Innovation in Manufacturing: Needs, Practices, and Performance in Georgia

2016-2018

By

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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.

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
# Table of Contents

- Introduction: The 2016 Georgia Manufacturing Survey ................................................................. 3
- Problems and Needs ...................................................................................................................... 5
- Manufacturing Strategy .............................................................................................................. 10
- Innovation ................................................................................................................................. 17
- Manufacturing Technologies and Techniques ........................................................................... 37
- Workforce and Training Practices ............................................................................................ 49
- Manufacturing Production and Performance .......................................................................... 59
- Business Assistance Resources ................................................................................................. 82
- Appendix 1. Survey Framework, Questionnaire Design, and Administration ..................... 93
- Appendix 2. Questionnaire ....................................................................................................... 98
- Appendix 3. Results by Question ............................................................................................. 108
List of Tables

Table 1.1. Industry Group Definitions............................................................................................................4
Table 2.2. Manufacturing Problems and Needs by Industry........................................................................8
Table 2.3. Manufacturing Problems and Needs by Region........................................................................9
Table 3.1. Most Important Manufacturing Strategies by Facility Employment Size ................................12
Table 3.2. Most Important Manufacturing Strategies by Industry Group ...............................................12
Table 3.3. Most Important Manufacturing Strategies by Region ................................................................12
Table 4.1. New to Market vs. New to Facility Innovations ........................................................................21
Table 4.2. Process Innovations Introduced from 2013 to 2015 ..................................................................24
Table 4.3. Organizational Innovations Introduced from 2013 to 2015 ....................................................25
Table 4.4. Marketing Innovations Introduced from 2013 to 2015 ...........................................................26
Table 4.5. Adoption of Specialized Innovation Activities from 2013 to 2015 by Facility Employment Size .................................................................30
Table 4.6. Adoption of Specialized Innovation Activities from 2013 to 2015 by Industry Group ..........30
Table 4.7. Innovations Introduced from 2013 to 2015 by Region ...............................................................31
Table 4.8: Average Innovation Expenditures and Investments Per Employee ...........................................34
Table 4.9: Average Innovation Expenditures and Investments Per Employee ...........................................34
Table 4.10: R&D Intensity: Georgia versus U.S. .........................................................................................35
Table 5.1. Current and Planned Use of Technologies and Techniques: 2014 and 2016 Surveys ..........38
Table 5.2. Current Use of Technologies and Techniques by Facility Employment Size .......................40
Table 5.3. Current Use of Technologies and Techniques by Industry Group .........................................40
Table 5.4. Current Use of Technologies and Techniques by Region .........................................................41
Table 5.5. Base Entry and Competitive/Advanced Entry: Manufacturing Technologies, Techniques ....42
Table 5.6. Use of Smart Manufacturing by Facility Employment Size, Industry Group, and Region ....46
Table 5.7. Employment and Technology Use .............................................................................................48
Table 6.1. 2015 Median Number of Employees and Payroll per Employee by Employment Size, Industry, and Location ......................................................................................................................51
Table 6.2. 2015 Mean Percent Number of Temporary Employees over Full Time Employees by Employment Size, Industry, and Location ..................................................................................52
Table 6.3. Employee Education by Employment Size, Industry, and Location ..........................................53
Table 6.4. Computer, Mobile Device, and Internet Usage of Production Workers At Least Once a Day By Employment Size and Industry ........................................................................................54
Table 6.5. Median Training Expenses per Employee By Employment Size, Industry, and Top Competitive Strategy ..........................................................................................................................55
Table 6.6. Percentage of Firms Offering Employee Incentives By Employment Size, Industry, and Top Competitive Strategy .................................................................55
Table 7.1. Mean Percentages for Sales Exported, Materials Imported, Products Imported .....................64
Table 7.2. Percentage of Firms Using State and Federal Tax Credits By Employment Size, Industry, and Location ........................................................................................................................................65
Table 7.3. Energy Intensity: Energy Expenditures by Sales.......................................................................66
Table 7.4. Export and Imports by Industry .................................................................................................68
Table 7.5. Percentage of Firms Outsourcing and In-sourcing by Industry ..............................................68
Table 7.6. Percentage of Manufactures Providing Employee Incentives by Industry ............................75
Table 8.1 Business Assistance Sources Used by Industry .......................................................................85
Table 8.2. Business Assistance Sources Used by Industry ......................................................................85
Table 8.3a. Interest in Managerial Training and Technical Assistance by Facility Employment Size ....88
Table 8.3b. Interest in Managerial Training and Technical Assistance by Industry Group ...................89
Table 8.3c. Interest in Managerial Training and Technical Assistance by Region ....................................89
Table 8.4a. Interest in Non-managerial Training and Technical Assistance by Facility Employment Size 90
Table 8.4c. Interest in Non-managerial Training and Technical Assistance by Region ...........................91
Table 8.5. Sales Growth is Significantly Higher for Georgia Tech Clients than for Non-clients ..............92
List of Figures

Figure 1. Georgia Regions Used in Analysis ................................................................. 4
Figure 2.1. Manufacturing Needs and Problems by Facility Employment Size ........... 7
Figure 3.1. Top Manufacturing Strategies: 1999-2016 .................................................. 11
Figure 3.3. Manufacturing Returns and Wages by Percentage of Respondents Ranking Strategies Highest in 2016 ........................................................................................................ 15
Figure 4.1. Introduction of New or Significantly Improved Goods and Services by Facility Employment Size .................. 19
Figure 4.2. Introduction of New or Significantly Improved Goods and Services by Industry Group, Region, Ownership ........................................................................................................... 20
Figure 4.4. Radar Charts of Innovation Area Adoption by Industry .............................. 27
Figure 4.5 Adoption of Specialized Innovation Activities .............................................. 29
Figure 4.6. Number of Innovation Activities Used by Establishment Size ..................... 32
Figure 4.7. Number of Innovation Activities Used by Establishment Size within Industry Groups .................................................................................................................. 33
Figure 4.8. Receipt of Public and Private Support by Facility Employment Size ............ 36
Figure 4.9. Technologies and Techniques Manufacturers Use and Plan to Use ................ 39
Figure 5.1. Usage of Basic and Advanced Technologies and Techniques by Size, Industry, Region (y-axis=mean number technologies used) ......................................................... 43
Figure 5.2. Usage of Basic and Advanced Technologies and Techniques ....................... 44
Figure 6.1. Distribution of Full-Time Equivalent Employees in 2015 ............................... 49
Figure 6.2. Distribution of Payroll in 2015 ...................................................................... 50
Figure 6.3. Mean Percentage of Production Employees that Work in Teams by Employment Size, Industry, and Competitive Strategy ......................................................... 58
Figure 7.1. Median Percent Change in Sales 2013-2015 for Georgia Manufacturers ........ 60
Figure 7.2. Mean Gross Margin as Percent of Sales for Georgia Manufacturers ............. 61
Figure 7.3. Mean Capital Expenditures as Percentage of Sales ........................................ 62
Figure 7.4. Best Performers by Competitive Strategy .................................................... 67
Figure 7.5. Percentage of Firms that Used Selected Information Technologies ............... 69
Figure 7.6. Percentage of Firms that Used Quality Management and Continuous Improvement Techniques ... 70
Figure 7.7. Manufacturing Production Technologies ..................................................... 71
Figure 7.8. State and Federal Government Benefits ....................................................... 72
Figure 7.9. Average Wages per Employee by Industry .................................................. 73
Figure 7.10. Percent of Temporary Workers ................................................................. 74
Figure 7.11. Production Workers that Use Technology Daily as Part of Their Job ............ 76
Figure 7.12. Educational Qualifications ........................................................................ 77
Figure 7.13. Training Expenses per Employee by Industry ............................................. 78
Figure 7.14. Percentage of Publicly-traded Manufacturers by Industry ......................... 79
Figure 7.15. Company Age by Industry ........................................................................ 80
Figure 8.1 Business Assistance Sources Used by Manufacturers .................................. 83
Figure 8.2 Business Assistance Sources Used by Facility Employment Size ................. 84
Figure 8.3. Areas of Interest for Training and Technical Assistance: Management .......... 86
Figure 8.3. Areas of Interest for Training and Technical Assistance: Non-managerial Employees ........................................................................................................... 87
Introduction: The 2016 Georgia Manufacturing Survey

The Georgia Manufacturing Survey 2016 is the 10th in a series of statewide manufacturing surveys conducted since 1994. 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. Results will also be presented terms of Georgia major geographic service areas—

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

<table>
<thead>
<tr>
<th>Industry Group</th>
<th>Abbreviation</th>
<th>NAICS</th>
<th>Description</th>
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<tbody>
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<td>Supplier sectors</td>
<td>Food-Text</td>
<td>311</td>
<td>Food Manufacturing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>312</td>
<td>Beverage and tobacco product manufacturing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>313</td>
<td>Textile mills</td>
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<td>314</td>
<td>Textile product mills</td>
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<tr>
<td></td>
<td></td>
<td>315</td>
<td>Apparel manufacturing</td>
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<td></td>
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<td>Leather and allied product manufacturing</td>
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<td>Scale intensive</td>
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<td>322</td>
<td>Paper manufacturing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>323</td>
<td>Printing and related support activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>326</td>
<td>Plastics and rubber products manufacturing</td>
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<tr>
<td></td>
<td></td>
<td>327</td>
<td>Non-metallic mineral product manufacturing</td>
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<tr>
<td></td>
<td></td>
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<td>Furniture &amp; related product manufacturing</td>
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<td>Specialized suppliers</td>
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<td>Primary metal manufacturing</td>
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<td>Fabricated metal product manufacturing</td>
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<td></td>
<td>333</td>
<td>Machinery manufacturing</td>
</tr>
<tr>
<td>Specialized suppliers</td>
<td>Elec-Trans</td>
<td>336</td>
<td>Transportation equipment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>334</td>
<td>Computer and electronic product manufacturing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>335</td>
<td>Electrical equipment, appliance &amp; component manuf.</td>
</tr>
<tr>
<td>Science-based</td>
<td>Science</td>
<td>324</td>
<td>Petroleum &amp; coal products manufacturing</td>
</tr>
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<td>325</td>
<td>Chemical manufacturing</td>
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<tr>
<td></td>
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<td>3391</td>
<td>Medical equipment and supplies manufacturing</td>
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Figure 1. Georgia Regions Used in Analysis
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.


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<tbody>
<tr>
<td>Marketing and sales</td>
<td>35.3%</td>
<td>32.3%</td>
<td>36.0%</td>
<td>39.1%</td>
<td>32.9%</td>
<td>25.2%</td>
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<td>15.0%</td>
<td>3.0%</td>
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<tr>
<td>Technical skills</td>
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<td>23.8%</td>
<td>23.3%</td>
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<td>31.0%</td>
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<td>7.2%</td>
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<tr>
<td>Manufacturing process/lean</td>
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<td>2.9%</td>
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<tr>
<td>Basic skills</td>
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<td>16.4%</td>
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<td>Expansion planning, facility layout</td>
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<td>Quality assurance</td>
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<td>22.0%</td>
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<tr>
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<td>Information systems &amp; hardware</td>
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<td>11.1%</td>
<td>10.7%</td>
<td>14.3%</td>
<td>20.1%</td>
<td>27.0%</td>
<td>17.0%</td>
<td>13.0%</td>
<td>2.3%</td>
</tr>
<tr>
<td>Management and leadership</td>
<td>12.0%</td>
<td>12.9%</td>
<td>12.2%</td>
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<td>12.6%</td>
<td>15.6%</td>
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<td>33.0%</td>
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<td>Business, Finance</td>
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<td>15.8%</td>
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<td>n/a</td>
<td>n/a</td>
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<td>Environmental, safety compliance, health, workplace</td>
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<td>13.3%</td>
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<td>17.6%</td>
<td>15.0%</td>
<td>17.0%</td>
<td>29.0%</td>
<td>-1.0%</td>
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<td>21.4%</td>
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<td>19.1%</td>
<td>15.3%</td>
<td>10.0%</td>
<td>13.0%</td>
<td>16.0%</td>
<td>-2.9%</td>
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</tbody>
</table>


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.
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

<table>
<thead>
<tr>
<th>Problems/Needs</th>
<th>Food-Text</th>
<th>Materials</th>
<th>Mach</th>
<th>Elec-Trans</th>
<th>Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketing and Sales</td>
<td>27.5%</td>
<td>37.9%</td>
<td>40.1%</td>
<td>36.7%</td>
<td>27.1%</td>
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<tr>
<td>Technical Skills</td>
<td>26.5%</td>
<td>30.8%</td>
<td>42.7%</td>
<td>40.6%</td>
<td>39.6%</td>
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<td>Lean manufacturing</td>
<td>26.1%</td>
<td>30.1%</td>
<td>32.7%</td>
<td>36.7%</td>
<td>31.2%</td>
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<tr>
<td>Basic workforce skills</td>
<td>32.3%</td>
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<td>18.5%</td>
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<td>Quality Assurance</td>
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<td>11.3%</td>
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<td>Product Development</td>
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<tr>
<td>Information Systems and Hardware</td>
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<td>10.9%</td>
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<td>Management and Leadership</td>
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<td>10.0%</td>
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<td>Business strategy, financial analysis...</td>
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</tbody>
</table>

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

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

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

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

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)

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

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)

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

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.
(mean return on sales shown on y axis)

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. 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. 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.

**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.
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>
<thead>
<tr>
<th>Table 4.1. New to Market vs. New to Facility Innovations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Percentage of Establishments that Introduced the Innovations)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total</th>
<th>New to Market</th>
<th>New to Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27.6%</td>
<td>28.2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-49</td>
</tr>
<tr>
<td>50-249</td>
</tr>
<tr>
<td>250+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food-text</td>
</tr>
<tr>
<td>Material</td>
</tr>
<tr>
<td>Mach</td>
</tr>
<tr>
<td>Elec-Trans</td>
</tr>
<tr>
<td>Science</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest</td>
</tr>
<tr>
<td>Northeast</td>
</tr>
<tr>
<td>Region</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>Atlanta</td>
</tr>
<tr>
<td>West</td>
</tr>
<tr>
<td>Central</td>
</tr>
<tr>
<td>East</td>
</tr>
<tr>
<td>South</td>
</tr>
<tr>
<td>Coastal</td>
</tr>
</tbody>
</table>

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.
(Y-axis represents percentage of firms)


**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)

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

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)

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

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)

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

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
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, 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)

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

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)

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

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)

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

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.
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.

Source: Georgia Manufacturing Survey 2016, weighted responses of 526 manufacturers.
Table 4.8: Average Innovation Expenditures and Investments Per Employee
(medians and trimmed means are reported)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Mean (trimmed)*</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-house R&amp;D</td>
<td>$6,169</td>
<td>$1,745</td>
<td>$1,176</td>
</tr>
<tr>
<td>Purchased R&amp;D (from external sources)</td>
<td>$412</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>R&amp;D capital investments</td>
<td>$9,963</td>
<td>$2,826</td>
<td>$2,240</td>
</tr>
<tr>
<td>Other R&amp;D</td>
<td>$883</td>
<td>$64</td>
<td>$0</td>
</tr>
<tr>
<td>All R&amp;D Expenditures</td>
<td>$13,540</td>
<td>$5,979</td>
<td>$3,752</td>
</tr>
</tbody>
</table>

*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)

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

<table>
<thead>
<tr>
<th>R&amp;D Intensity</th>
<th>R&amp;D Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 Georgia</td>
<td>2013 US Domestic*</td>
</tr>
<tr>
<td>Total</td>
<td>3.42%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry Group</th>
<th>R&amp;D Intensity 2015 Georgia</th>
<th>R&amp;D Intensity 2013 US Domestic*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food-text</td>
<td>3.59%</td>
<td>0.70%</td>
</tr>
<tr>
<td>Material</td>
<td>3.90%</td>
<td>1.68%</td>
</tr>
<tr>
<td>Mach</td>
<td>3.47%</td>
<td>2.39%</td>
</tr>
<tr>
<td>Elec-Trans</td>
<td>3.49%</td>
<td>6.21%</td>
</tr>
<tr>
<td>Science</td>
<td>2.76%</td>
<td>3.75%</td>
</tr>
</tbody>
</table>


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.
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)

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

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)

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

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)

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

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)

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

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

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

<table>
<thead>
<tr>
<th>Customer order monitoring</th>
<th>Supplier ordering and monitoring</th>
<th>Process improvement</th>
<th>Design specifications</th>
<th>Energy management</th>
<th>Cybersecurity issues</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90.9%</td>
<td>81.6%</td>
<td>84.3%</td>
<td>56.6%</td>
<td>37.2%</td>
<td>37.9%</td>
</tr>
<tr>
<td><strong>Facility employee Size</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-49</td>
<td>89.7%</td>
<td>86.2%</td>
<td>74.9%</td>
<td>51.5%</td>
<td>21.2%</td>
</tr>
<tr>
<td>50-249</td>
<td>90.7%</td>
<td>77.5%</td>
<td>89.4%</td>
<td>55.9%</td>
<td>36.9%</td>
</tr>
<tr>
<td>250+</td>
<td>93.0%</td>
<td>81.3%</td>
<td>92.1%</td>
<td>73.6%</td>
<td>77.1%</td>
</tr>
<tr>
<td><strong>Industry group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food-text</td>
<td>96.6%</td>
<td>84.4%</td>
<td>82.4%</td>
<td>64.8%</td>
<td>40.1%</td>
</tr>
<tr>
<td>Material</td>
<td>92.3%</td>
<td>83.4%</td>
<td>81.6%</td>
<td>57.1%</td>
<td>43.3%</td>
</tr>
<tr>
<td>Mach</td>
<td>95.3%</td>
<td>87.5%</td>
<td>80.4%</td>
<td>67.9%</td>
<td>27.4%</td>
</tr>
<tr>
<td>Elec-tran</td>
<td>88.5%</td>
<td>84.6%</td>
<td>92.3%</td>
<td>68.0%</td>
<td>40.0%</td>
</tr>
<tr>
<td>Science</td>
<td>75.8%</td>
<td>63.6%</td>
<td>90.9%</td>
<td>20.7%</td>
<td>31.3%</td>
</tr>
<tr>
<td><strong>Region</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northwest</td>
<td>89.7%</td>
<td>79.6%</td>
<td>80.8%</td>
<td>53.1%</td>
<td>26.6%</td>
</tr>
<tr>
<td>Northeast</td>
<td>92.6%</td>
<td>86.6%</td>
<td>87.6%</td>
<td>68.8%</td>
<td>36.0%</td>
</tr>
<tr>
<td>Atlanta</td>
<td>89.0%</td>
<td>80.5%</td>
<td>82.6%</td>
<td>63.0%</td>
<td>32.6%</td>
</tr>
<tr>
<td>West</td>
<td>100.0%</td>
<td>92.0%</td>
<td>81.9%</td>
<td>45.0%</td>
<td>43.2%</td>
</tr>
<tr>
<td>Central</td>
<td>81.9%</td>
<td>80.3%</td>
<td>100.0%</td>
<td>41.0%</td>
<td>53.6%</td>
</tr>
<tr>
<td>East</td>
<td>100.0%</td>
<td>79.2%</td>
<td>92.7%</td>
<td>35.6%</td>
<td>45.5%</td>
</tr>
<tr>
<td>South</td>
<td>90.2%</td>
<td>80.9%</td>
<td>77.4%</td>
<td>43.6%</td>
<td>53.3%</td>
</tr>
<tr>
<td>Coastal</td>
<td>89.1%</td>
<td>69.6%</td>
<td>100.0%</td>
<td>53.7%</td>
<td>54.7%</td>
</tr>
</tbody>
</table>

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.

Table 5.7. Employment and Technology Use

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

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%
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

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

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

<table>
<thead>
<tr>
<th>Employment Size</th>
<th>2015</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>10%</td>
<td>9%</td>
</tr>
<tr>
<td>50-249</td>
<td>9%</td>
<td>8%</td>
</tr>
<tr>
<td>250+</td>
<td>11%</td>
<td>8%</td>
</tr>
<tr>
<td>Food-text</td>
<td>11%</td>
<td>10%</td>
</tr>
<tr>
<td>Material</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Mach</td>
<td>6%</td>
<td>5%</td>
</tr>
<tr>
<td>Elec-Trans</td>
<td>27%</td>
<td>19%</td>
</tr>
<tr>
<td>Science</td>
<td>10%</td>
<td>7%</td>
</tr>
<tr>
<td>NW</td>
<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>NE</td>
<td>7%</td>
<td>4%</td>
</tr>
<tr>
<td>ATL</td>
<td>12%</td>
<td>9%</td>
</tr>
<tr>
<td>West</td>
<td>19%</td>
<td>20%</td>
</tr>
<tr>
<td>Central</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>East</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>South</td>
<td>8%</td>
<td>5%</td>
</tr>
<tr>
<td>Coast</td>
<td>1%</td>
<td>3%</td>
</tr>
<tr>
<td>All</td>
<td>10%</td>
<td>9%</td>
</tr>
</tbody>
</table>

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

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

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

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

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

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

<table>
<thead>
<tr>
<th>New Skills or Education</th>
<th>Productivity Increases</th>
<th>New Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>17%</td>
<td>41%</td>
</tr>
<tr>
<td>50-249</td>
<td>22%</td>
<td>44%</td>
</tr>
<tr>
<td>250+</td>
<td>39%</td>
<td>45%</td>
</tr>
<tr>
<td>Food-text</td>
<td>20%</td>
<td>42%</td>
</tr>
<tr>
<td>Material</td>
<td>17%</td>
<td>42%</td>
</tr>
<tr>
<td>Mach</td>
<td>18%</td>
<td>44%</td>
</tr>
<tr>
<td>Elec-Trans</td>
<td>27%</td>
<td>33%</td>
</tr>
<tr>
<td>Science</td>
<td>23%</td>
<td>45%</td>
</tr>
<tr>
<td>Low price</td>
<td>13%</td>
<td>34%</td>
</tr>
<tr>
<td>High quality</td>
<td>19%</td>
<td>43%</td>
</tr>
<tr>
<td>Innovation</td>
<td>36%</td>
<td>63%</td>
</tr>
<tr>
<td>Quick delivery</td>
<td>19%</td>
<td>47%</td>
</tr>
<tr>
<td>Customization</td>
<td>24%</td>
<td>48%</td>
</tr>
<tr>
<td>Sustainability</td>
<td>41%</td>
<td>67%</td>
</tr>
<tr>
<td>All</td>
<td>20%</td>
<td>42%</td>
</tr>
</tbody>
</table>

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
Georgia manufacturers reported a 12% median sales percent increase between 2013 and 2015 (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.

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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>4</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>50-249</td>
<td>12</td>
<td>14</td>
<td>4</td>
<td>11</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>250+</td>
<td>15</td>
<td>20</td>
<td>10</td>
<td>15</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>Food-text</td>
<td>7</td>
<td>11</td>
<td>4</td>
<td>6</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Material</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Mach</td>
<td>6</td>
<td>7</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Elec-Trans</td>
<td>17</td>
<td>23</td>
<td>8</td>
<td>15</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>Science</td>
<td>14</td>
<td>16</td>
<td>3</td>
<td>12</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>NW</td>
<td>3</td>
<td>11</td>
<td>2</td>
<td>3</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>NE</td>
<td>5</td>
<td>11</td>
<td>2</td>
<td>5</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>ATL</td>
<td>8</td>
<td>11</td>
<td>6</td>
<td>7</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>West</td>
<td>14</td>
<td>14</td>
<td>9</td>
<td>12</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>Central</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td>10</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>East</td>
<td>11</td>
<td>8</td>
<td>3</td>
<td>10</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>South</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>10</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Coast</td>
<td>9</td>
<td>13</td>
<td>2</td>
<td>8</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>All companies</td>
<td>8</td>
<td>10</td>
<td>4</td>
<td>7</td>
<td>9</td>
<td>4</td>
</tr>
</tbody>
</table>

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

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

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

<table>
<thead>
<tr>
<th>Energy Intensity</th>
<th>2015</th>
<th>2013-2015 % Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>0.012</td>
<td>-5%</td>
</tr>
<tr>
<td>50-249</td>
<td>0.013</td>
<td>-6%</td>
</tr>
<tr>
<td>250+</td>
<td>0.013</td>
<td>4%</td>
</tr>
<tr>
<td>Food-text</td>
<td>0.014</td>
<td>-11%</td>
</tr>
<tr>
<td>Material</td>
<td>0.016</td>
<td>3%</td>
</tr>
<tr>
<td>Mach</td>
<td>0.011</td>
<td>1%</td>
</tr>
<tr>
<td>Elec-Trans</td>
<td>0.006</td>
<td>-9%</td>
</tr>
<tr>
<td>Science</td>
<td>0.013</td>
<td>-5%</td>
</tr>
<tr>
<td>NW</td>
<td>0.015</td>
<td>-13%</td>
</tr>
<tr>
<td>NE</td>
<td>0.012</td>
<td>-21%</td>
</tr>
<tr>
<td>ATL</td>
<td>0.011</td>
<td>3%</td>
</tr>
<tr>
<td>West</td>
<td>0.015</td>
<td>-7%</td>
</tr>
<tr>
<td>Central</td>
<td>0.014</td>
<td>6%</td>
</tr>
<tr>
<td>East</td>
<td>0.014</td>
<td>13%</td>
</tr>
<tr>
<td>South</td>
<td>0.010</td>
<td>-22%</td>
</tr>
<tr>
<td>Coast</td>
<td>0.013</td>
<td>17%</td>
</tr>
<tr>
<td>All</td>
<td>0.013</td>
<td>-5%</td>
</tr>
</tbody>
</table>

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**

![Graph showing competitive strategy comparison between all manufacturers and best performers.](image)

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

<table>
<thead>
<tr>
<th>Industry</th>
<th>Exports (% of total sales)</th>
<th>Imports (% of total costs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Best</td>
</tr>
<tr>
<td>All</td>
<td>7%</td>
<td>8%</td>
</tr>
<tr>
<td>Food-text</td>
<td>7%</td>
<td>8%</td>
</tr>
<tr>
<td>Material</td>
<td>4%</td>
<td>5%</td>
</tr>
<tr>
<td>Mach</td>
<td>6%</td>
<td>7%</td>
</tr>
<tr>
<td>Elec-Trans</td>
<td>17%</td>
<td>24%</td>
</tr>
<tr>
<td>Science</td>
<td>14%</td>
<td>14%</td>
</tr>
<tr>
<td>Total</td>
<td>8%</td>
<td>10%</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Industry</th>
<th>Outsource</th>
<th>In-source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Best</td>
</tr>
<tr>
<td>All</td>
<td>7%</td>
<td>5%</td>
</tr>
<tr>
<td>Food-text</td>
<td>7%</td>
<td>5%</td>
</tr>
<tr>
<td>Material</td>
<td>7%</td>
<td>4%</td>
</tr>
<tr>
<td>Mach</td>
<td>17%</td>
<td>18%</td>
</tr>
<tr>
<td>Elec-Trans</td>
<td>17%</td>
<td>14%</td>
</tr>
<tr>
<td>Science</td>
<td>17%</td>
<td>14%</td>
</tr>
<tr>
<td>Total</td>
<td>12%</td>
<td>12%</td>
</tr>
</tbody>
</table>

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

![Bar chart showing percentage of firms using selected information technologies.](source)

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.
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.
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

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.
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.
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

<table>
<thead>
<tr>
<th>Industry</th>
<th>New Skills or Education</th>
<th>Productivity Increases</th>
<th>New Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Best</td>
<td>All</td>
</tr>
<tr>
<td>Food-text</td>
<td>20%</td>
<td>12%</td>
<td>42%</td>
</tr>
<tr>
<td>Material</td>
<td>17%</td>
<td>17%</td>
<td>42%</td>
</tr>
<tr>
<td>Mach</td>
<td>18%</td>
<td>22%</td>
<td>44%</td>
</tr>
<tr>
<td>Elec-Trans</td>
<td>27%</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>Science</td>
<td>23%</td>
<td>24%</td>
<td>45%</td>
</tr>
<tr>
<td>All</td>
<td>20%</td>
<td>22%</td>
<td>42%</td>
</tr>
</tbody>
</table>

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.
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.
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.
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.
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.
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.
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.
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)

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

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)

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

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: Management**
(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)

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

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)

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

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)

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

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)

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

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)

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

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)

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

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)

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

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.

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9We 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 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.

---

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

### 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.\(^\text{11}\)

The response to the survey was as follows:

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

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

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\(^\text{11}\) 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. 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

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

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
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
Attn: 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
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  
☐ Textiles  
☐ Apparel, leather  
☐ Lumber and wood products, except furniture  
☐ Furniture (wood or metal)  
☐ Pulp, paper, or paper products  
☐ Printing, publishing  
☐ Chemical, petroleum, coal & allied products  
☐ Plastics or rubber  
☐ Stone, clay, glass, or concrete products  
☐ Primary metals (iron, steel, nonferrous)  
☐ Fabricated metal products  
☐ Machinery (industrial, nonindustrial)  
☐ Computer and electronic products, instruments  
☐ Electrical equipment, appliances, or components  
☐ Transportation equipment  
☐ Medical or laboratory supplies  
☐ 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 2013-2015, did your facility introduce **new or significantly improved** goods or services? (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.)

<table>
<thead>
<tr>
<th>Product Innovations</th>
<th>Service Innovations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your company by itself</td>
<td>□</td>
</tr>
<tr>
<td>Your company together with other companies, universities, research institutes, laboratories</td>
<td>□</td>
</tr>
<tr>
<td>Your company by adapting or modifying goods or services originally developed by other companies, universities, research institutes, laboratories</td>
<td>□</td>
</tr>
<tr>
<td>Other companies, universities, research institutes, laboratories</td>
<td>□</td>
</tr>
</tbody>
</table>

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** 100 %
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.)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-house R&amp;D (including personnel costs &amp; capital expenditures on buildings &amp; equipment)</td>
<td>$</td>
</tr>
<tr>
<td>Acquisition of external R&amp;D</td>
<td>$</td>
</tr>
<tr>
<td>Acquisition of machinery, equipment and software (excluding R&amp;D-related expenditures)</td>
<td>$</td>
</tr>
<tr>
<td>Other development work for innovation and all other innovation-related expenditures</td>
<td>$</td>
</tr>
<tr>
<td>Total (sum of above 4 categories)</td>
<td>$</td>
</tr>
</tbody>
</table>

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
- Ever worked with suppliers 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.

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>What were your total annual sales or gross value of shipments?</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>What was the total purchase of materials, parts, and services (i.e., cost of goods)?</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>What were your energy expenditures (e.g., heat, electricity)?</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>What was the total new capital investment, including facility, equipment, machinery, and information systems?</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>What was the percentage of sales exported outside the U.S. (by value)?</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>What was the percentage of purchases of materials, parts, and services imported or acquired from outside the U.S. (by value)?</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>What was the percentage of finished goods imported or acquired from outside the U.S. (by value)?</td>
<td>%</td>
<td>%</td>
</tr>
</tbody>
</table>

3.2. What was the average annual return on sales (pre-tax) for this facility over the last 3 years? 
\[\frac{(Gross \ Sales - Cost \ of \ Goods)}{Gross \ Sales}\] (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?
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?
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.)

<table>
<thead>
<tr>
<th>Information Technologies</th>
<th>Practiced Now</th>
<th>Plan to practice in next 2 years</th>
<th>No plan to practice</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bar code readers for data collection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer aided design</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software for scheduling, inventory control, or purchasing (e.g., ERP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RFID for inventory and warehouse tracking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply chain management system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cloud-based design and manufacturing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.)

<table>
<thead>
<tr>
<th>Quality Management and Continuous Improvement Techniques</th>
<th>Practiced Now</th>
<th>Plan to practice in next 2 years</th>
<th>No plan to practice</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 9000, TS16949 certification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 14000 environmental management certification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 50001, Energy Management System</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon footprint, greenhouse gas emissions estimate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality systems (e.g., Six Sigma)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lean manufacturing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preventive/predictive machine maintenance program</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life cycle analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.)

<table>
<thead>
<tr>
<th>Manufacturing Production Technologies</th>
<th>Practiced Now</th>
<th>Plan to practice in next 2 years</th>
<th>No plan to practice</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer-integrated manufacturing (CIM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensors, vision, other real-time monitoring technology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapid prototyping</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-D, additive, printed manufacturing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robots</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced materials (e.g., nano-materials, bio-materials, composites)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.)

<table>
<thead>
<tr>
<th>Manufacturing Areas</th>
<th>Currently practiced</th>
<th>Plan to practice in next 2 years</th>
<th>No plan to practice</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer order monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplier ordering and monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process improvement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design specifications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy management</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cybersecurity issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.1. Please, answer for the years 2013 and 2015 about your workforce using exact numbers or estimates, for this facility.

<table>
<thead>
<tr>
<th>On average, how many employees worked at this location? (Include temporary workers and convert part-time and contract labor to full-time equivalents.)</th>
<th>2015</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-Time Equivalent Employees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temporary Employees</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Of your full-time equivalent employees listed above, how many are temporary workers?</th>
<th>2015</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary Employees</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What was your total payroll? (Please include direct payroll plus indirect fringe benefit payroll expenses. Include payments to agencies for temporary workers.)</th>
<th>2015</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payroll</td>
<td>$</td>
<td>$</td>
</tr>
</tbody>
</table>

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:

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

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)

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.)
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%

Total respondents: 524

1.1a. Is your company's head office located in Georgia
- Yes: 74.0%
- No: 26.0%

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:

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

Total respondents 526

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

<table>
<thead>
<tr>
<th>Factor</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low price</td>
<td>17.8%</td>
</tr>
<tr>
<td>High quality</td>
<td>64.1%</td>
</tr>
<tr>
<td>Innovation/new technology</td>
<td>7.9%</td>
</tr>
<tr>
<td>Quick delivery</td>
<td>12.2%</td>
</tr>
<tr>
<td>Adapting product to customer needs</td>
<td>9.7%</td>
</tr>
<tr>
<td>Sustainable or green manufacturing</td>
<td>1.8%</td>
</tr>
</tbody>
</table>

Total respondents 526

1.6. Did any of the following significant changes occur?

<table>
<thead>
<tr>
<th>Change</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merger with another business</td>
<td>7.4%</td>
</tr>
<tr>
<td>Sale or closure of part of business</td>
<td>2.9%</td>
</tr>
<tr>
<td>No major change</td>
<td>74.1%</td>
</tr>
<tr>
<td>Other (e.g., reduction of employees, production, new customers)</td>
<td>13.3%</td>
</tr>
</tbody>
</table>

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%
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?

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>$48,833,492</td>
<td>$45,016,539</td>
</tr>
</tbody>
</table>
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 9 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.

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

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)

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

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

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

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

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>-25% or less</td>
<td>1.4%</td>
</tr>
<tr>
<td>-15%</td>
<td>.7%</td>
</tr>
<tr>
<td>-9%</td>
<td>.3%</td>
</tr>
<tr>
<td>-6%</td>
<td>.3%</td>
</tr>
<tr>
<td>-3%</td>
<td>3.2%</td>
</tr>
<tr>
<td>0%</td>
<td>4.8%</td>
</tr>
</tbody>
</table>
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 3.4e. 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

| No plan to practice | 5.1% |
| Plan to practice in next 2 years | 9.1% |
| Practiced now | 31.4% |

#### 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**

<table>
<thead>
<tr>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No plan to practice</td>
<td>3.2%</td>
</tr>
<tr>
<td>Plan to practice in next 2 years</td>
<td>10.5%</td>
</tr>
<tr>
<td>Practiced now</td>
<td>84.3%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>2.0%</td>
</tr>
</tbody>
</table>

**Number of respondents**

243

**Design specifications**

<table>
<thead>
<tr>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No plan to practice</td>
<td>23.4%</td>
</tr>
<tr>
<td>Plan to practice in next 2 years</td>
<td>8.0%</td>
</tr>
<tr>
<td>Practiced now</td>
<td>56.6%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>12.1%</td>
</tr>
</tbody>
</table>

**Number of respondents**

222

**Energy management**

<table>
<thead>
<tr>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No plan to practice</td>
<td>32.4%</td>
</tr>
<tr>
<td>Plan to practice in next 2 years</td>
<td>22.7%</td>
</tr>
<tr>
<td>Practiced now</td>
<td>37.2%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>7.7%</td>
</tr>
</tbody>
</table>

**Number of respondents**

220

**Cybersecurity issues**

<table>
<thead>
<tr>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No plan to practice</td>
<td>33.7%</td>
</tr>
<tr>
<td>Plan to practice in next 2 years</td>
<td>15.9%</td>
</tr>
<tr>
<td>Practiced now</td>
<td>37.9%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>12.5%</td>
</tr>
</tbody>
</table>

**Number of respondents**

215

### 5. Workforce and Training

#### 5.1a. How many employees worked at this location?

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean number of employees</td>
<td>142</td>
<td>246</td>
</tr>
<tr>
<td>Std. deviation number of employees</td>
<td>753</td>
<td>2497</td>
</tr>
<tr>
<td>10th Percentile</td>
<td>12</td>
<td>11</td>
</tr>
</tbody>
</table>
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?

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean payroll</th>
<th>Std. deviation payroll</th>
<th>10th Percentile</th>
<th>25th Percentile</th>
<th>50th Percentile</th>
<th>75th Percentile</th>
<th>90th Percentile</th>
<th>Total respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>9</td>
<td>29</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>25</td>
<td>462</td>
</tr>
<tr>
<td>2013</td>
<td>8</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>20</td>
<td>452</td>
</tr>
</tbody>
</table>

5.1c. What was total payroll?

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Payroll</th>
<th>Mean Payroll</th>
<th>Std. deviation Payroll</th>
<th>10th Percentile</th>
<th>25th Percentile</th>
<th>50th Percentile</th>
<th>75th Percentile</th>
<th>90th Percentile</th>
<th>Total respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>$7,905,640</td>
<td>$51,214,139</td>
<td>$397,195</td>
<td>$660,599</td>
<td>$1,500,000</td>
<td>$4,380,000</td>
<td>$11,306,028</td>
<td>379</td>
<td>462</td>
</tr>
<tr>
<td>2013</td>
<td>$6,801,299</td>
<td>$39,699,604</td>
<td>$320,000</td>
<td>$600,000</td>
<td>$1,400,000</td>
<td>$3,750,000</td>
<td>$10,100,000</td>
<td>369</td>
<td>452</td>
</tr>
</tbody>
</table>

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%
<table>
<thead>
<tr>
<th>Percentile</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>25th</td>
<td>5.0%</td>
</tr>
<tr>
<td>50th</td>
<td>20.0%</td>
</tr>
<tr>
<td>75th</td>
<td>75.0%</td>
</tr>
<tr>
<td>90th</td>
<td>100.0%</td>
</tr>
<tr>
<td>Total</td>
<td>468</td>
</tr>
</tbody>
</table>

Mean percentage of workers using a mobile device: 8.2%
Std. deviation: 20.1%

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th</td>
<td>0.0%</td>
</tr>
<tr>
<td>25th</td>
<td>0.0%</td>
</tr>
<tr>
<td>50th</td>
<td>0.0%</td>
</tr>
<tr>
<td>75th</td>
<td>5.0%</td>
</tr>
<tr>
<td>90th</td>
<td>20.0%</td>
</tr>
<tr>
<td>Total</td>
<td>414</td>
</tr>
</tbody>
</table>

Mean percentage of workers using the Internet: 22.0%
Std. deviation: 29.2%

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th</td>
<td>0.0%</td>
</tr>
<tr>
<td>25th</td>
<td>0.0%</td>
</tr>
<tr>
<td>50th</td>
<td>10.0%</td>
</tr>
<tr>
<td>75th</td>
<td>30.0%</td>
</tr>
<tr>
<td>90th</td>
<td>75.0%</td>
</tr>
<tr>
<td>Total</td>
<td>456</td>
</tr>
</tbody>
</table>

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

Mean number of workers graduated in high school: 101.8
Std. deviation: 469.1

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th</td>
<td>469.1</td>
</tr>
<tr>
<td>25th</td>
<td>9.0</td>
</tr>
<tr>
<td>50th</td>
<td>14.0</td>
</tr>
<tr>
<td>75th</td>
<td>26.0</td>
</tr>
<tr>
<td>90th</td>
<td>65.0</td>
</tr>
<tr>
<td>Total</td>
<td>449</td>
</tr>
</tbody>
</table>

### 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: 86.8

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th</td>
<td>1.0</td>
</tr>
<tr>
<td>25th</td>
<td>2.0</td>
</tr>
</tbody>
</table>
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
Std. deviation number of workers with 4 year college degrees
10th Percentile
25th Percentile
50th Percentile
75th Percentile
90th Percentile
Total respondents

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
Std. deviation number of workers with 4 year college degrees
10th Percentile
25th Percentile
50th Percentile
75th Percentile
90th Percentile
Total respondents

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
Std. deviation numbers of workers with science or engineering degrees
10th Percentile
25th Percentile
50th Percentile
75th Percentile
90th Percentile
Total respondents

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

Mean spending on training
Std. deviation spending on training
10th Percentile
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 non-managerial employees at this facility?

- 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