providing incentives for new skills, and Science ranked first for productivity increases and new ideas.

The 2016 survey showed that percentages of companies providing employee incentives varied by their competitive strategy. A higher percentage of companies in the Innovation and Sustainability groups rewarded their employees for all categories: new skills or education, productivity increases and new ideas.

Table 6.6. Percentage of Firms Offering Employee Incentives By Employment Size, Industry, and Top Competitive Strategy

	New Skills or Education	Productivity Increases	New Ideas
<50	17%	41%	16%
50-249	22%	44%	25%
250+	39%	45%	25%
Food-text	20%	42%	12%
Material	17%	42%	13%
Mach	18%	44%	20%
Elec-Trans	27%	33%	31%
Science	23%	45%	36%
Low price	13%	34%	12%
High quality	19%	43%	19%
Innovation	36%	63%	39%
Quick delivery	19%	47%	23%
Customization	24%	48%	12%
Sustainability	41%	67%	29%
All	20%	42%	19%

Source: Georgia Manufacturing Survey 2016, weighted results of 503 manufacturers

Production Work in Teams

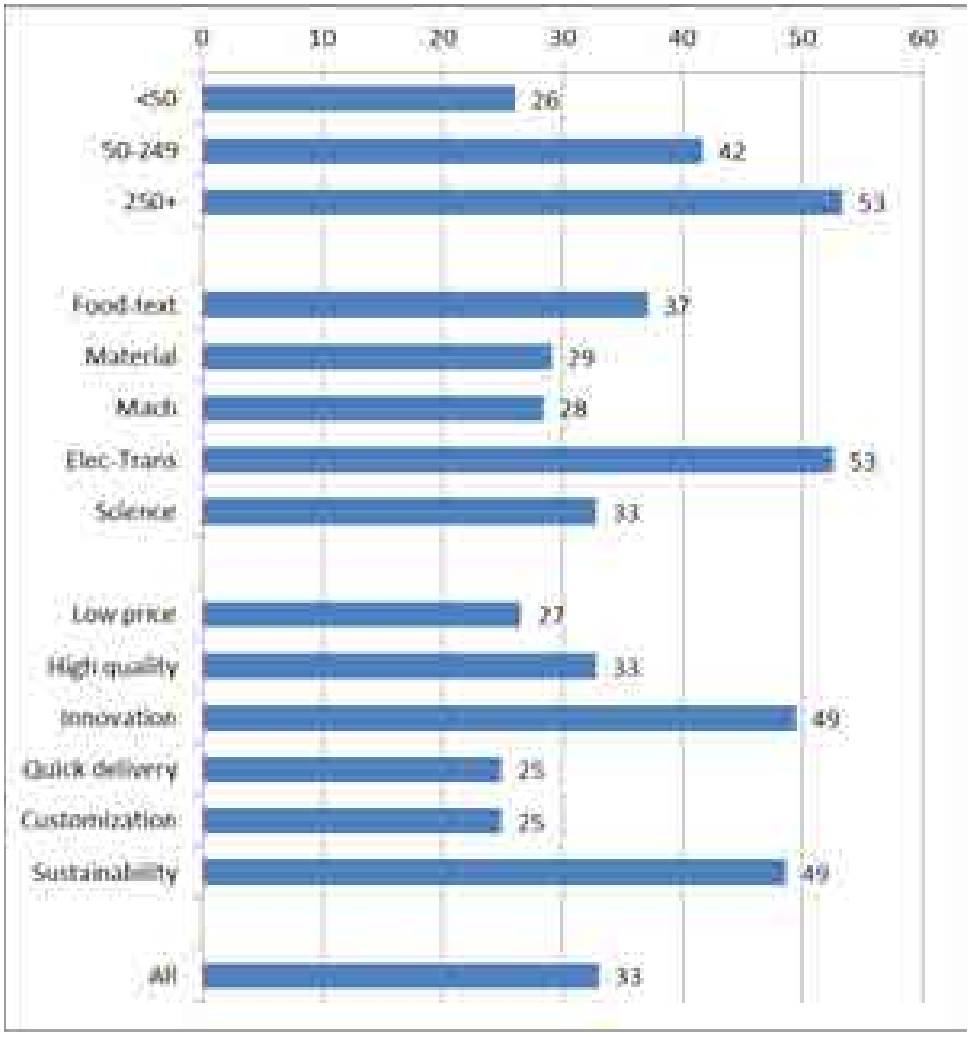
Thirty three percent of production workers in Georgia work in teams, the same percentage reported in the 2014 survey. The percentage of production employees working in teams ranges from manufacturers with less than 50 employees at 26% to companies with 250 and more employees at 53%.

Electrical-Transportation experienced the highest percentage of their force working in teams at 53% among industries and Machinery the least at 26%.

Innovation and Sustainability, with 49% each, reported the highest percentages of employees working in teams among companies grouped by competitive

strategy. These two groups ranked first and second respectively in the 2014 study.

Figure 6.3. Mean Percentage of Production Employees that Work in Teams by Employment Size, Industry, and Competitive Strategy



Source: Georgia Manufacturing Survey 2016, weighted results of 431 manufacturers

Chapter
7

Manufacturing Production and Performance

Sales, Purchases, and Investments

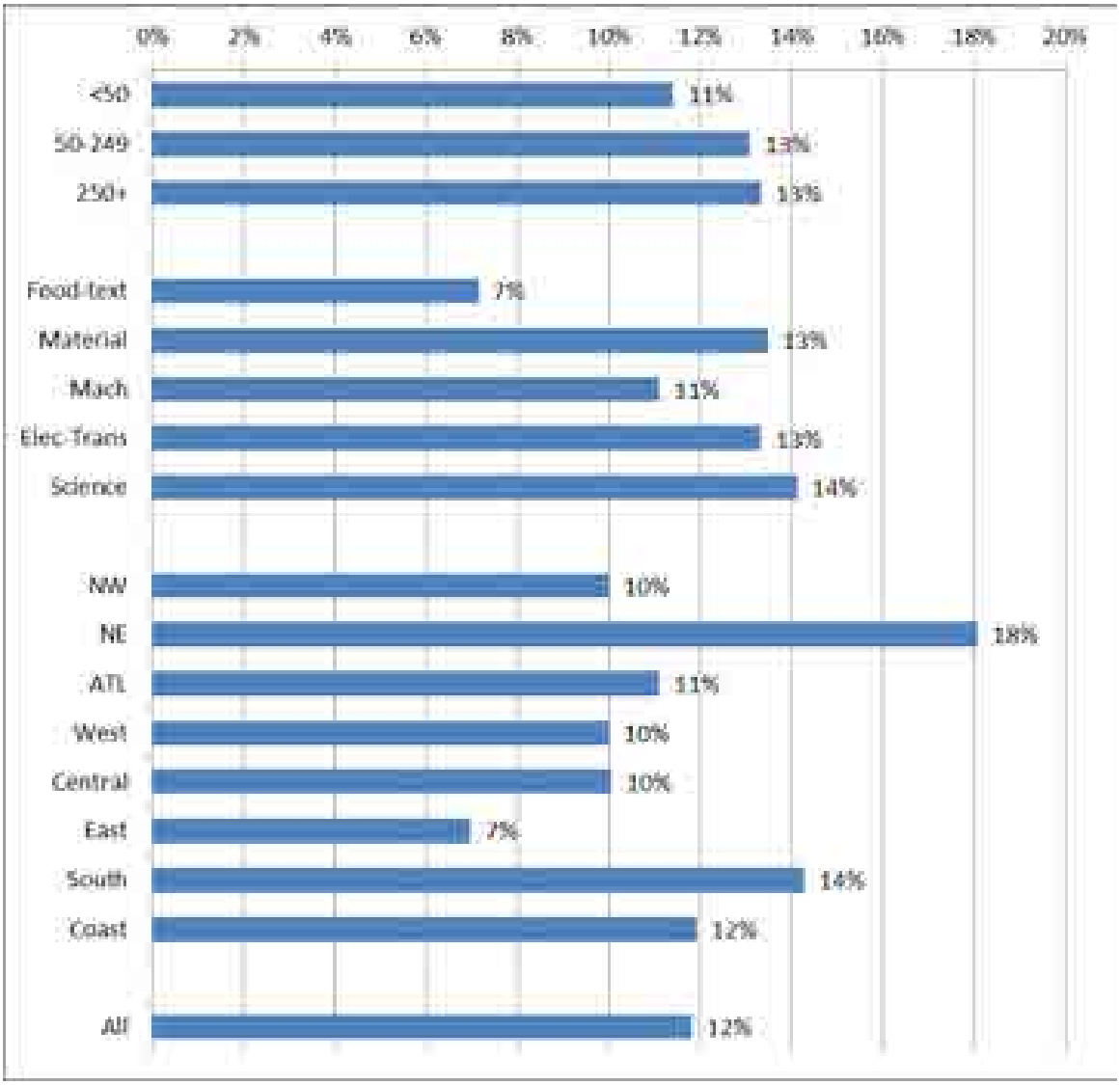
Georgia manufacturers reported a 12% median sales percent increase between 2013 and 2015[7](Figure 7.1), matching the median sales growth observed between 2011 and 2015. Companies under 50 employees experienced lower sales increases at 11.4%, while the other two categories both enjoyed a 13% increase.

The Science industry enjoyed the largest median growth rate at 14% and Food-Textiles recorded the lowest rate at 7%. These same two groups also ranked first and last by median sales growth in the 2014 study, respectively.

Manufacturers in the North East region outperformed the others in terms of median sales growth for 2013-2015. The East Georgia region experienced the lowest sales growth. At the bottom of the list of regions by sales growth, firms located in the East Georgia underperformed the rest of the manufacturers.

[7] The percentage is obtained by subtracting total sales of 2013 from 2015, and dividing the difference by sales of 2013.

Figure 7.1. Median Percent Change in Sales 2013-2015 for Georgia Manufacturers



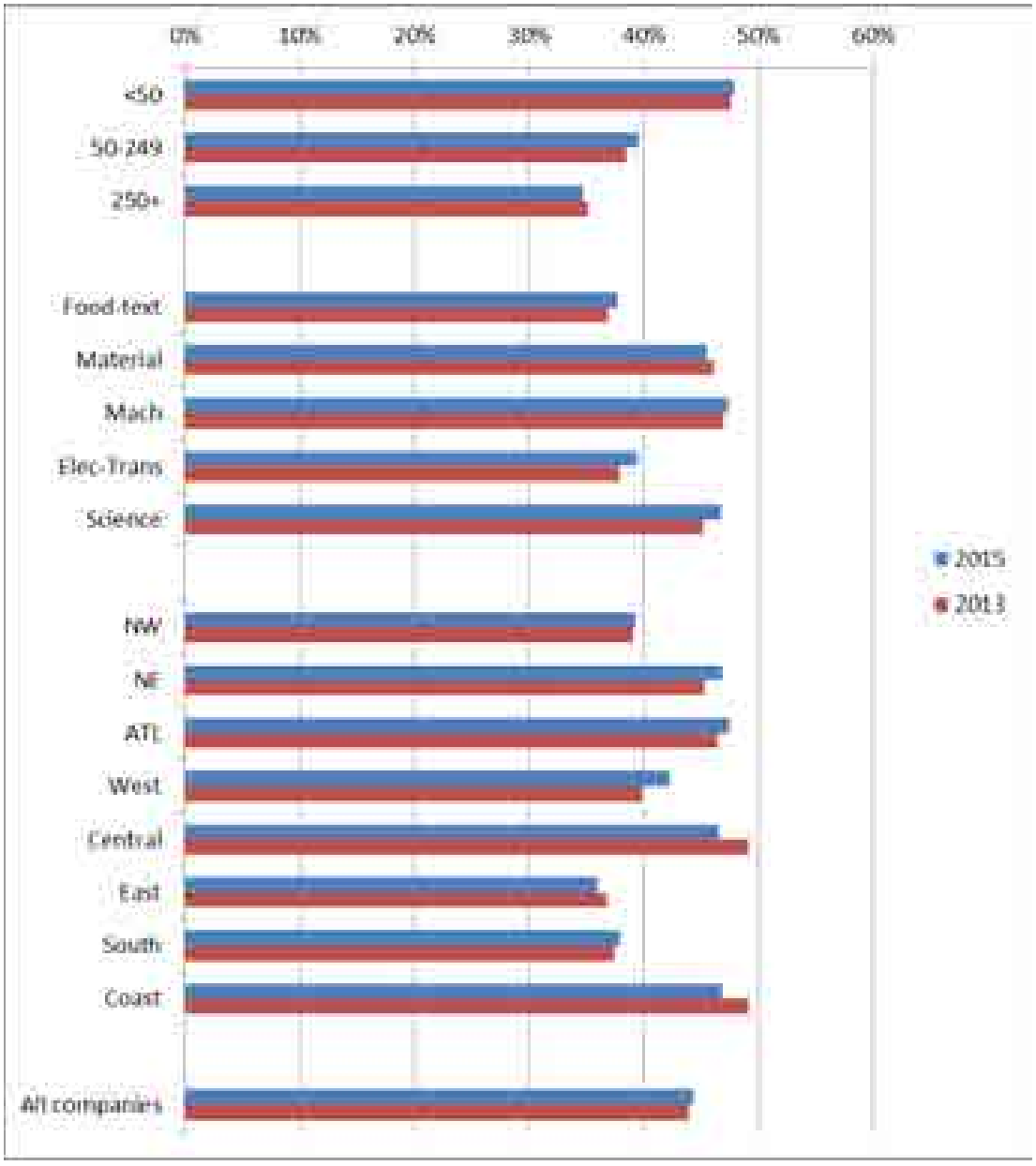
Source: Georgia Manufacturing Survey 2016, weighted results of 399 manufacturers

Gross margin as percentage of sales is calculated by subtracting cost of goods sold from total sales, and dividing the difference by total sales. Surveyed manufacturers reported a mean gross margin of 44% for both 2013 and 2015 (Figure 7.2). Gross margin decreased based on the size of the labor force. Firms under 50 employees averaged a margin of 48%, while margins dropped to 35% for firms with 250+ employees.

Gross margins by industry showed differences. Manufacturers in the Machinery and Science industries reported the highest mean gross margins for 2015 at 47%. Food-Textiles reported the lowest mean gross margin at 38%.

North East, Atlanta, Central, and Coast areas experienced the highest gross margins. Manufacturers in the East and South Georgia experienced the lowest gross margins.

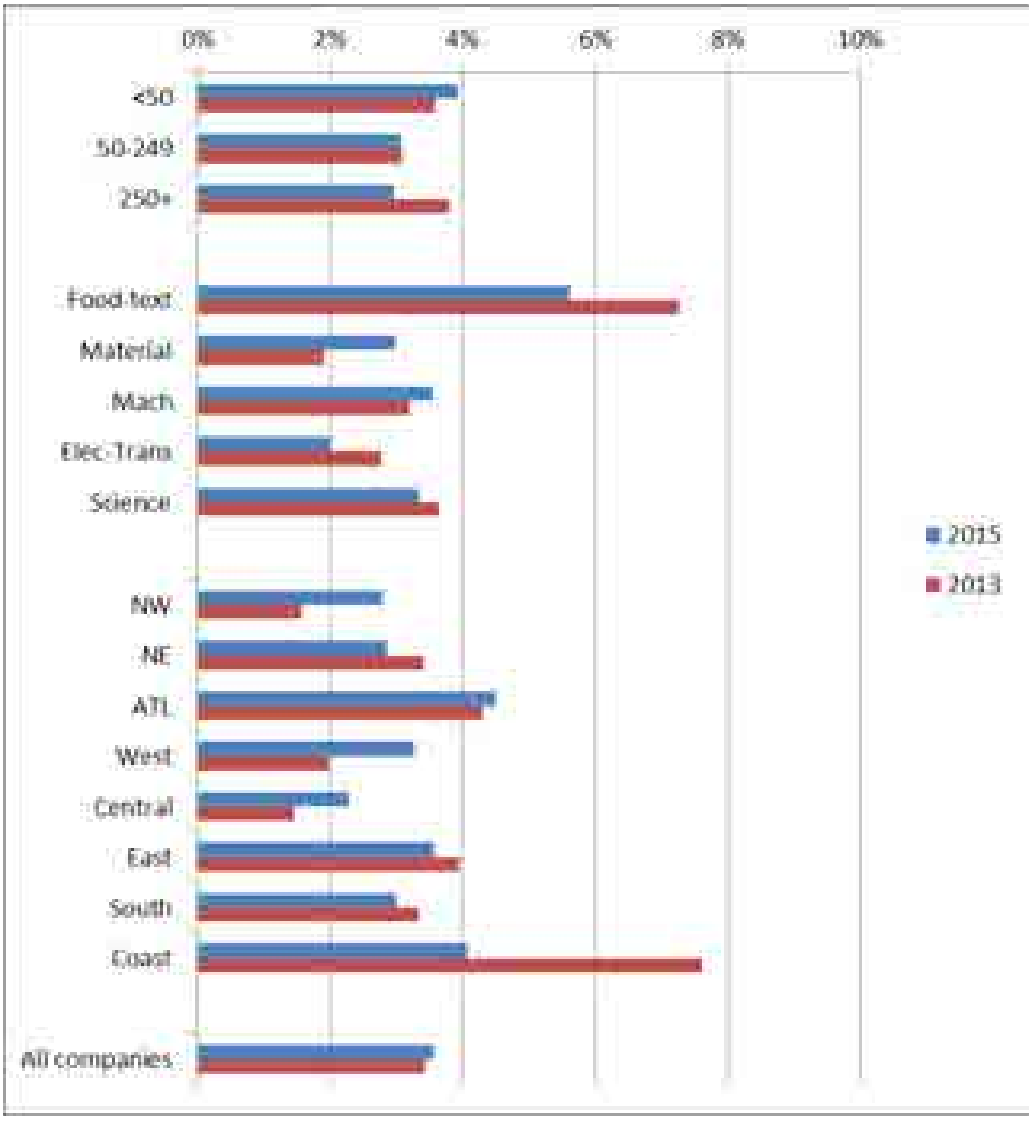
Figure 7.2. Mean Gross Margin as Percent of Sales for Georgia Manufacturers



Source: Georgia Manufacturing Survey 2016, weighted results of 360 manufacturers

Capital expenditures divided by sales for Georgia manufacturers revealed a slight increase to 3.6% in 2015 from 3.4% for 2013 (Figure 7.3). Companies with 250+ employees experienced a decline in the ratio in 2015. Companies in the Food-Textiles industry reported the largest decline, while Material enjoyed the largest increase among industries. Firms located in the Coast area experienced the largest decline.

Figure 7.3. Mean Capital Expenditures as Percentage of Sales



Source: Georgia Manufacturing Survey 2016, weighted results of 448 manufacturers

Imports and Exports

Manufacturers reported a slight increase in sales exported and materials imported in 2015 compared to 2013 (Table 7.1). In 2015, 8% of total sales were exported and 10% of the purchased materials were imported. Percent of exports and imports experienced a 1-point increase in each case compared to their corresponding values for 2013. The percentage of finished products that were imported remained the same between the two periods.

Larger employers reported higher levels of international trade. Sales exported for companies under 50 employees reached only 4% of total sales, while the sales exported for companies with 250+ employees accounted for 15% of total sales.

Firms in the Electrical-Transportation and Science industries consistently show higher levels of foreign trade. West Georgia ranked top in sales exported, materials imported, and products imported; The Coast area Coast experienced higher levels of materials imported compared to most other regions.

Table 7.1. Mean Percentages for Sales Exported, Materials Imported, Products Imported

	2015			2013		
	Sales Exported	Materials Imported	Products Imported	Sales Exported	Materials Imported	Products Imported
<50	4	7	3	4	6	4
50-249	12	14	4	11	13	4
250+	15	20	10	15	18	9
Food-text	7	11	4	6	9	5
Material	4	5	3	4	5	3
Mach	6	7	4	6	7	4
Elec-Trans	17	23	8	15	22	8
Science	14	16	3	12	15	2
NW	3	11	2	3	8	4
NE	5	11	2	5	10	3
ATL	8	11	6	7	11	6
West	14	14	9	12	13	9
Central	9	2	1	10	2	0
East	11	8	3	10	6	4
South	10	3	1	10	3	1
Coast	9	13	2	8	11	2
All companies	8	10	4	7	9	4

Source: Georgia Manufacturing Survey 2016, weighted results of 410 manufacturers

State and Federal Benefits

Similar to 2014, this year tax credits for jobs, R&D, investment, job, and energy were used by more than 14% of respondents. Retraining and import-export tax credits were used by fewer than 10% of respondents (Table 7.2). A smaller percent of manufacturers currently claim job and retraining tax credit compared to 2014.

The larger the employer the greater the percent taking advantage of the tax credit categories. Employers in the 250+ employees group exceeded smaller employers by a wide margin. Among industry categories, the Electrical-Transportation industry ranks first in all tax credit categories except for Energy.

Table 7.2. Percentage of Firms Using State and Federal Tax Credits By Employment Size, Industry, and Location

	R&D tax credit	Investment tax credit	Job credit	Retraining tax credit	Import/ export credit	Energy tax credit
<50	10%	11%	6%	3%	3%	9%
50-249	20%	19%	21%	10%	6%	11%
250+	41%	41%	49%	28%	24%	36%
Food-text	13%	18%	20%	9%	8%	11%
Material	10%	15%	9%	3%	3%	11%
Mach	11%	8%	13%	9%	4%	14%
Elec-Trans	38%	25%	21%	13%	8%	8%
Science	30%	20%	14%	9%	5%	18%
Low price	14%	18%	11%	6%	4%	10%
High quality	15%	14%	16%	8%	6%	12%
Innovation	16%	14%	10%	9%	0%	8%
Quick delivery	20%	16%	13%	5%	4%	10%
Customization	14%	8%	6%	8%	0%	15%
Sustainability	11%	6%	11%	0%	0%	11%
All	16%	16%	14%	7%	6%	12%

Source: Georgia Manufacturing Survey 2016, weighted results of 526 manufacturers

Energy Intensity

Energy intensity in this study has been obtained by dividing energy expenditures by sales. Surveyed Georgia manufacturers spent $13 in energy for every $1000 in sales in 2015, a 5% decline compared to the amount they spent in 2013 (Table 7.3).

Manufacturers with 250+ employees registered a 4% energy expense increase, while medium and small manufacturers experienced 6 and 5% declines, respectively. Food-Textiles, followed by Electrical-Transportation, experienced the largest decrease among industry groups. Firms located in the South and North East Georgia experienced the largest decreases in energy usage.

Table 7.3. Energy Intensity: Energy Expenditures by Sales

	Energy Intensity 2015	20131-2015 % Change
<50	0.012	-5%
50-249	0.013	-6%
250+	0.013	4%
Food-text	0.014	-11%
Material	0.016	3%
Mach	0.011	1%
Elec-Trans	0.006	-9%
Science	0.013	-5%
NW	0.015	-13%
NE	0.012	-21%
ATL	0.011	3%
West	0.015	-7%
Central	0.014	6%
East	0.014	13%
South	0.010	-22%
Coast	0.013	17%
All	0.013	-5%

Source: Georgia Manufacturing Survey 2016, weighted results of 325 manufacturers

Best Performers

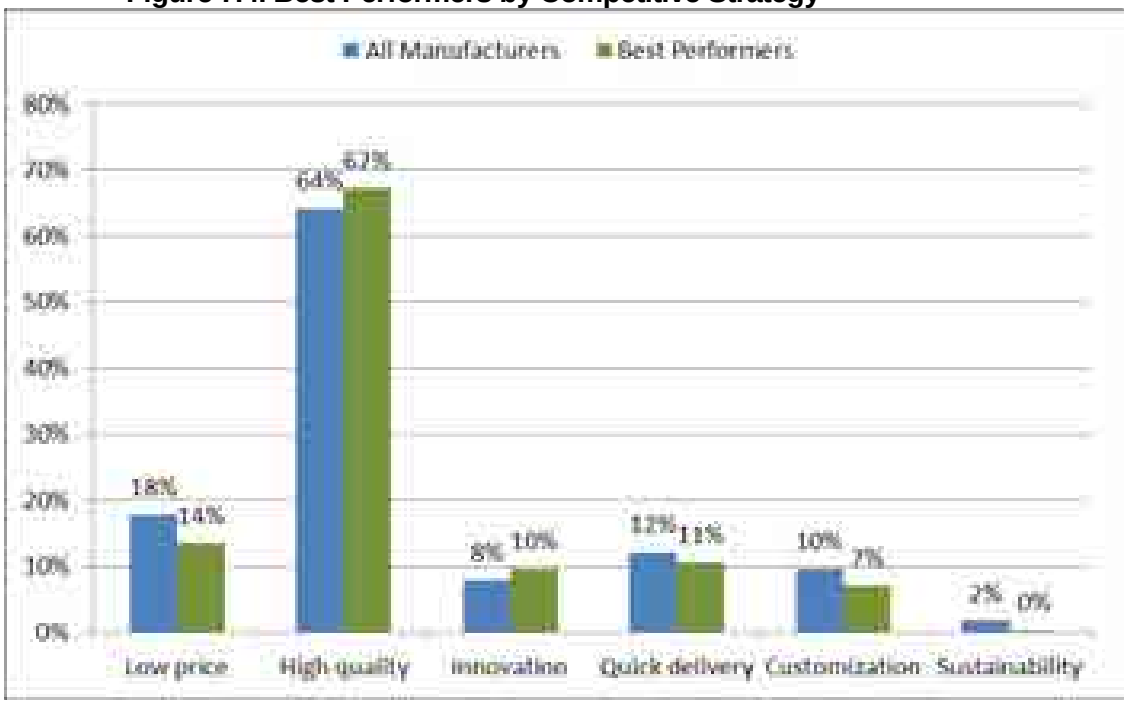
Return on sales is one of the best indicators for measuring company profitability. The ratio is measured by asking respondents to report the average annual return on sales (pre-tax) for their facility over the last three years. Return on sales is a proxy to identify best performers among manufacturers. Manufacturers with average annual returns on sales of 12 percent or more were used as best performers.

The best performers group represents the top 35 percent of the companies. In the following section, we will discuss differences between this group and the

rest of the companies in order to identify possible explanations for their above average performance during the current economic recovery.

Our first analysis highlights differences in competitive strategy between best performers and all other manufacturers. Regardless of company performance, the most common competitive strategy among participants was high quality. A higher percentage of best performers placed an emphasis on high quality and innovation, while a lower percentage of best performers placed an emphasis on the other strategies (Figure 7.4).

Figure 7.4. Best Performers by Competitive Strategy



Source: Georgia Manufacturing Survey 2016, weighted results of 526 manufacturers

Best performers reported slightly higher exports than the average manufacturer (Table 7.4). The greatest difference occurred in the Electrical-Transportation industry, where best performers' exports accounted for 24% of their sales, while exports of the average manufacturer in this industry accounted for only 17%.

Best performers did not show different percentages of imports at the aggregate level, but at industry level, top companies in the Electrical-Transportation industry have significantly lower imports.

Table 7.4. Export and Imports by Industry

	Exports (% of total sales)		Imports (% of total costs)	
	All	Best	All	Best
Food-text	7%	8%	15%	14%
Material	4%	5%	8%	12%
Mach	6%	7%	11%	12%
Elec-Trans	17%	24%	31%	18%
Science	14%	14%	19%	16%
Total	8%	10%	14%	14%

Source: Georgia Manufacturing Survey 2016, weighted results of 420 manufacturers

Best performance related to outsourcing and insourcing varies from sector to sector and in many cases with little difference. Best performers in the Material and Science industries showed lesser use of outsourcing compared to their corresponding industry averages (Table 7.5). In regards of in-sourcing, best performers in the Food-Textiles sector reported lower levels of in-sourcing, but Material, Mach, and Science industries reported higher levels of in-sourcing.

Table 7.5. Percentage of Firms Outsourcing and In-sourcing by Industry

	Outsource		In-source	
	All	Best	All	Best
Food-text	7%	5%	5%	0%
Material	7%	4%	10%	12%
Mach	17%	18%	15%	18%
Elec-Trans	23%	22%	27%	28%
Science	17%	14%	17%	20%
Total	12%	12%	13%	14%

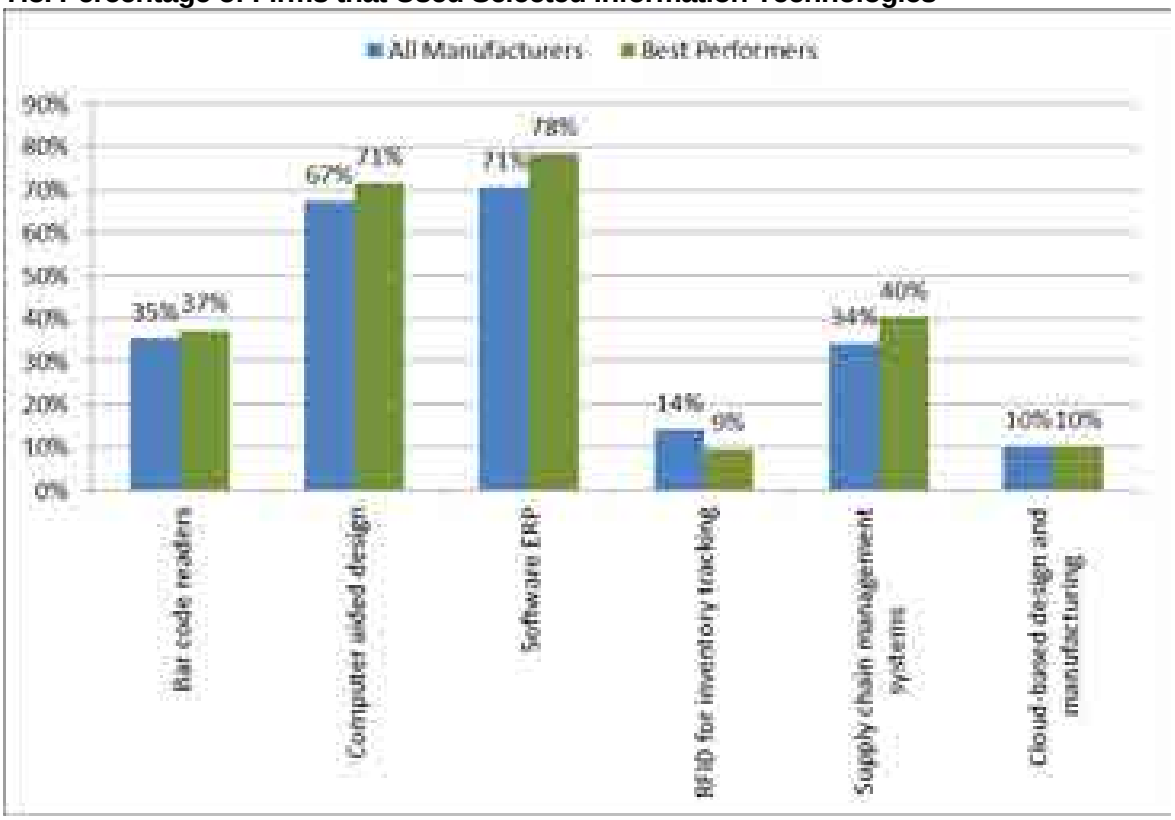
Source: Georgia Manufacturing Survey 2016, weighted results of 508 manufacturers

Performance was related to higher use of information technologies, particularly ERP systems, computer aided design, and supply chain management systems. For example, 78% of the best performers use ERP systems, while only 71% of all manufacturers use those systems (Figure 7.5).

The correlation of ERP use and company performance seems to be more evident for firms in the Material industry, where 80% of top performers employ the system versus only 66% among all firms. The use of ERP systems is also associated with higher performance among firms with less than 50 employees.

Sixty four percent of Best performers in the Food-Textile utilized computer-aided design versus 51% for the entire group of manufacturers. Another context where high company performance showed a relation to the use of computer-aided design is for manufacturers in the Food-Textile industry, where 64% of its best performers use computer-aided design versus only 51% of manufacturers in the industry.

Figure 7.5. Percentage of Firms that Used Selected Information Technologies

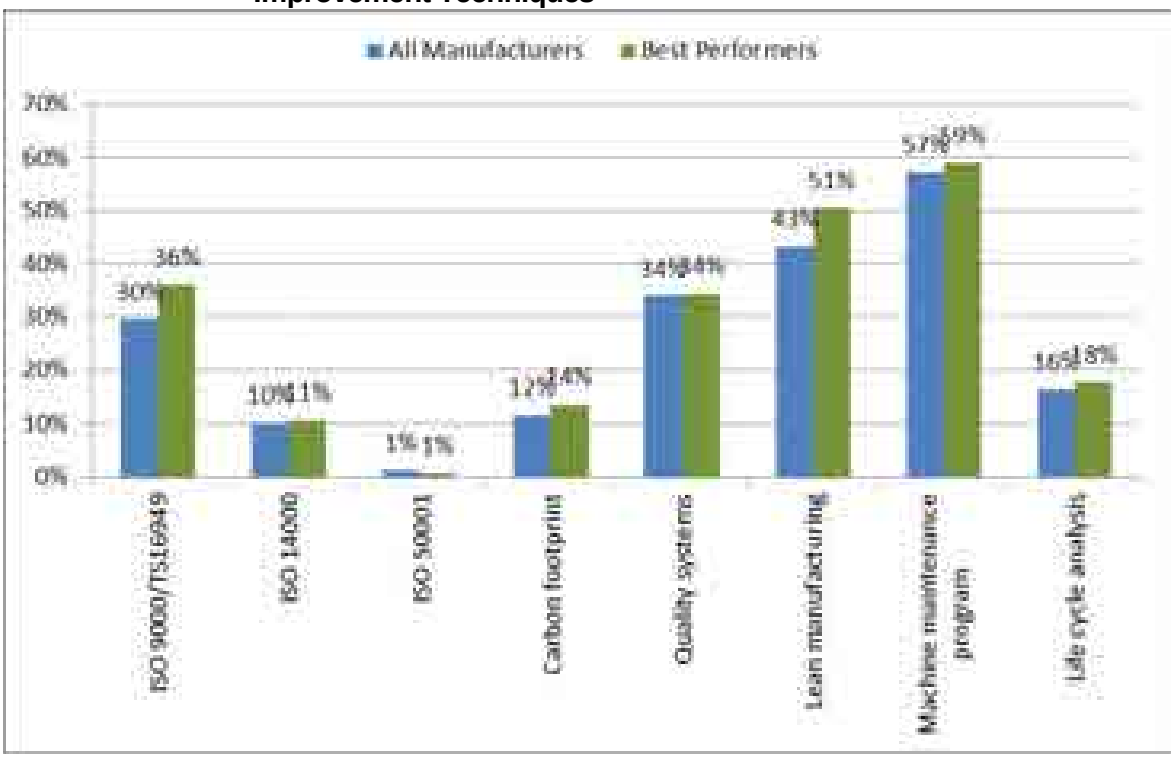


Source: Georgia Manufacturing Survey 2016, weighted results of 526 manufacturers

Lean manufacturing and ISO 9000/TS16949 are more commonly used systems for best performers. Fifty one percent of best performers use lean manufacturing while only 43% of all manufacturers use that system (Figure 7.6). The greatest difference in the use of lean manufacturing between best performers and all manufacturers was for manufacturers with 250+ employees. A great difference in the use of ISO 9000/TS16949 was for manufacturers with 250+ employees in the Science Industry.

One hundred percent of best performing manufacturers of 250+ employees use lean-manufacturing versus 81% for all manufacturers.

Figure 7.6. Percentage of Firms that Used Quality Management and Continuous Improvement Techniques

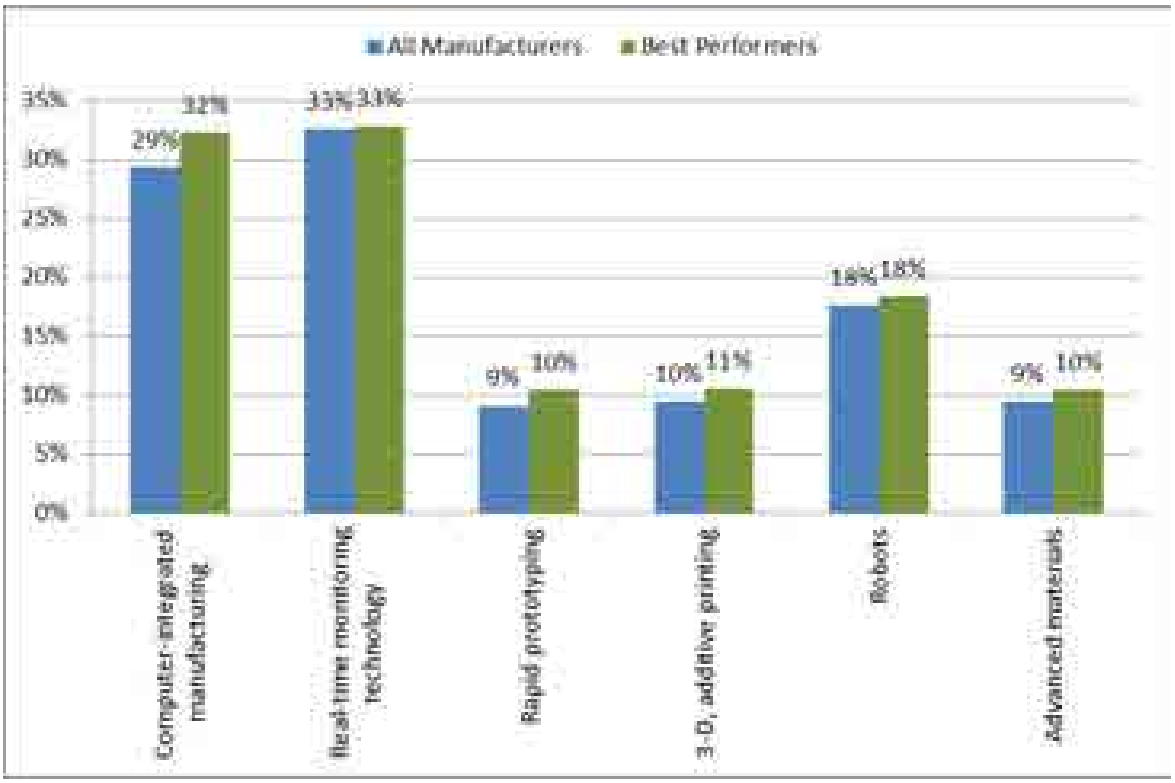


Source: Georgia Manufacturing Survey 2016, weighted results of 526 manufacturers

Best Performers use computer integrated manufacturing, as shown in Figure 7.7, slightly more than all manufacturers by 32% versus 29, respectively.

Forty four percent of best performers in the Food-Textiles industry use computer integrated manufacturing versus 34% for the all manufacturers in this industry. A higher percentage of best performers with 250+ employees use real-time monitoring than all manufacturers in this group. Best performing Science manufacturers use robots more than all manufacturers in this group.

Figure 7.7. Manufacturing Production Technologies



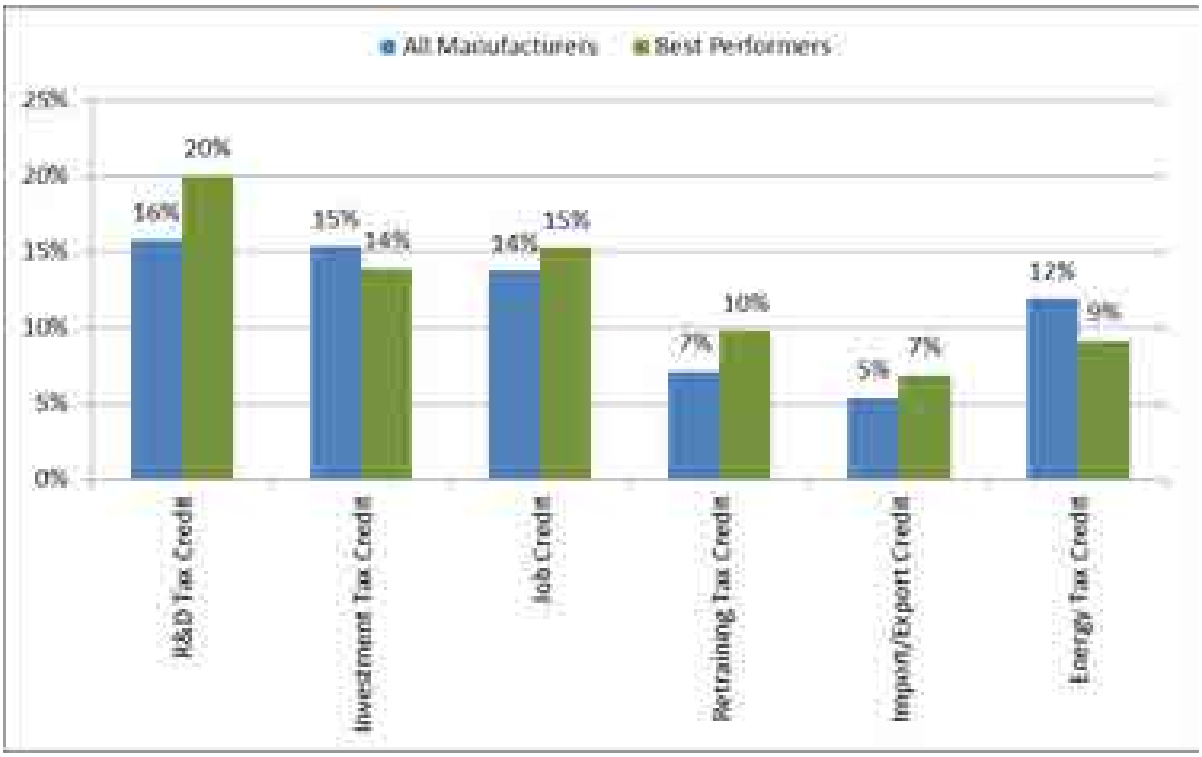
Source: Georgia Manufacturing Survey 2016, weighted results of 526 manufacturers

Best performers tend to claim more some state and federal benefits, including R&D tax credit, Job credit, Retraining tax credit, and Import/Export credit. Twenty percent of top performers claimed R&D credit compared to only 16% of all manufacturers (Figure 7.8).

Fifty two percent of best performers with 250+ employees claimed R&D tax credit compared to 42 percent of all manufacturers

Twenty two percent of Food Textiles best performers claimed retraining tax credit compared to 9% for all manufacturers.

Figure 7.8. State and Federal Government Benefits

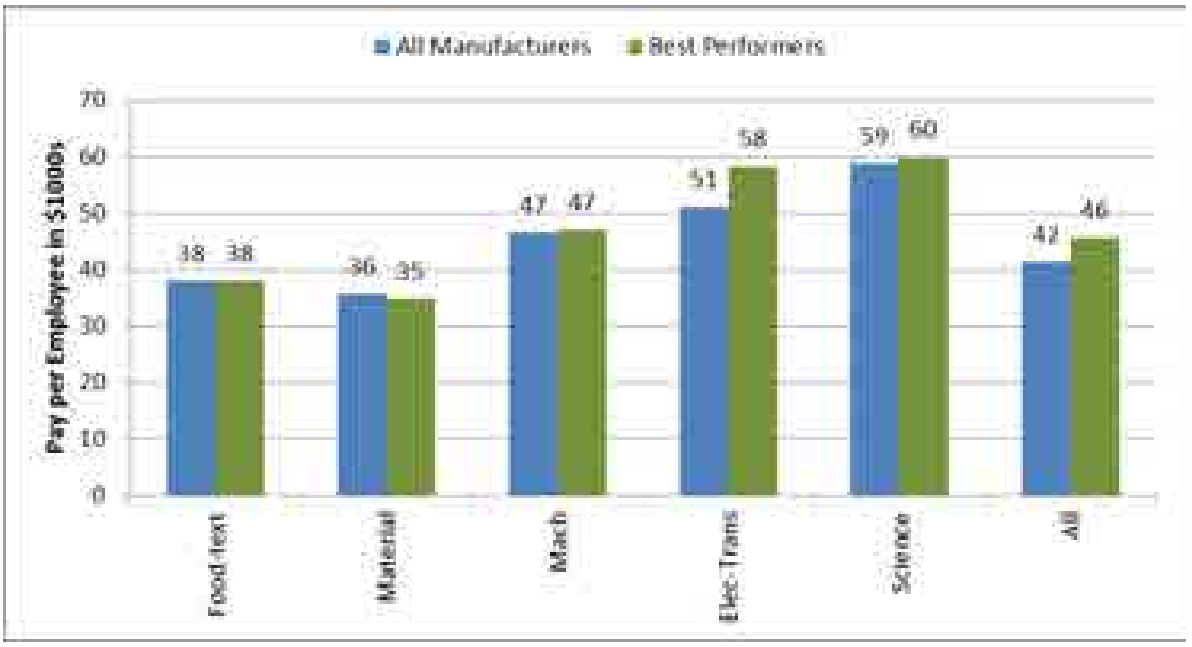


Source: Georgia Manufacturing Survey 2016, weighted results of 526 manufacturers

Best performers paid slightly better to their employees compared to the average manufacturer. Top performers paid an average of $46,000 per employee for 2015, $4,000 more than the compensation paid by the average manufacturer (Figure 7.9).

Electrical-Transportation best performers paid an average of $7,000 more than the average for all manufacturers. Best Performer with 250+ employees in this group paid an average of $12,000 more to their employees than the average for all Electrical-Transportation manufacturers of that size.

Figure 7.9. Average Wages per Employee by Industry

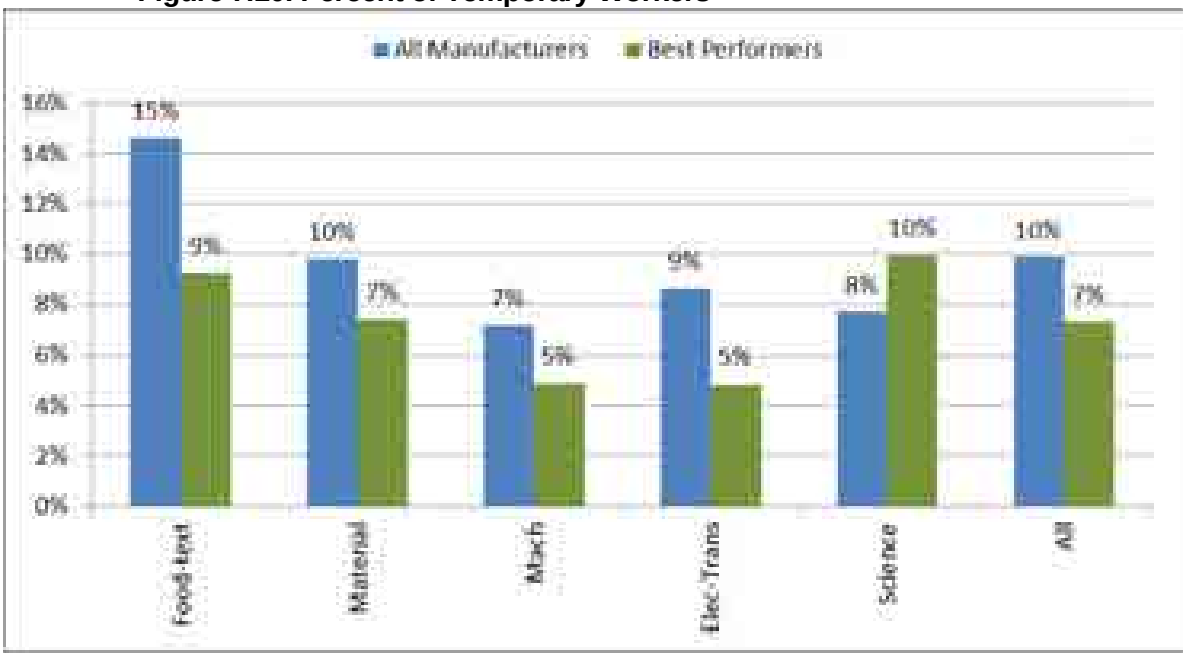


Source: Georgia Manufacturing Survey 2016, weighted results of 526 manufacturers

Best performers employed fewer temporary workers at 7% in 2015 compared to 10% for the average manufacturer (Figure 7.10). With the exception of the Science industry, top performers in all other industries used fewer temporary workers.

Both top performing manufacturers and all manufacturers increased their employment of temporary workers by 1% between 2013 and 2015.

Figure 7.10. Percent of Temporary Workers



Source: Georgia Manufacturing Survey 2016, weighted results of 526 manufacturers

Best performers were more likely to offer incentives to their employees than the average firm, particularly for new ideas and productivity increases (Table 7.6). Thirty percent of top performers rewarded employees for new ideas, compared to only 19% of all manufacturers. Almost 40% of top performers with between 50 and 250 employees rewarded employees for new ideas, 15 points above the percentage of all manufacturers in those company sizes.

Fifty eight percent of top performers with 250+ employees rewarded employees for productivity increases, compared to 45% of all manufacturers in that group. Forty four percent of top performers in the Electric-Transportation industry rewarded their employees for productivity increases compared to a 33% average for all manufacturers.

Table 7.6. Percentage of Manufactures Providing Employee Incentives by Industry

	New Skills or Education		Productivity Increases		New Ideas	
	All	Best	All	Best	All	Best
Food-text	20%	12%	42%	47%	12%	12%
Material	17%	17%	42%	41%	13%	25%
Mach	18%	22%	44%	49%	20%	32%
Elec-Trans	27%	33%	33%	44%	31%	33%
Science	23%	24%	45%	48%	36%	38%
All	20%	22%	42%	47%	19%	30%

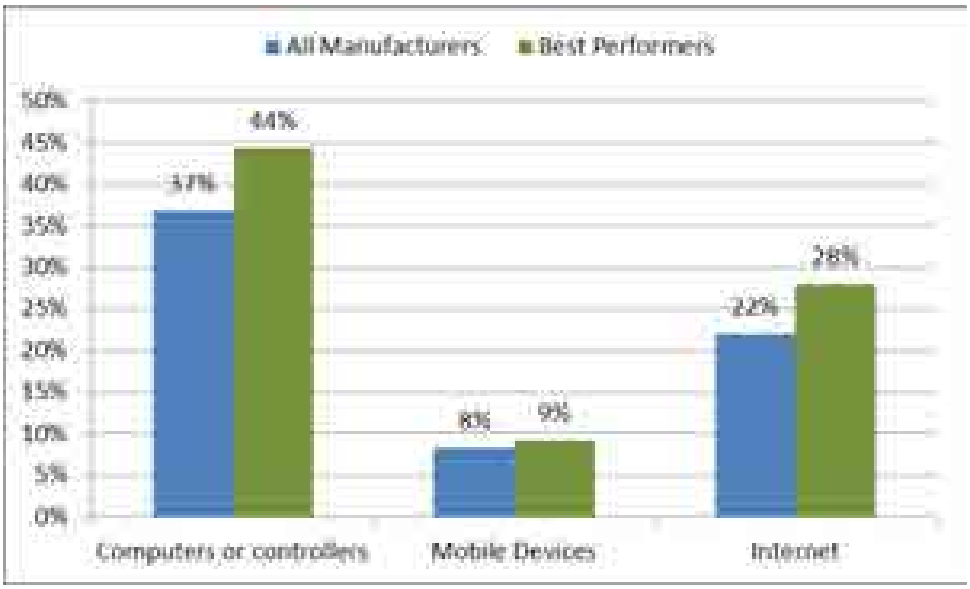
Source: Georgia Manufacturing Survey 2016, weighted results of 526 manufacturers

The production process and technology influences the use of particular technologies. Forty four percent of best performers have employees that use computers or controllers as part of their daily jobs, compared to 37% for all manufacturer employees (Figure 7.11).

Material industry best performers with 250+ employees reported the greatest percentage difference compared to all manufacturers in this group.

The use of the Internet is also more common for top performers, particularly for companies with 250+ employees and companies in the Food-Textile industry.

Figure 7.11. Production Workers that Use Technology Daily as Part of Their Job



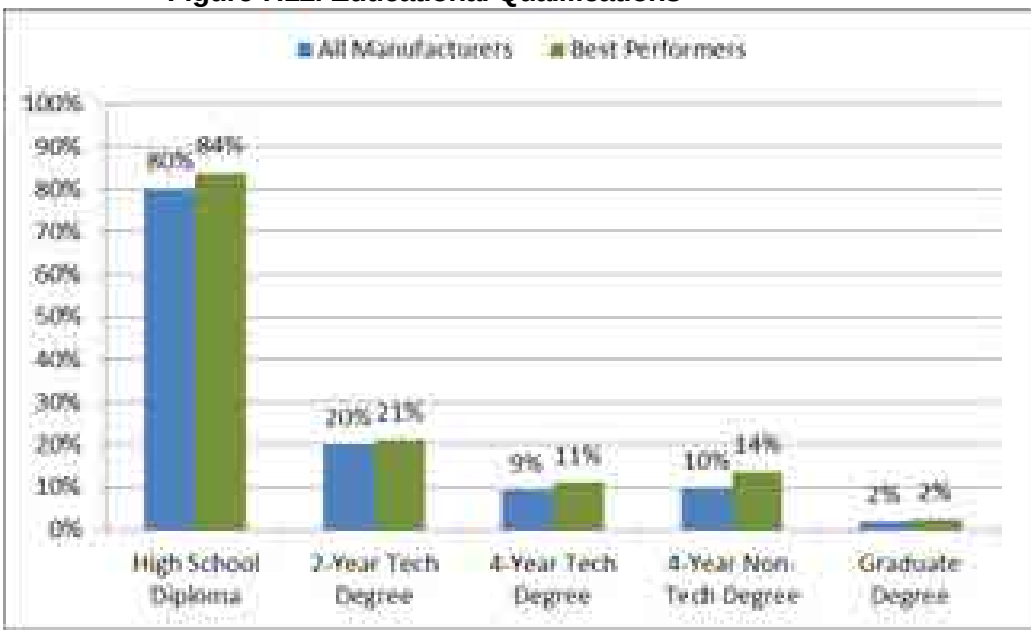
Source: Georgia Manufacturing Survey 2016, weighted results of 526 manufacturers

Best performers have a more educated workforce, particularly in terms of percent of high school diploma and non-technical bachelor degrees holders (Figure 7.12). Best performers reported an average of eighty four percent of employees with at least a high school diploma, four percent higher than the average for all manufacturers.

Best performers in the Electrical-Transportation industry with less than 50 employees reported the highest percentage difference to the average for the all manufacturer group.

Best performers used non-technical bachelor degrees more than the all manufacturer group. Best performers with less than 50 employees and the Material industry employed a higher average of non-technical degrees than the all manufacturers in these groups.

Figure 7.12. Educational Qualifications



Source: Georgia Manufacturing Survey 2016, weighted results of 468 manufacturers

Best performers spent an average of $871 per employee in training, 60% more than the average manufacturer (Figure 7.13). Material industry best performers spent 151% more in training compared to the average firm in that industry. Best performers with less than 50 employees spent 88% more in training compared to all companies of that size.

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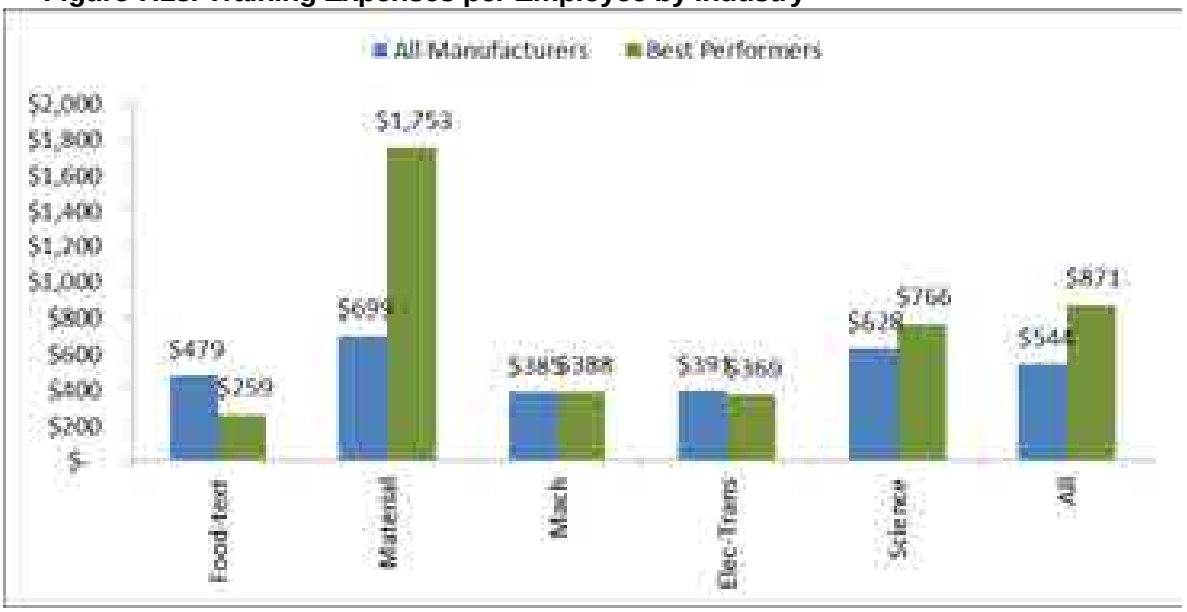
Figure 7.13. Training Expenses per Employee by Industry

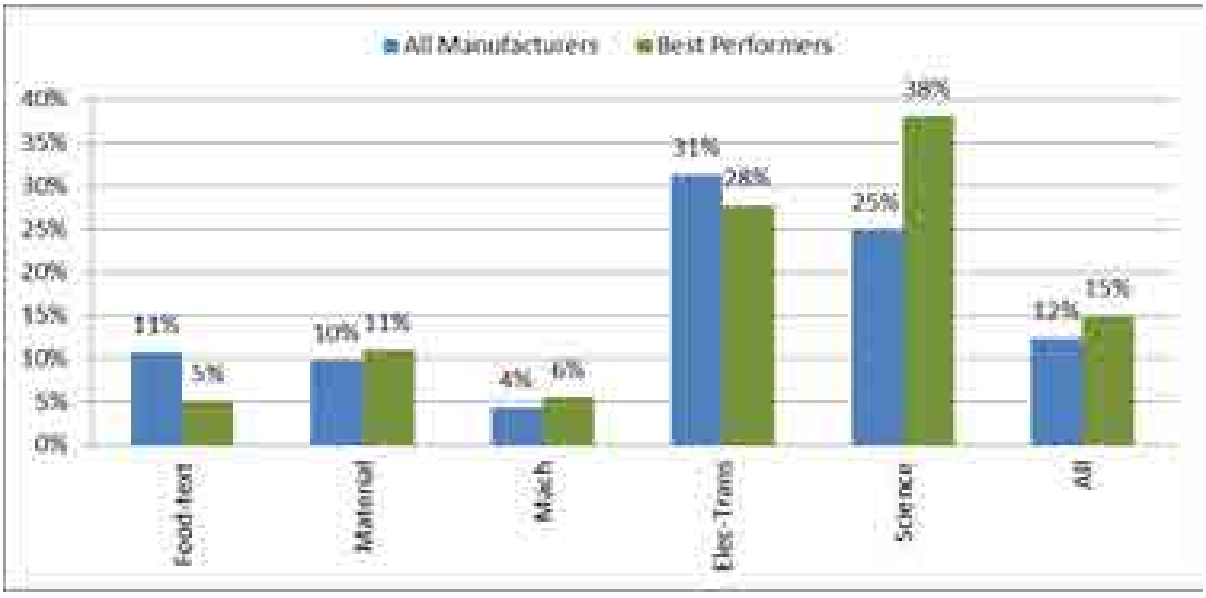


Source: Georgia Manufacturing Survey 2016, weighted results of 526 manufacturers

The percentage of best performers that trade their shares publicly varies from industry to industry. Fifteen percent of the best performers are public firms compared to 12% of all manufacturers are (Figure 7.14). Science industry best performers use public-traded stocks more than the average manufacturers in their industry. Best performers in other industries did not demonstrate much of a difference with the all manufacturers.

Best performers with less than 50 employees used public-traded stocks more than the all manufacturers in this group. A lower percentage of best performers with 250+ employees used public traded stocks than the all manufacturer group.

Figure 7.14. Percentage of Publicly-traded Manufacturers by Industry



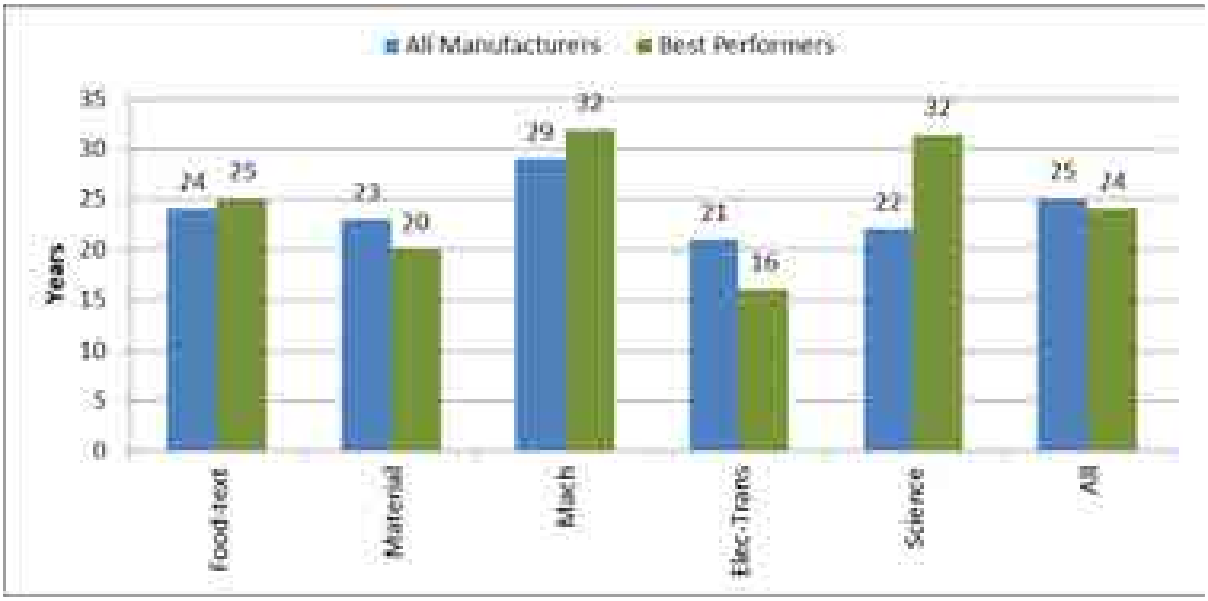
Source: Georgia Manufacturing Survey 2016, weighted results of 526 manufacturers

The data showed that company age was not related to performance at aggregate level; however some differences did exist at the industry level and also by employment size. The median age of the surveyed manufacturers was 25 years old, and the one for the best performers was 24 years old (Figure 7.15).

Best performers in the Science and Machinery are 10 years and 3 years older compared to the median ages of their corresponding industries. The opposite occurred in the Electrical-Transportation and Material industries, where best performers were younger by 5 and 3 years, respectively.

Performance seemed to be inversely related to employment size; best performers with less than 50 employees were older and best performers with 250+ employees were younger compared to their corresponding group medians.

Figure 7.15. Company Age by Industry



Source: Georgia Manufacturing Survey 2016, weighted results of 499 manufacturers

Conclusion

This study identified a group of manufacturers designed as best performers that reported average annual returns on sales of 12 percent or more. Best performers tend to adopt high quality and innovation as their top competitive strategies, and not so much low price, quick delivery or customization. Best performers reported slightly higher exports, and not necessarily lower imports.

Best performers in the Material and Science industries showed lesser use of outsourcing and best performers in the Food-Textiles industry reported lower levels of in-sourcing, compared to their corresponding industry averages.

Company performance was also related to the use of information technologies, particularly ERP systems, computer-aided design, and supply chain management systems.

Best performers use more lean manufacturing and ISO 9000/TS 16949 than the average for all manufacturers. Best performing manufacturers with 250+ employees are the greatest users of lean manufacturing and ISO 9000/TS 16949.

Best performers use more computer integrated manufacturing than the all manufacturing group. Food-Textile best performers are the greatest users of computer integrated manufacturing. Best performers with 250+ employees use real-time monitoring and rapid prototyping on average more than all manufacturers of their size.

Best performers tend to claim more from state and federal benefits, including R&D tax credit, job credit, retraining tax credit, and import/export credit. Best performing firms with 250+ employees and Food-Textile manufacturers are the greatest utilizers of these benefits.

Best performers paid slightly better to their employees compared to the average manufacturer in 2015. Best performers in the Electrical-Transportation industry and manufacturers of 250+ employees on average paid higher compensation to their employees.

Best performers employed fewer temporary workers than the average manufacturer in 2015. Nevertheless, the use of temporary workers in 2015 was 1 percent higher than the average recorded for 2013.

Best performers were more likely to offer incentives to their employees than the average firm, particularly for new ideas and for productivity increases. Best performers with 250+ employees and the Machinery industry offer more incentives for new ideas and productivity increases than all manufacturers in their group and other industries, respectively.

Best performers have higher percentages of employees that use computers and the Internet as part of their daily jobs, compared to the average manufacturer. Best performers with 250+ employees and the Material Industry are especially strong users of computers and the Internet compared to their all manufacturing group and other industries, respectively.

Best performers use a more educated workforce, especially for employees with high school diploma and non-technical bachelor degrees. Best performers with less than 50 employees and companies in the Electrical Transportation use more educated workforce compared to the average for all manufacturers and other industries, respectively.

Best performers spent more in per-capita training than the average manufacturer. Best performers with less than 50 employees and manufacturers in the Material industry have the highest per capita training average difference compared to all manufacturers and other industries, respectively.

Best performers with 250+ employees were slightly older and best performers with less than 50 employees were younger than their corresponding group averages. In addition, an association between older companies and higher performance was observed for companies in the Science and Machinery industries.

Chapter
8

Business Assistance Resources

Past Georgia Manufacturing Surveys have found that companies using outside service providers are better off than companies going at it alone. This section takes a further look at assistance source usage. It opens with an examination of the types of companies that seek outside assistance across a range of service providers—from Georgia Tech to other universities and technical colleges, to the Georgia Department of Labor, to private-sector firms, to other manufacturers. It then investigates the type of assistance that manufacturers are interested in seeking. It closes with an analysis of the type of benefits that manufacturers can experience from outside assistance by focusing on the quantitative and qualitative impacts of Georgia Tech assistance. A model that compares the productivity of Georgia Tech clients and non-clients is presented.

Business Assistance Usage

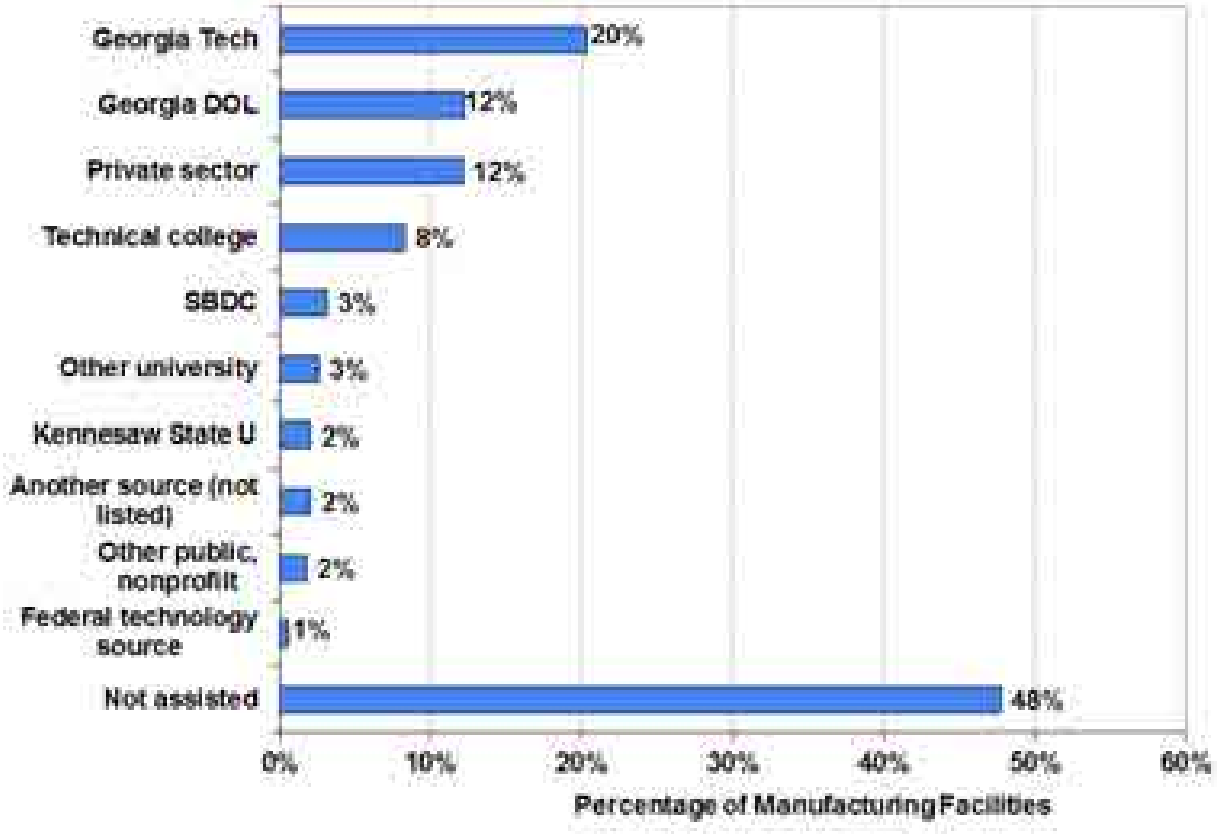
Nearly half of Georgia manufacturers use some type of business assistance provider. Georgia Tech was used by 20 percent of all manufacturing survey respondents, followed by Georgia Department of Labor or a private-sector business (12 percent each). Eight percent used a technical college/Quick Start program (Figure 8.1).

Facility employment size is a major determinant of using outside assistance. In general, the larger the firm, the more apt it is to use outside assistance sources. The exception is the Small Business Development Centers (SBDC) which serves a small percentage of manufacturing users and these tend to be in the smallest size class. The technical colleges show a steep slope in use between the large and small and medium sized manufacturers. This straight line suggests an emphasis on serving larger manufacturers. Georgia Tech's usage pattern has less of a steep slope between medium-size and large manufacturers, suggesting that the program, while serving larger manufacturers, also has a notable rate of service to small and medium-sized manufacturers as well (Figure 8.2).

The biggest challenge with the smallest companies of 10 to 49 employees is that they are least likely to use any outside assistance source. Fifty-five percent of manufacturers in this smallest employment size category have not obtained outside business assistance compared with 42 percent of medium-sized manufacturers and only 16 percent of large manufacturers.

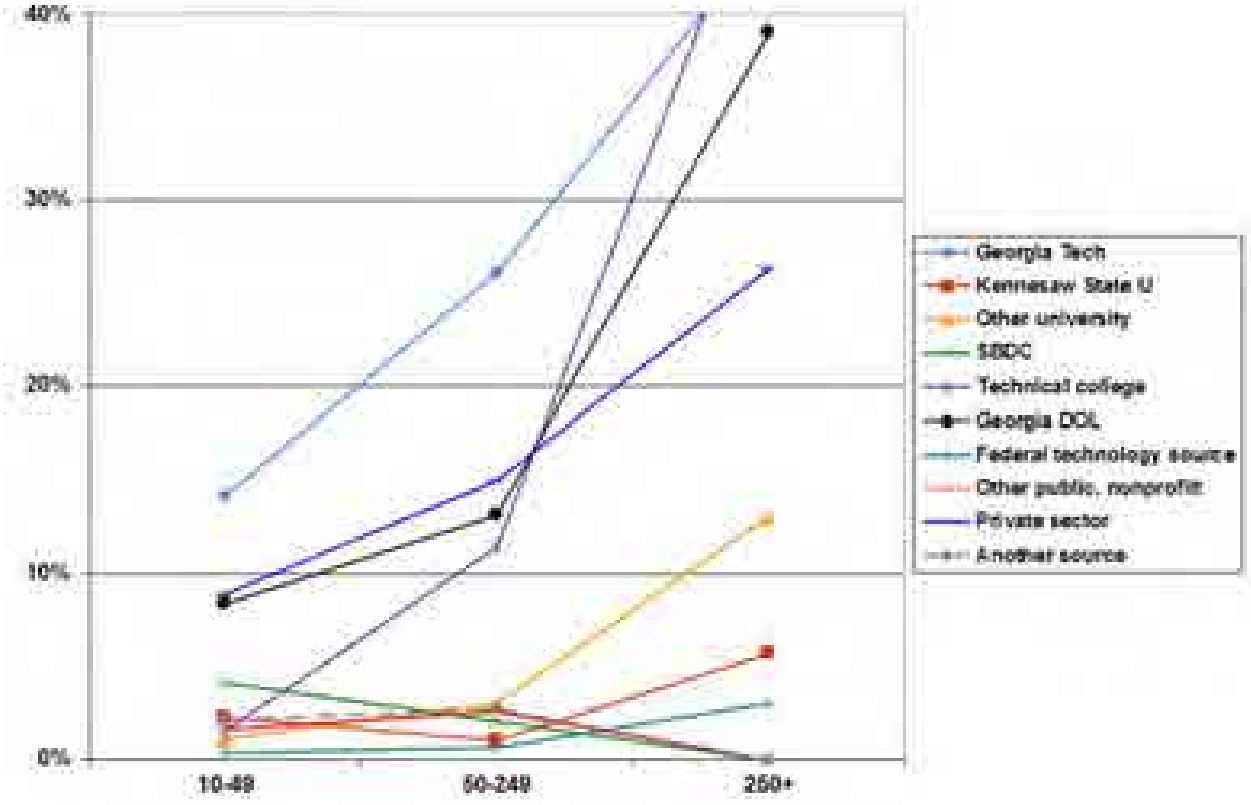
Figure 8.1 Business Assistance Sources Used by Manufacturers

(Percentage of manufacturers using source in last two years)



Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Figure 8.2 Business Assistance Sources Used by Facility Employment Size
(y-axis represents percentage of manufacturing facilities using source in last two years)



Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

By industry, the elec-trans groups have the highest percentage of users of business assistance sources, especially Georgia Tech and private sector firms. Science-based manufacturers are most apt to use private sector firms and Georgia Tech. Materials and machinery manufacturers tend to use Georgia Tech, but not many of the other sources. The Georgia Department of Labor and private sector are the most commonly used assistance sources by the food-text group. Manufacturers in the materials group are the least likely to use business assistance sources (Table 8.1).

By region, establishments in the West, and South regions are most apt to use outside assistance sources; those in the Northeast and East regions are the least apt to use outside assistance (Table 8.2). The percentage of respondents using Georgia Tech is highest in the Central region. Use of the Georgia Department of Labor is highest in the South region. The technical colleges have the highest penetration rates in the West region.

Table 8.1 Business Assistance Sources Used by Industry
(Percentage of respondents using business assistance source in last two years)

Source	Food-text	Materials	Mach	Elec-Trans	Science
Georgia Tech	13.3%	14.2%	27.7%	40.8%	18.8%
Georgia DOL	16.0%	9.8%	13.4%	16.3%	8.3%
Private sector	15.1%	8.3%	9.8%	16.3%	22.9%
Technical college	10.2%	5.5%	8.0%	16.3%	8.3%
SBDC	4.3%	3.0%	5.3%	0.0%	0.0%
Other university	2.5%	2.2%	1.0%	8.2%	2.1%
Kennesaw State U	1.2%	1.9%	1.5%	4.1%	4.2%
Another source (not listed)	2.7%	1.2%	0.5%	4.1%	6.3%
Other public, nonprofilt	1.2%	2.1%	1.5%	0.0%	4.2%
Federal technology source	1.2%	0.5%	0.0%	2.0%	0.0%
Not assisted	45.1%	55.7%	42.5%	32.7%	50.0%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Table 8.2. Business Assistance Sources Used by Industry
(Percentage of respondents using business assistance source in last two years)

Source	North-west	North-east	Atlan-ta	West	Cen-tral	East	South	Coastal
Georgia Tech	17.7%	20.1%	22.9%	18.5%	25.4%	11.1%	19.5%	13.8%
Georgia DOL	16.2%	13.2%	8.6%	15.1%	13.5%	9.0%	19.6%	7.4%
Private sector	16.4%	12.7%	12.0%	6.1%	10.2%	10.5%	14.0%	5.9%
Technical college	10.5%	13.7%	5.5%	26.9%	2.5%	9.0%	2.2%	3.9%
SBDC	1.1%	2.1%	2.0%	7.2%	1.7%	3.7%	9.6%	5.8%
Other university	7.0%	1.6%	2.2%	0.0%	2.5%	0.0%	2.2%	0.0%
Kennesaw State U	1.3%	0.8%	2.2%	0.0%	0.0%	6.9%	0.0%	14.3%
Another source (not listed)	1.4%	0.0%	4.4%	0.0%	3.3%	0.0%	0.0%	0.0%
Other public, nonprofilt	0.7%	2.5%	2.2%	0.0%	2.9%	0.0%	3.4%	0.0%
Federal technology source	1.4%	0.0%	0.6%	3.1%	0.0%	0.0%	0.0%	0.0%
Not assisted	47.5%	56.7%	49.6%	34.6%	43.3%	56.5%	34.2%	52.6%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Areas of Interest in Training/Technical Assistance

Fifty-four percent of the companies responding to the Georgia Manufacturing Survey 2016 were interested in receiving training or technical assistance directed toward managers, and 56 percent were also interested in receiving training programs for non-managerial employees. The most frequently mentioned areas of managerial interest were lean manufacturing and safety and health. Comparing these percentages to those in the 2014 survey, interest levels are higher in the 2016 survey, particularly in lean manufacturing and

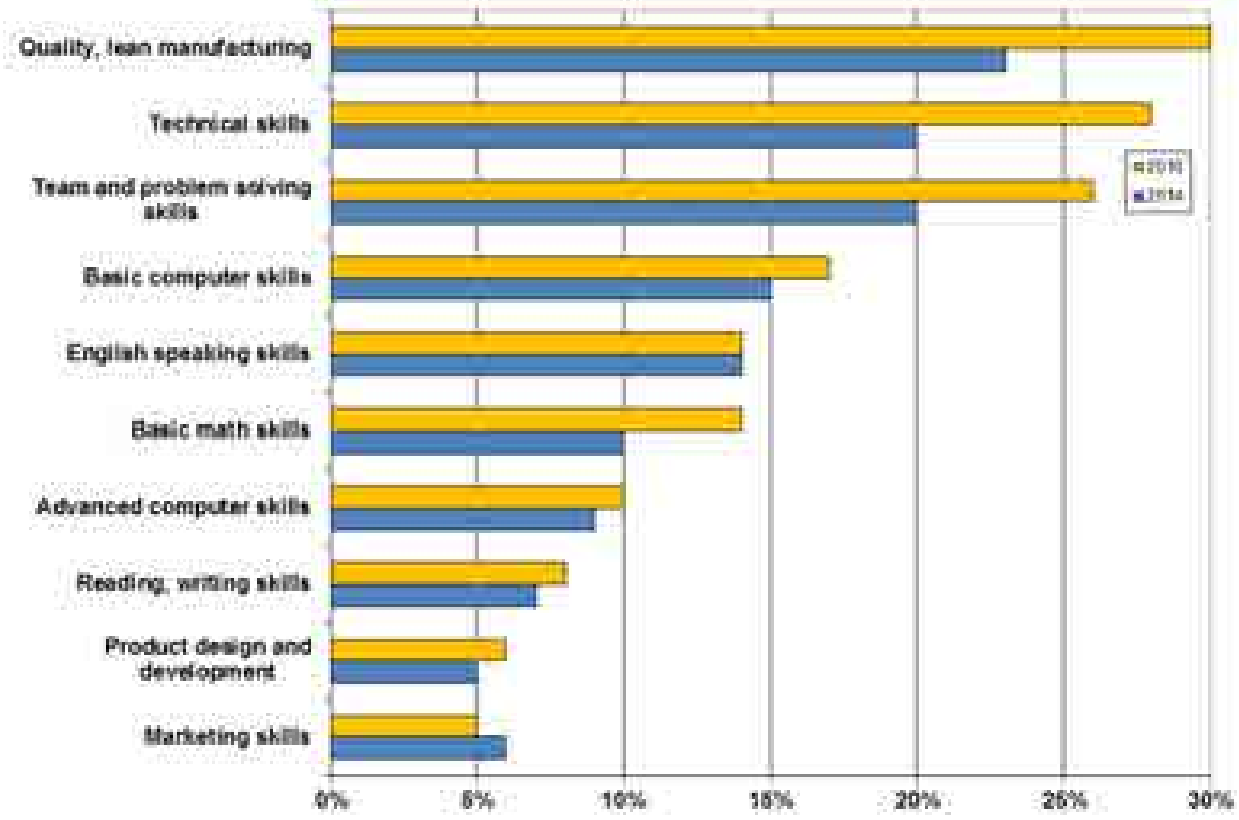
safety and health. Lean manufacturing was also the top non-managerial interest area, followed by technical skills (e.g., machinist), and team and problem-solving skills (Figures 8.3 and 8.4).

Figure 8.3. Areas of Interest for Training and Technical Assistance: <u>Management</u>
(Percentage of respondents indicating interest in area)

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers; Georgia Manufacturing Survey 2014, weighted responses of 504 manufacturers

Figure 8.3. Areas of Interest for Training and Technical Assistance: <u>Non-managerial Employees</u>

(Percentage of respondents indicating interest in area)



Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers; Georgia Manufacturing Survey 2014, weighted responses of 504 manufacturers

Interest in managerial assistance and training was related to facility employment size for some areas, but not others. Managerial interest in lean manufacturing was strongest for medium-sized and large manufacturers. The same is true of interest in safety and health and technology implementation. Waste minimization attracted higher interest among the largest manufacturers as did quality systems, ISO 14000 assistance, energy efficiency, supply chain development, and robotics. The smaller manufacturers were more interested than their larger counterparts in marketing and assistance with finance and taxes. Interest in product development was more prevalent among small and medium-sized manufacturers than large manufacturers. By industry, the electronics/electrical/transportation group was more likely than other groups to show interest in lean manufacturing, energy efficiency, quality systems, supply chain development, and cybersecurity. The top areas of interest for science-based manufacturers were lean manufacturing, safety and health, materials and waste minimization, and supply chain development. Marketing and sales and lean manufacturing were the most prevalent interests in the machinery group. Lean manufacturing also was the most common area of interest in the material group followed by safety and health and waste minimization. The food/textiles/apparel/leather group also was most interested in lean manufacturing and safety and health. We also present regional breakdowns of

the percentage of manufacturers with interest in assistance these areas. In general, interest is relatively higher in the Northeast and West regions (Tables 8.3a, 8.3b, 8.3c).

Non-managerial training programs attracted the highest percentage of interest among larger manufacturers in lean manufacturing, technical (e.g., machinist) skills, team and problem solving skills, basic computer skills, and basic math and reading skills. Interest in English language skills was similar across the three size classes as was product development skills. Advanced computer skills were nearly as prevalent among medium-sized manufacturers as large manufacturers. Marketing skills were slightly more common among smaller manufacturers. By industry, the electronics/electrical/transportation industry group respondents were relatively more interested in lean manufacturing, technical skills, computer skills and math skills. Science-based manufacturers had the highest extent of interest of any of the groups in team and problem solving skills. The food-text and machinery groups were most interested in technical skill training while the materials group was most interested in lean manufacturing. Regional differences in frequency of interest in non-managerial training programs are also presented. The level of interest in non-managerial training across was highest in respondents in the Northeast region and lowest for respondents in the East region (Tables 8.4a, 8.4b, 8.4c).

Table 8.3a. Interest in Managerial Training and Technical Assistance by Facility Employment Size

(Percentage of respondents indicating interest in area)

Area	10-49	50-249	250+	Total
Lean manufacturing and process improvement	20.0%	45.0%	44.0%	30.0%
Safety and health, ergonomics	17.0%	36.0%	37.0%	25.0%
Marketing and sales growth	24.0%	15.0%	7.0%	19.0%
Energy efficiency and management	12.0%	21.0%	34.0%	17.0%
Materials and waste minimization	12.0%	22.0%	34.0%	17.0%
Quality systems, ISO 9000, TS 16949	11.0%	14.0%	24.0%	13.0%
Technology implementation	12.0%	13.0%	11.0%	12.0%
Finance and taxes	14.0%	8.0%	7.0%	11.0%
Product design and dev.	10.0%	11.0%	6.0%	10.0%
Supply chain development	5.0%	15.0%	27.0%	10.0%
Robotics	5.0%	9.0%	21.0%	7.0%
ISO 14000 environmental management certification	2.0%	8.0%	15.0%	5.0%
Cybersecurity	4.0%	3.0%	7.0%	4.0%
Additive manufacturing	1.0%	2.0%	3.0%	2.0%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Table 8.3b. Interest in Managerial Training and Technical Assistance by Industry Group

(Percentage of respondents indicating interest in area)

Area	Food-text	Materials	Mach	Elec-trans	Science
Lean manufacturing and process improvement	26.0%	25.0%	27.0%	49.0%	40.0%
Safety and health, ergonomics	26.0%	23.0%	19.0%	33.0%	31.0%
Marketing and sales growth	20.0%	18.0%	24.0%	16.0%	17.0%
Energy efficiency and management	19.0%	19.0%	10.0%	22.0%	15.0%
Materials and waste minimization	13.0%	22.0%	9.0%	22.0%	21.0%
Quality systems, ISO 9000, TS 16949	12.0%	8.0%	15.0%	27.0%	15.0%
Technology implementation	15.0%	11.0%	14.0%	8.0%	8.0%
Finance and taxes	13.0%	11.0%	11.0%	12.0%	8.0%
Product design and dev.	6.0%	8.0%	14.0%	16.0%	10.0%
Supply chain development	7.0%	6.0%	8.0%	27.0%	21.0%
Robotics	4.0%	5.0%	10.0%	14.0%	10.0%
ISO 14000 environmental management certification	4.0%	5.0%	4.0%	8.0%	4.0%
Cybersecurity	1.0%	4.0%	3.0%	12.0%	2.0%
Additive manufacturing	1.0%	2.0%	1.0%	4.0%	0.0%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Table 8.3c. Interest in Managerial Training and Technical Assistance by Region

(Percentage of respondents indicating interest in area)

Area	North-west	North-east	Atlanta	West	Central	East	South	Coastal
Lean manufacturing and process improvement	26.0%	38.0%	31.0%	46.0%	24.0%	17.0%	23.0%	19.0%
Safety and health, ergonomics	21.0%	32.0%	22.0%	33.0%	21.0%	14.0%	32.0%	18.0%
Marketing and sales growth	13.0%	22.0%	22.0%	20.0%	21.0%	11.0%	24.0%	8.0%
Energy efficiency and management	22.0%	19.0%	15.0%	26.0%	15.0%	7.0%	14.0%	7.0%
Materials and waste minimization	16.0%	18.0%	16.0%	22.0%	18.0%	7.0%	22.0%	12.0%
Quality systems, ISO 9000, TS 16949	15.0%	12.0%	17.0%	14.0%	9.0%	7.0%	4.0%	11.0%
Technology implementation	14.0%	4.0%	16.0%	4.0%	7.0%	7.0%	15.0%	7.0%
Finance and taxes	8.0%	17.0%	11.0%	8.0%	11.0%	14.0%	12.0%	8.0%
Product design and dev.	8.0%	9.0%	15.0%	2.0%	7.0%	11.0%	7.0%	5.0%
Supply chain development	12.0%	10.0%	12.0%	13.0%	3.0%	0.0%	9.0%	5.0%
Robotics	8.0%	16.0%	6.0%	7.0%	0.0%	4.0%	9.0%	0.0%
ISO 14000 environmental management certification	6.0%	9.0%	4.0%	11.0%	4.0%	0.0%	4.0%	0.0%
Cybersecurity	0.0%	4.0%	7.0%	0.0%	0.0%	0.0%	7.0%	0
Additive manufacturing	0.0%	1.0%	3.0%	0.0%	4.0%	0.0%	2.0%	0.0%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Table 8.4a. Interest in Non-managerial Training and Technical Assistance by Facility Employment Size

(Percentage of respondents indicating interest in area)

Area	10-49	50-249	250+	Total
Quality, lean manufacturing	20.0%	45.0%	51.0%	30.0%
Technical skills	22.0%	35.0%	46.0%	28.0%
Team and problem solving skills	19.0%	36.0%	44.0%	26.0%
Basic computer skills	12.0%	21.0%	36.0%	17.0%
English speaking skills	12.0%	16.0%	15.0%	14.0%
Basic math skills	9.0%	18.0%	26.0%	14.0%
Advanced computer skills	8.0%	13.0%	16.0%	10.0%
Reading, writing skills	5.0%	11.0%	17.0%	8.0%
Product design and development	5.0%	6.0%	7.0%	6.0%
Marketing skills	6.0%	4.0%	3.0%	5.0%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Table 8.4b. Interest in Non-managerial Training and Technical Assistance by Industry Group

(Percentage of respondents indicating interest in area)

Area	Food-text	Materials	Mach	Elec-trans	Science
Quality, lean manufacturing	27.0%	26.0%	29.0%	43.0%	40.0%
Technical skills	36.0%	21.0%	31.0%	41.0%	21.0%
Team and problem solving skills	25.0%	22.0%	22.0%	35.0%	44.0%
Basic computer skills	19.0%	13.0%	15.0%	33.0%	15.0%
English speaking skills	15.0%	18.0%	11.0%	8.0%	8.0%
Basic math skills	16.0%	13.0%	11.0%	22.0%	10.0%
Advanced computer skills	12.0%	9.0%	10.0%	16.0%	6.0%
Reading, writing skills	11.0%	7.0%	5.0%	10.0%	8.0%
Product design and development	4.0%	6.0%	7.0%	10.0%	0.0%
Marketing skills	2.0%	6.0%	7.0%	4.0%	2.0%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Table 8.4c. Interest in Non-managerial Training and Technical Assistance by Region
(percentage of respondents indicating interest in area)

Area	North-west	North-east	Atlanta	West	Central	East	South	Coastal
Quality, lean manufacturing	27.0%	35.0%	30.0%	43.0%	19.0%	11.0%	33.0%	32.0%
Technical skills	27.0%	30.0%	31.0%	28.0%	18.0%	18.0%	25.0%	32.0%
Team and problem solving skills	21.0%	31.0%	27.0%	37.0%	23.0%	0.0%	32.0%	15.0%
Basic computer skills	19.0%	20.0%	16.0%	25.0%	9.0%	11.0%	8.0%	18.0%
English speaking skills	11.0%	26.0%	16.0%	2.0%	3.0%	0.0%	14.0%	4.0%
Basic math skills	13.0%	16.0%	15.0%	18.0%	7.0%	0.0%	10.0%	18.0%
Advanced computer skills	10.0%	12.0%	15.0%	14.0%	0.0%	0.0%	4.0%	0.0%
Reading, writing skills	7.0%	8.0%	9.0%	3.0%	0.0%	7.0%	13.0%	2.0%
Product design and development	5.0%	6.0%	8.0%	3.0%	7.0%	4.0%	2.0%	4.0%
Marketing skills	3.0%	9.0%	7.0%	3.0%	0.0%	0.0%	2.0%	5.0%

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.

Impact of Georgia Tech Assistance on Productivity

How does one assess the impact of assistance on manufacturers? Using Georgia Tech assistance as an example, we could ask Georgia Tech-assisted manufacturers whether or not they received any benefits from this assistance. However, their answers would not necessarily prove that the results are attributable to Georgia Tech services. Unassisted firms could also have experienced these same benefits during the 2013-to-2015 time period. Benefits or lack thereof may have arisen from the general economic conditions of the time rather than the assistance received from Georgia Tech. Georgia Tech-assisted manufacturers may also have been influenced by other companies (for example, vendors and consultants, other manufacturers) or by other public assistance sources (for example, federal laboratories, other state-funded educational or assistance institutions).

To account for these influences, we have developed a model to estimate the impact of Georgia Tech project-related extension services on client productivity. In this analysis, we are proxying productivity with growth in sales. Drawing on Jarmin[8], we examined the growth rate in the standard value-added production function from 2013 to 2015, as a function of receiving Georgia Tech services. We controlled for an array of facility characteristics, including:

- change in capital intensity, i.e., the capital/labor ratio 2013-2015
- facility employment size (dummy variables)

[8]Ronald S. Jarmin, 1999. "Evaluating the Impact of Manufacturing Extension on Productivity Growth," *Journal of Policy Analysis and Management* 18 (1): 99-119. We employ a similar model which estimates the logged change in value-added per employee as a function of changes in labor and capital (logged), along with control variables representing manufacturing characteristics (e.g., employment size, industry, location, and status as a branch plant).

- industry classification (dummy variables)

This model was estimated using ordinary least squares. We did not log the dependent variables because they approximated a normal distribution (based on a review of a histogram of these variables). Georgia Tech assistance is positively and significantly linked to sales growth (Table 8.5). Over the study period, Georgia Tech clients had $1.8 million higher sales growth than non-clients. Simultaneity is an issue, so results should be viewed as associational rather than causative. Nevertheless, they do suggest a positive effect of Georgia Tech services.

Table 8.5. Sales Growth is Significantly Higher for Georgia Tech Clients than for Non-clients.

(Ordinary Least Squares – Sales Growth 2013-2015)

Variables	OLS
Received assistance from Georgia Tech	$1,799,248 (568,011)***
Change in capital/labor 2013-15	43 (10)***
1-49 employees, 2015	-20,424,920 (895,963)**
50-249 employees, 2015	-19,393,303 (880,225)***
Industry dummies	Mixed
Constant	31,596,644 (1,590,178)
Observations	262
R-squared	0.34

Dependent variable is the difference between sales per employee in 2013 and 2015. Standard errors in parentheses
* Significant at 10%; ** Significant at 5%; *** Significant at 1%

Source: Georgia Manufacturing Survey 2015, weighted responses of 262 manufacturers.

As pointed by Jarmin (1998, p.108) companies with higher than average growth in sales may self-select into the group of Georgia Tech clients. If this is the case, the impact of MEP programs is likely to be overstated. To correct for selection biases, an instrumental variable model is applied. In the prior years' surveys, interest in training or technical assistance for managers was found to be a good instrument, in that is can be a precursor to use of Georgia Tech for assistance.[9] The instrumental variable regression results are not markedly different from the OLS model. We also ran a two-step Heckman model which did not find that the selection bias was significant (inverse mills ratio > 0.10) so we conclude that the OLS model is sufficient for this analysis.

[9]We did not use location of the manufacturer in a metropolitan area with a center office, as Jarmin did, given that the concept of physical offices in around the Georgia has been changed beyond the notion of "bricks and mortar."

Appendix
1

Survey Framework, Questionnaire Design, and Administration

The section will describe our methodology for analyzing industries, developing the sampling frame for the survey, designing the questionnaire, and administering the survey.

Industry Groupings

Our industry groupings were inspired by Pavitt's[10] taxonomy of industries because of its basis in innovation and technology adoption. We utilized several indicators from the survey to verify Pavitt's classifications. These indicators are shown below. For example, we were able to confirm that chemicals and medical supply firms both have an intensive use of scientists and engineers and thus belong in a science-based classification. However, automotive and transportation establishments in Georgia were not found to have a high use of engineers, so we decided that we could not develop a "scale intensive" grouping around this industry. While we saw a notable level of engineers and scientists in the electrical and electronics industries, it was not as high as was the case with the science-based (i.e., medical supply) group, so we set them into their own segment.

We also wanted to balance our numbers of respondents within each industry group. For example, putting all the supplier-dominated industries together would have meant that most of our respondents would have been in this grouping. The table below shows that these NAICS-based groups vary widely by size and use of scientists and engineers. We therefore made the decision based on the NAICS classification system, dividing this grouping into the non-durables (or "food-text") and the natural resource goods industries (or "material"). We also determined to classify that automotive group into the electrical and electronics industries rather than the metals and machinery group because the automotive industry had higher median employment levels that were more akin to the electrical and electronic industries in our sample.

[10] Keith Pavitt. (1984) 'Sectoral patterns of technical change: towards a taxonomy and a theory', Research Policy, Vol. 13, pp. 343–373

NAICS-Based Industries	# respon dents	Modified Pavitt Taxonomy	GMS 2016 grouping	Median Employ-ment	Median # Scientists, Engineers
Food – 311,2	26	Supplier dominated	Food-text	60	2
Textiles – 313,4	35	Supplier dominated	Food-text	40	3
Apparel – 315,6	12	Supplier dominated	Food-text	45	1
Wood – 321	54	Supplier dominated	Materials	30	1
Furniture – 337	16	Supplier dominated	Materials	26	2
Paper – 322	14	Supplier dominated	Materials	77	2
Printing – 323	31	Supplier dominated	Materials	17	1
Chemicals – 324,5	40	Science-based	Science	40	5
Plastics – 326	45	Supplier dominated	Materials	56	3
Nonmetallic– 327	27	Scale intensive	Materials	23	0
Prim. Metals–331	9	Multiple	Mach.	25	1
Fab. Metals–332	105	Specialized suppliers	Mach.	24	1
Machinery–333	55	Specialized suppliers	Mach.	33	4
Computer–334	9	Science-based	Elec-trans	120	24
Electrical–335	18	Science-based	Elec-trans	43	2
Transportation–336	22	Scale intensive	Elec-trans	118	11
Medical supply–3391	8	Science-based	Science	80	10

Survey Framework

The population for the survey was all manufacturing establishments with 10 or more employees in the state of Georgia. An establishment is defined by the U.S. Census Bureau as "a single physical location where business is conducted or where services or industrial operations are performed."

To identify all manufacturing establishments/facilities, we compiled a list of Georgia establishments various internal Georgia Tech lists and respondents to past surveys. This list of companies was cleaned of duplicates, out-of-state companies, and insufficient addresses. Further refinement was provided by a process of contacting these companies that took place through Georgia Tech Industry Services. Companies that had moved or had an undeliverable address were removed from the list. This process resulted in 3,917 companies.

Questionnaire Design

The questionnaire was designed to approximate previous Georgia Manufacturing Surveys to enable comparisons and determine trends. Themes addressed in the questionnaire included manufacturers' problems and needs, changes in business structure and practices, product and process

development, constraints to development, use of information technology, manufacturing productivity and performance, workforce costs and training, and interest in technical assistance. The 2016 survey specifically focused on smart manufacturing technologies.

Once a draft questionnaire and cover letter had been designed, a pilot test was conducted to get feedback on the survey's format, wording, and design. Comments from manufacturers and Industry Services management were incorporated into a final version presented in Appendix 2.

Administration

The survey was conducted from January to May 2016 using two waves of mailings and follow-up. A packet containing a questionnaire, a cover letter from the Georgia Department of Labor, and a self-addressed, postage-paid envelope was mailed to 3,917 manufacturing establishments. Similar second follow-up mailing was sent. A web survey adoption was also available. This entire process yielded a total response of 552 surveys.[11]

The response to the survey was as follows:

Companies in initial database	3,917
Wrong address/undeliverable, out of business, not a manufacturer	48
Total surveys delivered to active manufacturers	3,869
Declared refusals	9
Undeclared non-respondents	3,308
Total surveys received	552
Respondents with less than 10 employees	26
Complete surveys with manufacturers having 10+ employees	526
Response rate	17%

The response rate was calculated by eliminating all the wrong addresses, non-manufacturers, and companies that were out of business from the list of Georgia manufacturers. Then, the number of completed survey forms of manufacturers (552) was divided by the total number of manufacturing establishments, established as legitimate, in the target population (3,317). The response rate was 14 percent. Our analysis focuses only in those establishments with 10 or more employees (526).

To evaluate the representativeness of the survey responses, Table 1.1 compares them to Georgia Department of Labor information. All manufacturing NAICS codes were grouped into five categories: food/apparel/textiles/leather, other materials related manufacturing (e.g., lumber, furniture, paper, stone, clay, glass and concrete), Machinery (metals, industrial machinery), Electronics

[11] The process yielded additional surveys not included in this summary due to late response of the respondents. These surveys are included in other analyses that draw on the data provided by this survey.

(electronics, electrical, transportation), and Science-based (e.g., chemicals, medical supplies). Smaller establishments and those in the materials group are most noticeably underrepresented in the sample. Because of the importance of scale and product characteristics in determining firm behavior such as technology use, the sample was stratified by industry and establishment size and an expansion weight was applied.[12] The Georgia Department of Labor database of 3,563 establishments was used to calculate these weights. Note that Table 1.1 has a total survey response of 526. This total excludes survey forms from companies with fewer than 10 employees, and companies with missing employment and industry information.

Table A.1: Number of Establishments by Industry and Employment Size
Georgia Department of Labor (2012) vs. Survey Respondents

	GA Dept. of Labor		Georgia Survey	
	# estab.	% estab.	# estab.	% estab.
Industry Group				
Food-text	660	18%	73	14%
Materials	1397	39%	187	36%
Mach	822	23%	169	32%
IT-Trans	380	10%	49	9%
Science	365	10%	48	9%
Employment				
10-19	1,154	32%	120	23%
20-99	1,700	47%	277	53%
100+	770	21%	129	25%

Failure to participate in the study is not the only type of non-response. Some respondents preferred not to answer one or more of the items on the questionnaire. Inter-item response rates are presented on each table. In many cases, the response rates neared or exceeded 90 percent, but for a few questions, response rates were below 70 percent. What these item response rates mean is unclear. For example, the 79 percent rate for return on sales may reflect a preference not to disclose this information, whereas the 74 percent rate for money spent on training may mean that the company did not collect the information. (Inter-item response rates are shown in Appendix 3)

Another step in the analysis involved verification of the accuracy of responses to certain questions. The project team ran checks on answers to the performance measure questions. For items that fell outside generally accepted ranges (e.g., payroll per employee or average wages of more than $100,000), the team sought to obtain correct information. Responses were also checked for internal consistency. For example, the number of employees with high school diplomas or their equivalent was checked against the total number of employees in the facility to ensure that these two items were consistent (i.e.,

[12] See Terance Rephann and Philip Shapira, *Survey of Technology Use in West Virginia Manufacturing*, Morgantown, WV: West Virginia University Regional Research Institute, December 1, 1993, p. 8. Non-respondent surveys were not conducted. However, a few non-respondents told us that they did not understand, use, or feel that the technologies mentioned in the survey were applicable to their business. It is possible that the survey respondents are more advanced in technology use than the non-respondents.

there were not more employees with high school diplomas than the total number that worked in the facility).

Appendix 3 contains a breakdown of survey responses for every question on the survey form. Percentages of general managers answering each question and of item response rates are available. For questions that ask for quantitative information, percentile breakdowns, means, and standard error of the means are presented.

Appendix
2

Questionnaire

The 2016 Georgia Manufacturing Survey

Smart Manufacturing

This survey is conducted to develop benchmark information to help Georgia manufacturers be more competitive and improve state business and technology services to industry. We appreciate your cooperation in making the 2016 survey a success.

- **In return for completing your survey, we will send a summary and customized report comparing your data with industry statistics.**
- **All company information will be kept confidential**. All individual firm and facility information will be kept in a secured, limited access location. Results will only be presented in an aggregated form. Your firm or facility's identity will not be revealed in any publication or presentation of the results of this survey.
- We understand you do not always keep exact records of all activities – estimates and rounding are fine.
- This is the only copy sent to this facility. If there is another person at your location who can complete the survey, please forward this mailing to him or her.
- Survey questions refer to this facility or plant.

Web-based survey is available at http://www.gms-ei2.org/2012/01/2012-survey-2/

Please return this survey in the enclosed postage-paid envelope within 10 days to:

Kennesaw State University
Econometric Center
Atn: 2014 Georgia Manufacturing Survey, Project Number [ID]
1000 Chastain Road
MD 0403, BB, Bldg. 4, Rm 322
Kennesaw, GA 30144-9732

Questions about the survey?

Contact: Dimitri Dodonova
Telephone: (770) 499-3390 Fax: (770) 423-6144
e-mail: dcamargo@kennesaw.edu http://www.gms-ei2.org/2012/01/2012-survey-2

Please confirm your name and address and make any changes if necessary.

[Contact Name]
[Company Name]
[Address]
[City], [State] [Zip]
[Phone]

THANK YOU FOR YOUR HELP

Georgia Tech

Georgia Manufacturing Extension Partnership
Enterprise Innovation Institute
School of Public Policy

Georgia Department of Labor

Kennesaw State University

Habif, Arogeti, and Wynne

1 FACILTY - INDUSTRY AND NEEDS

1.1. Is this facility a single-establishment enterprise not affiliated with any other enterprises?

- ❑ **Yes** (*skip to Question 1.2)*
- ❑ **No** – this facility is part of a company or group with two or more separate facilities.
  - ➥ If part of a multi-facility company or group, is the **head office** located in Georgia?
    - ❑ **Yes**
    - ❑ **No**, head office is located in _____(U.S. state) or _____ (country outside of the U.S.)

1.2. Is this business:

- ❑ Publicly traded (registered securities are available for sale to general public)
- ❑ Privately owned
  - ➥ If privately owned, is this a **family-owned** business?
    - ❑ Yes
    - ❑ No

1.3. In what year did you begin manufacturing at this facility? Year: ☐

1.4. Your facility's **main product** or manufacturing activity is: *(Please check one.)*

❑ Food, beverages, feed	❑ Stone, clay, glass, or concrete products
❑ Textiles	❑ Primary metals (iron, steel, nonferrous)
❑ Apparel, leather	❑ Fabricated metal products
❑ Lumber and wood products, except furniture	❑ Machinery (industrial, nonindustrial)
❑ Furniture (wood or metal)	❑ Computer and electronic products, instruments
❑ Pulp, paper, or paper products	❑ Electrical equipment, appliances, or components
❑ Printing, publishing	❑ Transportation equipment
❑ Chemical, petroleum, coal & allied products	❑ Medical or laboratory supplies
❑ Plastics or rubber	❑ Other (please describe) _____

1.5. For the plant's main product(s), please **RANK** the order of importance of the following factors according to how your facility competes in the marketplace for sales. 1=most important, 6=least important. (*Please do not give the same ranking to more than one factor.)*

☐	Low price
☐	High quality
☐	Innovation/new technology
☐	Quick delivery
☐	Adapting product to customer needs
☐	Sustainable or green manufacturing

1.6. Did any of the following significant changes occur to this facility in the last 2 years?

- ❑ Facility expanded due to acquisition or merger with another business or part of it
- ❑ Facility downsized due to sale or closure of part of the business
- ❑ No major change
- ❑ Other major change (please describe): _____

1.7. In which of the following areas does your facility have the most significant problems or needs? (*Please check all that apply.*)

- ❑ Expansion planning, facility layout
- ❑ Lean manufacturing and workflow improvement
- ❑ Quality assurance (e.g., ISO 9000, QS-9000, Six Sigma)
- ❑ Product development/design
- ❑ Marketing and sales
- ❑ Information systems and hardware
- ❑ Business strategy, financial analysis, competitiveness planning
- ❑ Basic workforce skills (e.g., reading, writing, math, keyboard skills)
- ❑ Technical skills (e.g., machining, electrical work)
- ❑ Management and leadership
- ❑ Energy cost management
- ❑ Environmental, health, safety, and workforce compliance and improvement
- ❑ Cybersecurity
- ❑ Other (please describe):_____

2. PRODUCT, PROCESS AND ORGANIZATIONAL INNOVATION

A **product innovation** is the introduction of a **new or significantly improved good or service**. *The innovation must be new to your facility, but does not need to be new to your sector or market.* Resale of goods purchased elsewhere or changes to color or look are excluded.

2.1. During the period 2013-20015, did your facility introduce **new or significantly improved**: *(Please check if yes.)*

- ❑ Goods
- ❑ Services

*If you **do not check any option**, skip to Question 2.4.*

If ANY of the boxes above (from 2.1.) are checked, please continue, otherwise skip to Question 2.4.

2.2a. Who developed these product or service innovations? *(Check all that apply.)*

	Product Innovations	**Service Innovations**
Your company by itself	❑	❑
Your company together with other companies, universities, research institutes, laboratories	❑	❑
Your company by adapting or modifying goods or services originally developed by other companies, universities, research institutes, laboratories	❑	❑
Other companies, universities, research institutes, laboratories	❑	❑

2.2b. Were any of your goods and service innovations during 2013-2015: *(Check all that apply.)*

- ❑ New to one of your markets (introduced before your competitors)
- ❑ New only to your facility (already available from your competitors)

2.3. Using the definitions above, please, indicate what percentage of your total sales from goods and services introduced during the period 2013-2015 were:

Sales of new or significantly improved goods and services that were **new to one of your markets** (introduced earlier than competitors)	%
Sales of new or significantly improved goods and services that were **new to your firm**, but NOT to your market	%
Sales from existing products	%
Total sales	1 0 0 %

A **process innovation** is the implementation of a **new or significantly improved production process or method of providing services**. *The innovation must be new to your facility, but it does not need to be new to your sector or market.*

2.4. During the period 2013-2015, did your facility introduce **new or significantly improved:** *(Please check if yes.)*

- ❑ Processes or manufacturing technologies
- ❑ Logistics, delivery, or distribution methods
- ❑ Support activities for the processes not covered above, such as improved purchasing, accounting, or maintenance processes
- ❑ Higher performing materials

An **organizational innovation** involves **new or significant changes in firm structure**, management methods, or information exchange systems.

2.5. During the period 2013-2015, did your facility introduce **new or significant changes** in: *(Please check if yes.)*

- ❑ Corporate strategy
- ❑ Management systems to better use or exchange information, knowledge and skills
- ❑ Work organization, such as changes in management or departmental structure
- ❑ Relations with other firms, such as alliances, partnerships, outsourcing, or subcontracting

A **marketing innovation** covers **new or significant changes in marketing methods** to increase the appeal of your goods or services or enter new markets. Routine or seasonal changes are excluded.

2.6. During the period 2013-2015, did your facility introduce **new or significant changes** in: *(Please check if yes.)*

- ❑ Design or packaging of goods or services
- ❑ Sales methods or distribution channels, such as Facebook/Twitter/other social media, franchising, direct sales or distribution licenses

2.7. Did your facility engage in any of the following activities to achieve **any of the types of innovation mentioned in Questions 2.1 to 2.6**? *(Please check if yes for all those that apply.)*

- ❑ In-house R&D (to increase knowledge or devise innovations, including software research)
- ❑ Purchase of R&D from research organizations or other branches of your company
- ❑ Purchase of machinery, equipment, computers or software to implement innovations
- ❑ Planning, engineering, design, or other development work to implement an innovation
- ❑ Purchase or license patents, inventions, know-how, or other types of knowledge to implement an innovation
- ❑ Training of staff to develop or introduce innovations
- ❑ Market research, advertising, and other marketing activities linked to implementing an innovation

2.8. Please indicate the **facility's expenditures** for the following innovation activities **over the last 12 months**, including personnel and related costs. (*Please insert zero in categories with no expenditures.)*

In-house R&D (including personnel costs & capital expenditures on buildings & equipment)	$
Acquisition of external R&D	$
Acquisition of machinery, equipment and software (excluding R&D-related expenditures)	$
Other development work for innovation and all other innovation-related expenditures	$
Total (sum of above 4 categories)	$

2.9. During the period 2013-2015, check if your facility:

- ❑ Ever worked with <u>customers</u> to create or design a product, process or other innovation
- ❑ Ever worked with <u>suppliers</u> to create or design a product, process or other innovation
- ❑ Applied for a patent or registered an industrial design
- ❑ Registered a trademark or assumed a copyright
- ❑ Signed a confidentiality agreement
- ❑ Published one or more papers or technical articles (in journals or conference proceedings)

2.10. During the period 2013-2015, did your facility **receive financial support** from any of these public or private sources for any of the innovation activities indicated in this section? *(Please check if yes.)*

- ❑ Public support through the U.S. Small Business Innovation Research program (SBIR or STTR)
- ❑ Other public support (loans or grants from the national, state, or local government, not the SBIR program)
- ❑ Venture capital, angel funding, or other private equity investment
- ❑ Bank loan or other private debt instrument
- ❑ Personal savings, friends, family

4. MANUFACTURING PRODUCTION AND PERFORMANCE

3.1. Please, answer for the fiscal years 2013 and 2015 using rounded approximate numbers or estimates **for this facility**.

	2015	2013
What were your **total annual sales or gross value** of shipments?	$	$
What was the total purchase of materials, parts, and services (i.e., **cost of goods**)?	$	$
What were your **energy expenditures** (e.g., heat, electricity)?	$	$
What was the total **new capital investment**, including facility, equipment, machinery, and information systems?	$	$

	2015	2013
What was the percentage of sales **exported** outside the U.S. (by value)?	%	%
What was the percentage of purchases of materials, parts, and services **imported** or acquired from outside the U.S. (by value)?	%	%
What was the percentage of finished goods **imported** or acquired from outside the U.S. (by value)?	%	%

3.2. What was the average annual return on sales (pre-tax) for this facility **over the last 3 years**? [(Gross Sales-Cost of Goods)/Gross Sales] *(Please circle the closest number.)*

← Negative return **Positive return →**

-25% or more	-15%	-9%	-6%	-3%	**0%**	+3%	+6%	+9%	+15%	+25% or more

3.3. Has any work that was formerly performed at this facility been **moved outside of Georgia** within the last 2 years? Yes ❑ No ❑

*If **YES**, this work was transferred outside of Georgia to:*	❑Elsewhere in USA	❑Mexico, other Central or South America	❑Asia (including China, India)	❑Europe	❑Elsewhere in world

3.4. Has any work been **transferred back to this facility in Georgia** from outside the state within the last 2 years? Yes ❑ No ❑

*If **YES**, this work was transferred back to Georgia from:*	❑Elsewhere in USA	❑Mexico, other Central or South America	❑Asia (including China, India)	❑Europe	❑Elsewhere in world

3.5. Which of the following state or federal government benefits does your company use? (*Check all that apply.*)

- ❑ R&D tax credit
- ❑ Investment tax credit
- ❑ Job credit
- ❑ Retraining tax credit
- ❑ Import/export credit
- ❑ Energy tax credit

3.6. Which of the following **information technologies** are currently used (or planned to be used) at your facility? (*Check one option for each item.*)

	Practiced Now	*Plan to practice in next 2 years*	*No plan to practice*	*Not applicable*
Bar code readers for data collection	❑	❑	❑	❑
Computer aided design	❑	❑	❑	❑
Software for scheduling, inventory control, or purchasing (e.g., ERP)	❑	❑	❑	❑
RFID for inventory and warehouse tracking	❑	❑	❑	❑
Supply chain management system	❑	❑	❑	❑
Cloud-based design and manufacturing	❑	❑	❑	❑

3.7. Which of the following **quality management and continuous improvement techniques** are currently used (or planned to be used) at your facility? (*Check one option for each item.*)

	Practiced Now	*Plan to practice in next 2 years*	*No plan to practice*	*Not applicable*
ISO 9000, TS16949 certification	❑	❑	❑	❑
ISO 14000 environmental management certification	❑	❑	❑	❑
ISO 50001, Energy Management System	❑	❑	❑	❑
Carbon footprint, greenhouse gas emissions estimate	❑	❑	❑	❑
Quality systems (e.g., Six Sigma)	❑	❑	❑	❑
Lean manufacturing	❑	❑	❑	❑
Preventive/predictive machine maintenance program	❑	❑	❑	❑
Life cycle analysis	❑	❑	❑	❑

3.8. Which of the following **manufacturing production technologies** are currently used (or planned to be used) at your facility? (*Check one option for each item.*)

	Practiced Now	*Plan to practice in next 2 years*	*No plan to practice*	*Not applicable*
Computer-integrated manufacturing (CIM)	❑	❑	❑	❑
Sensors, vision, other real-time monitoring technology	❑	❑	❑	❑
Rapid prototyping	❑	❑	❑	❑
3-D, additive, printed manufacturing	❑	❑	❑	❑
Robots	❑	❑	❑	❑
Advanced materials (e.g., nano-materials, bio-materials, composites)	❑	❑	❑	❑

3.9. Do you electronically collect and analyze data for manufacturing performance improvement

❑ **No** (*skip to Question 5.1)*

❑ **Yes**

If YES, please indicate the current (or planned) collection and analysis of data in each of the following areas) at your facility? (*Check one option for each item.*)

	Currently practice	*Plan to practice in next 2 years*	*No plan to practice*	*Not applicable*
Customer order monitoring	❑	❑	❑	❑
Supplier ordering and monitoring	❑	❑	❑	❑
Process improvement	❑	❑	❑	❑
Design specifications	❑	❑	❑	❑
Energy management	❑	❑	❑	❑
Cybersecurity issues	❑	❑	❑	❑

5. WORKFORCE AND TRAINING

5.1. Please, answer for the years 2013 and 2015 about your workforce using exact numbers or estimates, **for this facility**.

	2015	**2013**
On average, how many employees worked at this location? (Include temporary workers and convert part-time and contract labor to full-time equivalents.)	Full-Time Equivalent Employees	Full-Time Equivalent Employees
Of your full-time equivalent employees listed above, how many are temporary workers?	Temporary Employees	Temporary Employees
What was your total payroll? (Please include direct payroll plus indirect fringe benefit payroll expenses. Include payments to agencies for temporary workers.)	Payroll $	Payroll $

5.2. Does the facility provide bonuses or other incentives to employees based on the following? *(Check if yes.)*

- ❑ New skills or education acquired
- ❑ Productivity increases
- ❑ New ideas suggested or implemented

5.3. On average in 2015, what percentage of your production workers used, at least once a day, as part of their job:

A computer or programmable controller?	%
A mobile device to monitor and control industrial equipment	%
The Internet?	%

5.4. In 2015, how many employees at this facility had at least the following training or educational qualifications:

	Number of Employees
a. High school graduate or GED?	
b. Two or more years of industrial-related training, through technical college, vocational school, or apprenticeship?	
c. Four-year college degrees (e.g., B.A., B.S.) with majors in science, engineering or information technology?	
d. Four-year college degrees (e.g., B.A., B.S.) with majors in other subjects (**not** science, engineering, or information technology)?	
e. Master's, Ph.D., or other graduate degrees with majors in science, engineering or information technology?	

5.5. How much did your company spend on all training activities in fiscal year 2015?

$	
Of this, approximately what percentage was related to new activities and tasks (i.e., not routine training)?	%

5.6. What percentage of employees in production work are in teams (e.g., quality team, work cell)? *(If none, enter zero.)*

%

6. BUSINESS ASSISTANCE RESOURCES

6.1. In the past 2 years, has your facility **received business assistance** from: *(Check all that apply.)*

- ❑ Georgia Tech (main campus or regional office)
- ❑ Kennesaw State University
- ❑ Other university (not Georgia Tech or Kennesaw State University))
- ❑ Small Business Development Centers (SBDC, provided by University of Georgia)
- ❑ Technical college (Technical College System of Georgia, Quick Start)
- ❑ Georgia Department of Labor's recruitment, labor market information, or welfare-to-work services
- ❑ Federal laboratory, NASA, or other federal technology program
- ❑ Other public or nonprofit business assistant source
- ❑ A private-sector business assistance source, such as a private consultant or vendor
- ❑ Another source not included in the above
- ❑ **Facility has not received outside business assistance**

6.2. Would **you or your managers** be interested in receiving training or technical assistance in any of the following areas? *(Check all that apply.)*

- ❑ Product design and development
- ❑ Technology implementation
- ❑ Marketing and sales growth
- ❑ Lean manufacturing and process improvement
- ❑ Supply chain development
- ❑ Quality systems, ISO 9000, TS 16949
- ❑ ISO 14000 environmental management certification
- ❑ Finance and taxes
- ❑ Safety and health, ergonomics
- ❑ Energy efficiency and management
- ❑ Materials and waste minimization
- ❑ Other topics *(please describe)*

_____

6.3. What new training programs would you like to have available to **non-managerial employees** at this facility? *(Check box if your company would benefit from training in a category even if is not currently available or provided.)*

- ❑ English speaking skills
- ❑ Reading, writing skills
- ❑ Basic math skills
- ❑ Technical skills (e.g., machinist)
- ❑ Product design and development
- ❑ Marketing skills
- ❑ Team and problem solving skills
- ❑ Quality, lean manufacturing
- ❑ Basic computer skills (e.g., keyboarding, word processing, e-mail)
- ❑ Advanced computer skills (e.g., database, Web design)
- ❑ Other topics *(please describe)*

_____

- ❑ Check here if facility does not need/would not use non-managerial training

Please check any of the following boxes if you would like to receive information about:

- ❑ Georgia Tech's industrial services, seminars, and workshops
- ❑ Kennesaw State University's services, seminars, and workshops
- ❑ Georgia Department of Labor's services, information, training
- ❑ Federal and state manufacturing tax incentives and credits
- ❑ Reducing indirect costs in the manufacturing and distribution process

(No individual information besides contact information for the company will be transmitted.)

Appendix
3

Manufacturer Responses by Survey Question

(Total respondents is 526)

1. Facility-Industry and Needs

1.1. This facility is	
Single establishment enterprise	62.7%
A multi-facility, company or group, head office	11.3%
An affiliate of a parent group or holding company	26.0%
	100.0%
Total respondents	524
1.1a. Is your company's head office located in Georgia	
Yes	74.0%
No	26.0%
	100.0%
Total respondents	524
1.2. Is this business:	
Publicly traded	13.2%
Privately owned, family business	60.1%
Privately owned, not a family business	26.7%
Total respondents	493
1.3. In what year did you begin manufacturing at this facility	
Mean year	1987.26
Std. deviation year	20.98
10th Percentile	1964
25th Percentile	1978
50th Percentile	1991
75th Percentile	2001
90th Percentile	2009
Total respondents	499

1.4. Your facility's main product or manufacturing activity is:

Food beverages, feed	6.4%
Textiles	8.7%
Apparel, leather	3.1%
Lumber and wood, except furniture	11.1%
Furniture (wood or metal)	3.4%
Pulp Paper and paper products	2.7%
Printing and publishing	6.9%
Chemical, petroleum, coal & allied products	8.4%
Plastics or Rubber	8.6%
Stone, clay, glass or concrete	5.8%
Primary metals (iron, steel, nonferrous)	1.2%
Fabricated metals	14.5%
Machinery (industry, nonindustrial)	7.0%
Computer and electronic products, Instruments	1.9%
Electrical equipment, appliances, or components	3.9%
Transportation equipment	4.7%
Medical or laboratory supplies	1.7%
	100.0%
Total respondents	526

1.5. Rank order of importance of the following factors facility competition for sales (percent ranking factor #1)

Low price	17.8%
High quality	64.1%
Innovation/new technology	7.9%
Quick delivery	12.2%
Adapting product to customer needs	9.7%
Sustainable or green manufacturing	1.8%
Total respondents	526

1.6. Did any of the following significant changes occur?

Merger with another business	7.4%
Sale or closure of part of business	2.9%
No major change	74.1%
Other (e.g., reduction of employees, production, new customers)	13.3%
Total respondents	521

1.7. In which of the following areas does your facility have the most significant problems or needs?

Expansion planning, facility layout	18.6%
Lean manufacturing and workflow improvement	30.8%
Quality assurance (e.g., ISO 9000, QS-9000, Six Sigma)	10.4%
Product development/design	14.0%
Marketing and sales	35.3%
Information systems and hardware	13.5%
Business strategy, financial analysis, competitiveness planning	11.1%
Basic workforce skills (e.g., reading, writing, math, keyboard skills)	21.8%
Technical skills (e.g., machining, electrical work)	34.7%
Management and leadership	12.0%
Energy cost management	8.5%
Environmental, health, safety, and workforce compliance and improvement	12.1%
Cybersecurity	4.5%
Other (please describe)	8.8%
Total respondents	502

2. Product, Process and Organizational Innovation

2.1. During the period 2013-2015, did your facility introduce:

New or significantly improved goods	45.4%
New or significantly improved services	14.8%
Total respondents	526

2.2a. Who developed these product or service innovations?

Product	
Your company by itself	83.5%
Your company together with other companies, universities, research institutes, laboratories	21.1%
Your company by adapting or modifying goods or services originally developed by other companies, universities, research institutes, laboratories	19.5%
Other companies, universities, research institutes, laboratories	4.5%
Total respondents	243
Service	
Your company by itself	60.1%
Your company together with other companies, universities, research institutes, laboratories	24.0%
Your company by adapting or modifying goods or services originally developed by other companies, universities, research institutes, laboratories	8.3%

Other companies, universities, research institutes, laboratories	0.0%
Total respondents	47

2.2b. Were any of your goods and service innovations during 2013-2015

New to one of your markets? (introduced before your competitors)	27.6%
New only to your facility? (already available from your competitors)	28.2%
Total respondents	243

2.3. Please give the percentage of your total sales from goods and services introduced during the period 2013 to 2015.

2.3a Sales from goods and services that were **new to one of your markets**

Mean percentage	12.61%
Std. deviation percentage	15.35%
10th Percentile	0%
25th Percentile	2%
50th Percentile	10%
75th Percentile	15%
90th Percentile	30%
Total respondents	206

2.3b Sales from goods and services that were **new to your firm**, but NOT to your market

Mean percentage	19.16%
Std. deviation percentage	22.98%
10th Percentile	1%
25th Percentile	5%
50th Percentile	10%
75th Percentile	25%
90th Percentile	50%
Total respondents	191

2.3c Sales from existing products

Mean percentage	79.67%
Std. deviation percentage	21.52%
10th Percentile	50%
25th Percentile	70%
50th Percentile	85%
75th Percentile	95%
90th Percentile	99%
Total respondents	256

2.4. During the period 2013-2015, did your facility engage in any of the following process

innovation activities?

Processes or manufacturing technologies	44.0%
Logistics, delivery, or distribution methods	12.8%
Support activities for processes	22.6%
Higher performing materials	16.0%
Total respondents	526

2.5. During the period 2013-2015, did your facility engage in any of the following organizational innovation activities?

Corporate strategy	21.9%
Implement new or significantly improved management systems to better use or exchange information, knowledge and skills	24.0%
Make a major change to the organization of work, such as changes in management or departmental structure	35.1%
New or significant changes in your relations with other firms, such as alliances, partnerships, outsourcing, or subcontracting	22.9%
Total respondents	526

2.6. During the period 2013-2015, did your facility engage in any of the following activities? (please check if yes)

Make significant changes to the design or packaging of a good or service (exclude routine or seasonal changes)	16.4%
New or significant changes to sales methods or distribution channels, such as Internet sales, franchising, direct sales or distribution licenses	22.1%
Total respondents	526

2.7. During the period 2013-2015, did your facility engage in any of the following innovation-related activities?

In-house R&D (to increase knowledge or devise innovations, including software research)	36.8%
Purchase R&D from research organizations or other branches of your company	3.7%
Purchase machinery, equipment, computers or software to implement innovations	52.0%
Planning, engineering, design, or other development work to implement an innovation	32.0%
Purchase or license patents, inventions, know-how, or other types of knowledge to implement an innovation	6.3%

Training staff to develop or introduce innovations	31.8%
Market research, advertising, and other marketing activities linked to implementing an innovation	16.0%
Total respondents	526

2.8. Please estimate your expenditures for the following innovation activities over the last 12 months. (Include personnel and related costs).

2.8a In-house R&D (including personnel costs & capital expenditures on buildings & equipment)	
Mean In-house R&D	$450,436
Std. deviation In-house R&D	$1,738,154
10th Percentile	$0
25th Percentile	$0
50th Percentile	$50,000
75th Percentile	$264,000
90th Percentile	$1,000,000
Total respondents	299

2.8b Acquisition of external R&D	
Mean external R&D	$19,638
Std. deviation external R&D	$93,724
10th Percentile	$0
25th Percentile	$0
50th Percentile	$0
75th Percentile	$0
90th Percentile	$12,700
Total respondents	180

2.8c Acquisition of machinery, equipment and software (excluding R&D-related expenditures)	
Mean acquisition of machinery, equipment and software	$1,233,263
Std. deviation acquisition of machinery, equipment and software	$6,856,683
10th Percentile	$0
25th Percentile	$11,750
50th Percentile	$100,000
75th Percentile	$500,000
90th Percentile	$1,500,000
Total respondents	318

2.8d Other development work for innovation and all other innovation-related expenditures	
Mean other development work	$56,587
Std. deviation other development work	$216,356
10th Percentile	$0
25th Percentile	$0

50th Percentile	$0
75th Percentile	$5,000
90th Percentile	$100,000
Total respondents	189

2.8e Total (sum of above 4 categories)

Mean Total	$1,387,184
Std. deviation Total	$6,464,308
10th Percentile	$0
25th Percentile	$27,875
50th Percentile	$176,250
75th Percentile	$700,000
90th Percentile	$2,500,000
Total respondents	390

2.9. During the period 2013-2015, check if your facility

Ever worked with customers to create or design a product, process or other innovation	61.1%
Ever worked with suppliers to create or design a product, process or other innovation	39.2%
Applied for a patent or registered an industrial design	13.3%
Registered a trademark or assumed a copyright	12.9%
Signed a confidentiality agreement	50.7%
Staff published one or more papers or technical articles (in journals or conference proceedings)	6.7%
Total respondents	526

2.10. During the period 2013-15, did you receive for innovation activities from

Public support through the SBIR or STTR programs	0.7%
Other public support (loans or grants from the national, state, or local government)	2.2%
Venture capital, angel funding, or other private equity investment	3.5%
Bank loan or other private debt instrument	30.8%
Personal savings, friends, family	9.9%
Total respondents	526

3. Manufacturing Production and Performance

3.1a. What were your total annual sales or gross value of shipments at this plant?

	2015	**2013**
Mean sales	$48,833,492	$45,016,539

Std. deviation sales	270,634,533	265,836,136
10th Percentile	$1,400,000	$1,223,852
25th Percentile	$2,500,000	$2,241,016
50th Percentile	$7,452,884	$6,388,000
75th Percentile	$27,000,000	$22,500,000
90th Percentile	$80,000,000	$80,000,000
Total Respondents	431	421

3.1b. How much did you spend on materials, parts and services?

	2015	**2013**
Mean spending on direct inputs	$34,824,633	$32,869,473
Std. deviation spending on direct inputs	220,958,781	221,155,303
10th Percentile	$570,646	$500,000
25th Percentile	$1,200,000	$1,119,000
50th Percentile	$4,000,000	$3,429,000
75th Percentile	$17,961,000	$14,164,569
90th Percentile	$54,000,000	$48,000,000
Total respondents	382	372

3.1c. How much did you spend in energy at this location?

	2015	**2013**
Mean energy expenditure	$1,226,173	$1,150,406
Std. deviation energy expenditure	$8,851,618	$8,549,830
10th Percentile	$15,000	$13,000
25th Percentile	$28,211	$24,000
50th Percentile	$81,000	$76,000
75th Percentile	$305,389	$295,000
90th Percentile	$1,282,334	$1,250,000
Total respondents	384	375

3.1d. How much new capital investment was made at this location?

	2015	**2013**
Mean new capital investment	$2,383,912	$2,145,133
Std. deviation new capital investment	$17,818,17 9	$15,520,57 9
10th Percentile	$0	$0
25th Percentile	$30,000	$5,000
50th Percentile	$130,000	$100,000
75th Percentile	$600,000	$464,200
90th Percentile	$2,500,000	$2,032,816
Total respondents	377	362

3.1e. What percentage of sales was exported outside the U.S.

	2015	2013
Mean percentage of sales outside the U.S.	7.6%	7.2%
Std. deviation percentage of sales outside the U.S.	16.7%	16.2%
10th Percentile	0.0%	0.0%
25th Percentile	0.0%	0.0%
50th Percentile	0.0%	0.0%
75th Percentile	5.0%	5.0%
90th Percentile	30.0%	25.0%
Total respondents	430	423

3.1f. Approximate percentage of your facility's purchases of materials, parts, and services imported or acquired from sources outside of the United States (by value)

	2015	2013
Mean percentage of purchases outside the U.S.	9.7%	9.0%
Std. deviation percentage of purchases outside the U.S.	19.1%	18.8%
10th Percentile	0.0%	0.0%
25th Percentile	0.0%	0.0%
50th Percentile	0.0%	0.0%
75th Percentile	10.0%	9.0%
90th Percentile	34.0%	30.0%
Total respondents	415	409

3.1g. Approximate percentage of your facility's purchases of final goods imported or acquired from sources outside of the United States (by value)

	2015	2013
Mean percentage of purchases outside the U.S.	4.0%	4.1%
Std. deviation percentage of purchases outside the U.S.	13.6%	14.5%
10th Percentile	0.0%	0.0%
25th Percentile	0.0%	0.0%
50th Percentile	0.0%	0.0%
75th Percentile	0.0%	0.0%
90th Percentile	10.0%	8.0%
Total respondents	422	415

3.2. What was the average annual return on sales (pre-tax) over the last 3 years?

-25% or less	1.4%
-15%	.7%
-9%	.3%
-6%	.3%
-3%	3.2%
0%	4.8%

1%	13.9%
3%	15.1%
6%	19.2%
9%	17.7%
15%	23.4%
+25% or more	1.4%
Average return on sales - mean	11.0%
Average return on sales - Std. deviation	9.9%
Total respondents	417

3.3. Has any work that was formerly performed at this facility been moved outside of Georgia within the last 2 years?

Yes	11.8%
No	88.2%
Total Respondents	508

3.3a to 4.3e. If YES, this work was moved from Georgia to:

Elsewhere in USA	6.7%
Mexico, other Central or South America	2.7%
Asia (including China, India)	2.9%
Europe	.6%
Elsewhere in world	.2%

3.4. Has any work been transferred back to this facility in Georgia from outside the state within the last 2 years?

Yes	12.7%
No	87.3%
Total Respondents	487

3.4b to 3.4e. If YES, this work was transferred back to Georgia from:

Elsewhere in USA	8.7%
Mexico, other Central or South America	1.2%
Asia (including China, India)	2.0%
Europe	1.7%
Elsewhere in world	0.2%

3.5. Which of the following state or federal government benefits does your company use?

R&D tax credit	16.0%
Investment tax credit	15.5%
Job credit	13.9%
Retraining tax credit	7.1%

Import/export credit	5.5%
Energy tax credit	11.9%
Total Respondents	526

3.6. Which of the following information technologies are currently used (or planned to be used) at your facility?

3.6a. Bar code readers

No plan to practice	25.9%
Plan to practice in next 2 years	21.3%
Practiced now	35.3%
Not applicable	17.5%

3.6b. Computer aided design

No plan to practice	14.7%
Plan to practice in next 2 years	3.9%
Practiced now	67.4%
Not applicable	14.0%

3.6c. Software for scheduling, inventory control, or purchasing (e.g., ERP)

No plan to practice	11.6%
Plan to practice in next 2 years	10.9%
Practiced now	70.7%
Not applicable	6.8%

3.6d. RFID for inventory and warehouse tracking

No plan to practice	49.5%
Plan to practice in next 2 years	17.0%
Practiced now	14.2%
Not applicable	19.3%

3.6e. Supply chain management systems

No plan to practice	37.2%
Plan to practice in next 2 years	11.8%
Practiced now	34.3%
Not applicable	16.7%

3.6f. Cloud-based design and manufacturing

No plan to practice	55.3%
Plan to practice in next 2 years	11.6%
Practiced now	10.0%
Not applicable	23.0%

3.7. Which of the following quality management and continuous improvement techniques are currently used (or planned to be used) at your facility?
3.7a. ISO 9000, TS16949 certification

No plan to practice	40.8%
Plan to practice in next 2 years	9.9%
Practiced now	29.6%
Not applicable	19.6%

3.7b. 14000 environmental management certification

No plan to practice	57.9%
Plan to practice in next 2 years	5.1%
Practiced now	10.3%
Not applicable	26.7%

3.7c. ISO 50001, Energy Management System

No plan to practice	66.3%
Plan to practice in next 2 years	4.4%
Practiced now	1.3%
Not applicable	28.0%

3.7d. Carbon footprint, greenhouse gas emissions estimate

No plan to practice	55.3%
Plan to practice in next 2 years	5.3%
Practiced now	11.9%
Not applicable	27.4%

3.7e. Quality systems (e.g., Six Sigma)

No plan to practice	36.4%
Plan to practice in next 2 years	11.7%
Practiced now	34.0%
Not applicable	17.9%

3.7f. Lean manufacturing

No plan to practice	26.3%
Plan to practice in next 2 years	14.0%
Practiced now	43.4%
Not applicable	16.3%

4.6f. Preventive/predictive machine maintenance program

No plan to practice	21.7%
Plan to practice in next 2 years	8.1%
Practiced now	57.3%
Not applicable	12.9%

3.7g. Life cycle analysis

No plan to practice	47.1%
Plan to practice in next 2 years	11.3%
Practiced now	16.3%
Not applicable	25.4%

3.8. Which of the following manufacturing production technologies are currently used (or planned to be used) at your facility?

3.8a. Computer-integrated manufacturing (CIM)

No plan to practice	42.9%
Plan to practice in next 2 years	6.6%
Practiced now	29.3%
Not applicable	21.2%

3.8b. Sensors, vision, other real time monitoring

No plan to practice	36.5%
Plan to practice in next 2 years	8.8%
Practiced now	32.7%
Not applicable	22.0%

3.8c. Rapid prototyping	54.5%
No plan to practice	5.1%
Plan to practice in next 2 years	9.1%
Practiced now	31.4%
Not applicable	

3.8d. Additive manufacturing, printed manufacturing

No plan to practice	54.8%
Plan to practice in next 2 years	5.2%
Practiced now	9.5%
Not applicable	30.5%

3.8e. Robots

No plan to practice	48.7%
Plan to practice in next 2 years	7.7%
Practiced now	17.6%
Not applicable	26.0%

3.8f. Advanced materials (e.g., nano-materials, bio-materials, composites)

No plan to practice	54.7%
Plan to practice in next 2 years	3.2%
Practiced now	9.4%
Not applicable	32.7%

3.9. Do you electronically collect and analyze data for manufacturing performance improvement

Yes	49.8%
No	50.2%
Number of respondents	502

If Yes, please indicate the current (or planned) collection and analysis of data in each of the following areas at your facility

Customer order monitoring

No plan to practice	3.8%
Plan to practice in next 2 years	3.1%
Practiced now	90.9%
Not applicable	2.2%
Number of respondents	246

Supplier ordering and monitoring

No plan to practice	7.9%
Plan to practice in next 2 years	7.7%
Practiced now	81.6%
Not applicable	2.8%

Number of respondents	242
Process improvement	
No plan to practice	3.2%
Plan to practice in next 2 years	10.5%
Practiced now	84.3%
Not applicable	2.0%
Number of respondents	243
Design specifications	
No plan to practice	23.4%
Plan to practice in next 2 years	8.0%
Practiced now	56.6%
Not applicable	12.1%
Number of respondents	222
Energy management	
No plan to practice	32.4%
Plan to practice in next 2 years	22.7%
Practiced now	37.2%
Not applicable	7.7%
Number of respondents	220
Cybersecurity issues	
No plan to practice	33.7%
Plan to practice in next 2 years	15.9%
Practiced now	37.9%
Not applicable	12.5%
Number of respondents	215

5. Workforce and Training

5.1a. How many employees worked at this location?	**2015**	**2013**
Mean number of employees	142	246
Std. deviation number of employees	753	2497
10th Percentile	12	11

25th Percentile	18	16
50th Percentile	35	34
75th Percentile	94	85
90th Percentile	215	200
Total respondents	526	484

5.1b. Of your full-time equivalent employees listed above, how many are temporary workers?	**2015**	**2013**
Mean payroll	9	8
Std. deviation payroll	29	24
10th Percentile	0	0
25th Percentile	0	0
50th Percentile	0	0
75th Percentile	5	4
90th Percentile	25	20
Total respondents	462	452

5.1c. What was total payroll?	**2015**	**2013**
Mean payroll	$7,905,640	$6,801,299
Std. deviation payroll	$51,214,139	$39,699,604
10th Percentile	$397,195	$320,000
25th Percentile	$660,599	$600,000
50th Percentile	$1,500,000	$1,400,000
75th Percentile	$4,380,000	$3,750,000
90th Percentile	$11,306,028	$10,100,000
Total respondents	379	369

5.2. Does the facility provide bonuses or other incentives to employees based on the following?	
New skills or education acquired	20.0%
Productivity increases	42.4%
New ideas suggested or implemented	19.3%
Total respondents	

5.3a. On average in 2015, what percentage of your workers used a computer or programmable controller at least once a week as part of their job?	
Mean percentage of workers using computers	36.7%
Std. deviation percentage of workers using computers	36.2%
10th Percentile	0.0%

25th Percentile	5.0%
50th Percentile	20.0%
75th Percentile	75.0%
90th Percentile	100.0%
Total respondents	468
Mean percentage of workers using a mobile device	8.2%
Std. deviation percentage of workers using computers	20.1%
10th Percentile	0.0%
25th Percentile	0.0%
50th Percentile	0.0%
75th Percentile	5.0%
90th Percentile	20.0%
Total respondents	414
Mean percentage of workers using the Internet	22.0%
Std. deviation percentage of workers using computers	29.2%
10th Percentile	0.0%
25th Percentile	0.0%
50th Percentile	10.0%
75th Percentile	30.0%
90th Percentile	75.0%
Total respondents	456

5.4a. How many persons were high school graduate or GED?

Mean number of workers graduated in high school	
Std. deviation number of workers graduated in high school	101.8
10th Percentile	469.1
25th Percentile	9.0
50th Percentile	14.0
75th Percentile	26.0
90th Percentile	65.0
Total respondents	449

5.4b. How many persons had two or more years of industrial-related training?

Mean number of workers with 2 or more years of industrial training	20.4
Std. deviation number of workers with 2 or more years of industrial training	86.8
10th Percentile	1.0
25th Percentile	2.0

50th Percentile	5.0
75th Percentile	12.0
90th Percentile	27.0
Total respondents	414

5.4c. How many persons had a 4 year college degree or higher with majors in science, engineering or information technology?

Mean number of workers with 4 year college degrees	12.0
Std. deviation number of workers with 4 year college degrees	81.2
10th Percentile	.0
25th Percentile	.0
50th Percentile	2.0
75th Percentile	6.0
90th Percentile	20.0
Total respondents	413

5.4d. How many persons had a 4 year college degree or higher with majors in other subjects ?

Mean number of workers with 4 year college degrees	6.4
Std. deviation number of workers with 4 year college degrees	16.3
10th Percentile	.0
25th Percentile	1.0
50th Percentile	2.0
75th Percentile	5.0
90th Percentile	13.0
Total respondents	409

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5.4e. How many persons had master's, Ph.D., or other graduate degrees with majors in science, engineering or information technology?

Mean number of workers with science or eng. degrees	2.6
Std. deviation numbers of workers with science or engineering degrees	15.3
10th Percentile	.0
25th Percentile	.0
50th Percentile	.0
75th Percentile	1.0
90th Percentile	5.0
Total respondents	374

5.5a. How much did the company spend on all training activities in 2013?

Mean spending on training	$86,185
Std. deviation spending on training	$756,884
10th Percentile	$0

25th Percentile	$0
50th Percentile	$5,000
75th Percentile	$25,000
90th Percentile	$100,000
Total respondents	387

5.5b. Of this, approximately what percentage was related to new activities and tasks?

Mean percentage training related to new activities	28.6%
Std. deviation percentage training related to new activities	33.7%
10th Percentile	0.0%
25th Percentile	0.0%
50th Percentile	15.0%
75th Percentile	50.0%
90th Percentile	90.0%
Total respondents	328

5.6. What percentage of employees in production work are in teams?

Mean percentage of employees in teams	33.0%
Std. deviation percentage of employees in teams	40.3%
10th Percentile	0.0%
25th Percentile	0.0%
50th Percentile	10.0%
75th Percentile	75.0%
90th Percentile	100.0%
Total respondents	453

6. Business Assistance Resources

6.1. Have you received business assistance from:

Georgia Tech (main campus or regional office)	20.3%
Kennesaw State University	4.0%
Other university (not Georgia Tech or Kennesaw State University))	4.0%
Small Business Development Centers (SBDC, provided by University of Georgia)	8.7%
Technical college (Technical College System of Georgia, Quick Start)	11.5%
Georgia Department of Labor's recruitment, labor market information, or welfare-to-work services	0.7%
Federal laboratory, NASA, or other federal technology program	0.6%
Other public or nonprofit business assistant source	11.4%

A private-sector business assistance source, such as a private consultant or vendor	12.2%
Another source not included in the above	57.3%
Facility has not received outside business assistance	47.8%
Total Respondents	526

6.2. Would you or your managers be interested in receiving training or technical assistance in:	
Product design and development	10.0%
Technology implementation	12.0%
Marketing and sales growth	19.0%
Lean manufacturing and process improvement	30.0%
Supply chain development	10.0%
Quality systems, ISO 9000, TS 16949	13.0%
ISO 14000 environmental management certification	5.0%
Finance and taxes	11.0%
Safety and health, ergonomics	25.0%
Energy efficiency and management	17.0%
Materials and waste minimization	17.0%
Additive manufacturing	2.0%
Robotics	7.0%
Cybersecurity	4.0%
Total Respondents	526

6.3. What new training programs would you like to have available to <u>non-managerial employees</u> at this facility?	14.0%
English speaking skills	8.0%
Reading, writing skills	14.0%
Basic math skills	28.0%
Technical skills (e.g., machinist)	6.0%
Product design and development	5.0%
Marketing skills	26.0%
Team and problem solving skills	30.0%
Quality, lean manufacturing	5.0%
Basic computer skills (e.g., keyboarding, word processing, email)	9.0%
Advanced computer skills (e.g., database, ERP, Web design)	
Total Respondents	526