FLATE’s Future of Work Caucus 2021

View the video recording on YouTube
Caucus Project Team

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Caucus Grant:

Technician Future of Work Issues
Caucus for Florida Community Colleges and Manufacturers

GOAL: Identify technologies in Florida’s small to medium manufacturers that directly contribute to Florida’s technicians’ skills gap.

(NSF ATE #1939173)
Industry 4.0 Technologies

- Autonomous robots
- Big data and analytics
- Simulation
- Augmented reality
- Horizontal and vertical system integration
- Additive manufacturing
- The cloud
- Cybersecurity
- The industrial Internet of Things

Nine Technologies Are Transforming Industrial Production

Source: BCG analysis.
Caucus Grant Activities

- Research Industry 4.0 technologies
- Develop questionnaires
- Distribute questionnaires
- Collect and analyze results
- Share / discuss at virtual Caucus
- Disseminate
- Review input from Caucus
- Find curriculum gaps; publish results
- Implement findings
Future of Work for Technicians Questionnaire

- Company (College)
- Industry sector/college program
- County
- Name
- Number employees/number of graduates
- Future of Work Skills (select top 5 of 15 skill areas in 4 technology areas)
- Number of future technician hires and students graduating
- Level of anticipated technician hires (entry, mid, high level)
- Importance of Industry Credentials and which credentials

- Open 3+ weeks
- Responses
  - 133 manufacturers (of >2000 invitees)
  - 26 college educators (of 50 invitees)
Industry 4.0 Technologies

- Production Technician Skills

Nine Technologies Are Transforming Industrial Production

- Autonomous robots
- Big data and analytics
- Simulation
- Augmented reality
- Horizontal and vertical system integration
- Additive manufacturing
- The cloud
- Cybersecurity
- The industrial Internet of Things

Source: BCG analysis.
Summary Questionnaire Responses
Google map of Responses

- 133 Manufacturers
- 26 Colleges

Link to live map
Questionnaire Skills Questions

For Manufacturers:
In the following technologies and their related skill sets, please select the top 5 technician skills below that will be impacted by emerging technologies you plan for your company within the next 5 years.

For Educators
In the following technologies and their skill sets, please select the top 5 technician skills that you feel will be impacted by emerging technologies for your service area within the next 5 years.

Skills Data Analysis
1-minute Overview Video
Skills Data Analysis 1-minute Overview Video
Manufacturers (133)

- Autonomous Robots;
- Programming
- System Integration
- Repair
- Simulation;
- Perform Root Cause Analysis

Participate in Planning & Evaluation Processes

- Compare & Contrast Process Alternative
- Recommend new situations & their effects on process response to change
- Participate in developing existing & new products & operations

- Industrial Internet of Things;
- Ethernet Communication (M2M);
- Record and store data
- Additive/Subtractive & Advanced Materials;
- 3D CAD and printing/prototyping
- CNC programming
- Precision Manufacturing
- Fabrication
- Testing (destructive /non-destructive
Technician Future of Work Issues Caucus for Florida Community Colleges and Manufacturers

Manufacturers (133)

- Autonomous Robots; Programming System Integration Repair
- Simulation;
- Perform Root Cause Analysis
- Participate in Planning & Evaluation Processes
- Compare & Contrast Process Alternative
- Recommend new situations & their effects on process response to change
- Participate in developing existing & new products & operations
- Industrial Internet of Things;
- Ethernet Communication (M2M);
- Record and store data
- Additive/Subtractive & Advanced Materials;
- 3D CAD and printing/prototyping
- CNC programming
- Precision Manufacturing
- Fabrication
- Testing (destructive /non-destructive

(21 Colleges)

- 52% Automate
- 60% Additive/Subtractive & Advanced Materials
- 48% 3D CAD and printing/prototyping
- 48% CNC programming
- 48% Ethernet Communication (M2M);
- 40% Industrial Internet of Things;
- 36% Participate in developing existing & new products & operations
- 34% Participate in Planning & Evaluation Processes
- 33% Recommend new situations & their effects on process response to change
- 30% Perform Root Cause Analysis
- 24% Compare & Contrast Process Alternative
- 24% Participate in Planning & Evaluation Processes
- 22% Automate
- 12% 3D CAD and printing/prototyping
- 12% Additive/Subtractive & Advanced Materials;
- 15% Testing (destructive /non-destructive

20% 30% 40% 50% 60%
### Manufacturers (133)

- **Autonomous Robots; Programming**
  - **System Integration**: 34%
- **Repair**: 38%
- **Simulation**: 36%
- **Perform Root Cause Analysis**: 39%
- **Participate in Planning & Evaluation Processes**: 36%
- **Compare & Contrast Process Alternative**: 20%
- **Recommend new situations & their effects on process response to change**: 20%
- **Participate in developing existing & new products & operations**: 20%
- **Industrial Internet of Things**: 36%
- **Ethernet Communication (M2M)**: 30%
- **Record and store data**: 24%
- **Additive/Subtractive & Advanced Materials**: 30%
- **3D CAD and printing/prototyping**: 36%
- **CNC programming**: 39%
- **Precision Manufacturing**: 42%
- **Fabrication**: 48%
- **Testing (destructive /non-destructive)**: 30%

### (21 Colleges)

- **Autonomous Robots; Programming**
  - **System Integration**: 52%
- **Repair**: 24%
- **Simulation**: 40%
- **Perform Root Cause Analysis**: 40%
- **Participate in Planning & Evaluation Processes**: 24%
- **Compare & Contrast Process Alternative**: 20%
- **Recommend new situations & their effects on process response to change**: 20%
- **Participate in developing existing & new products & operations**: 12%
- **Industrial Internet of Things**: 22%
- **Ethernet Communication (M2M)**: 22%
- **Record and store data**: 12%
- **Additive/Subtractive & Advanced Materials**: 48%
- **3D CAD and printing/prototyping**: 60%
- **CNC programming**: 48%
- **Precision Manufacturing**: 48%
- **Fabrication**: 36%
- **Testing (destructive /non-destructive)**: 20%
Technician Future of Work Issues Caucus for Florida Community Colleges and Manufacturers

Manufacturers (133)

- Autonomous Robots; Programming System Integration
- Repair
- Simulation;
- Perform Root Cause Analysis
- Participate in Planning & Evaluation Processes
- Compare & Contrast Process Alternative
- Recommend new situations & their effects on process response to change
- Participate in developing existing & new products & operations
- Industrial Internet of Things;
  Ethernet Communication (M2M);
  Record and store data
- Additive/Subtractive & Advanced Materials;
  3D CAD and printing/prototyping
- CNC programming
- Precision Manufacturing
- Fabrication
- Testing (destructive /non-destructive

(21 Colleges)
Technician Future of Work Issues Caucus for Florida Community Colleges and Manufacturers

- Participate in Planning & Evaluation Processes
  - Compare & Contrast Process Alternative
  - Recommend new situations & their effects on process response to change
  - Participate in developing existing & new products & operations
- Perform Root Cause Analysis
- Manufacturers (133)
  - Autonomous Robots;
  - Programming
  - System Integration
  - Repair
  - Simulation;
- (21 Colleges)
  - 20% 
  - 30%
  - 40%
  - 50%
  - 60%
- 51%
- 36%
- 34%
- 18% difference
- 12%
- 52%
- 60%
- 39% difference
- 18% difference
- Additive/Subtractive & Advanced Materials;
- 3D CAD and printing/prototyping
- CNC programming
- Precision Manufacturing
- Fabrication
- Participate in developing existing & new products & operations
- Industrial Internet of Things;
- Ethernet Communication (M2M);
- Record and store data
- Autonomous Robots;
- Programming
- System Integration
- Repair
- Simulation;

Testing (destructive /non-destructive)
Technician Future of Work Issues Caucus for Florida Community Colleges and Manufacturers

Manufacturers (133)

- System Integration as a taught skill
  - 40% (50%)
  - 30% (40%)
  - 20% (30%)

- System Integration as a needed skill
  - 38% (40%)
  - 34% (36%)

20% 30% 40% 50%

(21 Colleges)

- System Integration as a taught skill
  - 56% (52%)

- System Integration as a needed skill
  - 51% (52%)
  - 36% (34%)

20% 30% 40% 50% 60%

- Participate in Planning & Evaluation Processes
- Compare & Contrast Process Alternative
- Recommend new situations & their effects on process response to change

- Develop existing and new products & operations as needed skill
  - 51% (39% difference)

- 3D CAD/prototyping as a needed skill
  - 36% (24% difference)

- Perform Root Cause Analysis
- Simulation;

- Participate in developing existing & new products & operations

- System Integration as a taught skill
  - 52% (56%)

- System Integration as a needed skill
  - 40% (42%)
  - 34% (36%)

- Repair
- Programming

- Autonomous Robots; Programming
- System Integration
- Repair

- Additive/Subtractive & Advanced Materials;

- 3D CAD and printing/prototyping
- CNC programming
- Precision Manufacturing
- Fabrication

- Industrial Internet of Things;
- Ethernet Communication (M2M);

- Participate in developing existing & new products & operations
- Record and store data

- Autonomous Robots; Programming
- System Integration
- Repair

- Participate in Planning & Evaluation Processes
- Compare & Contrast Process Alternative
- Recommend new situations & their effects on process response to change

- System Integration as needed skill
  - 38% (40%)
  - 34% (36%)

- 3D CAD/prototyping as needed skill
  - 36% (24% difference)

- Repair
- Programming

- Autonomous Robots; Programming
- System Integration
- Repair

- Additive/Subtractive & Advanced Materials;

- 3D CAD and printing/prototyping
- CNC programming
- Precision Manufacturing
- Fabrication

- Industrial Internet of Things;
- Ethernet Communication (M2M);
- Participate in developing existing & new products & operations
- Record and store data

- Autonomous Robots; Programming
- System Integration
- Repair

- Participate in Planning & Evaluation Processes
- Compare & Contrast Process Alternative
- Recommend new situations & their effects on process response to change

- System Integration as needed skill
  - 38% (40%)
  - 34% (36%)

- 3D CAD/prototyping as needed skill
  - 36% (24% difference)
The Technician Future of Work Issues Caucus for Florida Community Colleges and Manufacturers has identified significant industry-related skills gaps. The skills in high demand include System Integration as a taught skill, System Integration as a needed skill, and Developing existing and new products & operations as needed skill. These skills are taught at 34%, 38%, and 51% of manufacturers (133) respectively.

In contrast, skills such as Repair, Simulation, and Performance Root Cause Analysis are not being taught at all (12%). The skills that are taught are 3D CAD/prototyping, CNC programming, and Precision Manufacturing. These skills are taught at 36%, 34%, and 34% respectively.

The skills in low demand include 3D CAD and printing/prototyping, as a taught skill at 24% and as a needed skill at 20%. The skills that are being taught are Automation Systems, as a taught skill at 56% and as a needed skill at 52%.

The differences in percentage of skills taught at Florida Community Colleges and Manufacturers range from 18% to 39%.
Technician Future of Work Issues Caucus for Florida Community Colleges and Manufacturers

Manufacturers (133)

- System Integration as a taught skill
  - 34% taught
  - 38% needed
  - 18% difference

- System Integration as a needed skill
  - 51% needed
  - 56% taught
  - 5% difference

- System Integration as a taught skill
  - 52% taught
  - 56% needed
  - 4% difference

(21 Colleges)

- 3D CAD/prototyping as a needed skill
  - 36% needed
  - 60% taught
  - 24% difference

- 3D CAD/prototyping as a taught skill
  - 40% taught
  - 60% needed
  - 20% difference

- 3D CAD and printing/prototyping
- CNC programming
- Precision Manufacturing
- Fabrication
- Testing (destructive/non-destructive)

Industry related skills gap

High demand
- Develop existing and new products & operations as needed skill
  - 51% needed
  - 56% taught
  - 5% difference

Low demand
- 3D CAD/prototyping as a taught skill
  - 36% taught
  - 60% needed
  - 24% difference

A skill that basically is not being taught at all
- 12% needed
- 60% taught
- 48% difference

A skill that is taught at 12 colleges across Florida
- 51% taught
- 60% needed
- 9% difference
## Summary Skills Results

<table>
<thead>
<tr>
<th>TECHNOLOGY and SKILLS SETS</th>
<th>MANUFACTURERS</th>
<th>EDUCATORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomous Robots: Programming</td>
<td>34</td>
<td>52</td>
</tr>
<tr>
<td>Autonomous Robots: System integration</td>
<td>38</td>
<td>56</td>
</tr>
<tr>
<td>Autonomous Robots: Repair</td>
<td>15</td>
<td>24</td>
</tr>
<tr>
<td>Simulation: Perform root cause analysis</td>
<td>39</td>
<td>40</td>
</tr>
<tr>
<td>Simulation: Participate in planning and evaluation processes</td>
<td>36</td>
<td>24</td>
</tr>
<tr>
<td>Simulation: Compare &amp; contrast process alternatives</td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td>Simulation: Recommend new situations &amp; their effects on process responses</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Simulation: Participate in developing existing &amp; new products &amp; operations</td>
<td>51</td>
<td>12</td>
</tr>
<tr>
<td>Industrial Internet of Things: Ethernet Communication (M2M)</td>
<td>22</td>
<td>28</td>
</tr>
<tr>
<td>Industrial Internet of Things: Record and store data</td>
<td>36</td>
<td>60</td>
</tr>
<tr>
<td>Additive/Subtractive &amp; Advanced Materials: 3D CAD &amp; printing, prototype</td>
<td>39</td>
<td>48</td>
</tr>
<tr>
<td>Additive/Subtractive &amp; Advanced Materials: CNC programming</td>
<td>33</td>
<td>48</td>
</tr>
<tr>
<td>Additive/Subtractive &amp; Advanced Materials: Fabrication</td>
<td>42</td>
<td>36</td>
</tr>
<tr>
<td>Additive/Subtractive &amp; Advanced Materials: Destructive/non testing</td>
<td>30</td>
<td>20</td>
</tr>
</tbody>
</table>
Summary Skills Data - Questions

• Which skills were selected more often by manufacturers?
• Which skills were selected more often by educators?
• Which skills were selected <30% by both?
• Which skills were selected by both over 30%
• Which skills had big gaps of manufacturers > educators?
• Which skills had big gaps of educators over manufacturers?
## Summary Skills Results

<table>
<thead>
<tr>
<th>TECHNOLOGY AREAS and SKILLS</th>
<th>% MANUFACTURERS</th>
<th>% EDUCATORS</th>
<th>% DELTA</th>
<th>RANK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomous Robots: Programming</td>
<td>34</td>
<td>52</td>
<td>18</td>
<td>3</td>
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<tr>
<td>Autonomous Robots: System integration</td>
<td>38</td>
<td>56</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Simulation: Perform root cause analysis</td>
<td>39</td>
<td>40</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Simulation: Participate in planning and evaluation processes</td>
<td>36</td>
<td>24</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Simulation: Recommend new situations &amp; the effects on process responses</td>
<td>30</td>
<td>20</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Simulation: Participate in developing existing &amp; new products &amp; processes</td>
<td>51</td>
<td>12</td>
<td>39</td>
<td>1</td>
</tr>
<tr>
<td>Industrial Internet of Things: Record and store data</td>
<td>36</td>
<td>60</td>
<td>24</td>
<td>2</td>
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<tr>
<td>Additive/Subtractive &amp; Advanced Materials: 3D CAD &amp; printing, prototype</td>
<td>39</td>
<td>48</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Additive/Subtractive &amp; Advanced Materials: CNC programming</td>
<td>33</td>
<td>48</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Additive/Subtractive &amp; Advanced Materials: Fabrication</td>
<td>42</td>
<td>36</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>
Caucus Grant Activities

- Research Industry 4.0 technologies
- Collect and analyze results
- Find curriculum gaps; publish results
- Develop questionnaires
- Share / discuss at virtual Caucus
- Disseminate
- Distribute questionnaires
- Review input from Caucus
- Implement findings
Questions we asked for each of the skill areas selected for discussion.

1. What is the technician’s role?
2. What skills do technicians need in that role?
# Autonomous Robots: Programming and Systems Integration

<table>
<thead>
<tr>
<th>Q1 What is the technician’s role in new product/process development?</th>
<th>Q2 What skills do technicians need in that role?</th>
</tr>
</thead>
<tbody>
<tr>
<td>execution</td>
<td>How the process works today, so that the output from the robot is the same. A technician would know what the expected outcome should be</td>
</tr>
<tr>
<td>Our QT is on of our main programmers</td>
<td>continue education by attending more seminars</td>
</tr>
<tr>
<td>programming</td>
<td>basic mathematics</td>
</tr>
<tr>
<td>heavily involved in programming, systems integration, testing setup, etc.</td>
<td>programming, troubleshooting, - techs executing, problem solving, interpreting</td>
</tr>
<tr>
<td>being able to translate the &quot;current state&quot; to future state</td>
<td></td>
</tr>
<tr>
<td>safety analysis</td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1</td>
<td>support mockup/test</td>
</tr>
<tr>
<td>2</td>
<td>provide design data</td>
</tr>
<tr>
<td>3</td>
<td>testing &amp; executing</td>
</tr>
<tr>
<td>4</td>
<td>quality testing</td>
</tr>
<tr>
<td>5</td>
<td>prototyping</td>
</tr>
<tr>
<td>6</td>
<td>critical thinking</td>
</tr>
<tr>
<td>7</td>
<td>data interpretation</td>
</tr>
<tr>
<td>8</td>
<td>3D printing</td>
</tr>
<tr>
<td>9</td>
<td>material knowledge</td>
</tr>
<tr>
<td>10</td>
<td>material testing</td>
</tr>
<tr>
<td>11</td>
<td>destructive testing</td>
</tr>
<tr>
<td>12</td>
<td>ask 5 whys</td>
</tr>
<tr>
<td>13</td>
<td>fishbones</td>
</tr>
<tr>
<td>14</td>
<td>brainstorming</td>
</tr>
<tr>
<td>15</td>
<td>use the Root Cause tools</td>
</tr>
<tr>
<td>16</td>
<td>write SOP</td>
</tr>
<tr>
<td>17</td>
<td>cloud</td>
</tr>
<tr>
<td>18</td>
<td>integrating systems, PLC</td>
</tr>
<tr>
<td>19</td>
<td>data integrity</td>
</tr>
<tr>
<td>20</td>
<td>programming</td>
</tr>
<tr>
<td>21</td>
<td>troubleshooting</td>
</tr>
<tr>
<td>22</td>
<td>interdisciplinary skills</td>
</tr>
<tr>
<td>23</td>
<td>ensure measurement have uncertainty stated</td>
</tr>
<tr>
<td>24</td>
<td>basic understanding of databases &amp; networks</td>
</tr>
<tr>
<td>25</td>
<td>spreadsheet creation &amp; manipulation</td>
</tr>
<tr>
<td>26</td>
<td>CAD for layout of production processes</td>
</tr>
<tr>
<td>27</td>
<td>math, communication, teamwork, solve problem</td>
</tr>
<tr>
<td>28</td>
<td>human factors and interactions</td>
</tr>
<tr>
<td>29</td>
<td>write technical reports and data</td>
</tr>
<tr>
<td>30</td>
<td>reverse engineering</td>
</tr>
<tr>
<td>31</td>
<td>building /assembling prototypes</td>
</tr>
<tr>
<td>32</td>
<td>use technology tools to identify root causes</td>
</tr>
<tr>
<td>33</td>
<td>awareness of the security requirement</td>
</tr>
<tr>
<td>34</td>
<td>identify opportunities for improved products</td>
</tr>
<tr>
<td>35</td>
<td>knowledge of product standards and regulations</td>
</tr>
<tr>
<td>36</td>
<td>integration of eng tech/adv mfg / computing</td>
</tr>
<tr>
<td>37</td>
<td>diagnose &amp; understanding full process</td>
</tr>
</tbody>
</table>
37 Essential Technician Skills – 6 categories

<table>
<thead>
<tr>
<th>6 - CATEGORIES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpersonal skills</td>
<td>System Integration</td>
</tr>
<tr>
<td>Problem Solving - quality</td>
<td>Prototyping</td>
</tr>
<tr>
<td>Problem Solving - maintenance</td>
<td>Big data and analytics</td>
</tr>
</tbody>
</table>
2 Pathways to analyze the 37 Skills

37 Essential Skills

Alignment to FDOE Frameworks

Defining 5 Critical Crosscutting Skills
### 5 Critical Crosscutting Technician Skills – in all categories

<table>
<thead>
<tr>
<th>CATEGORIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpersonal skills</td>
</tr>
<tr>
<td>Problem Solving – quality</td>
</tr>
<tr>
<td>Problem Solving – maintenance</td>
</tr>
</tbody>
</table>

#### 5 Crosscutting Skills Found in all Categories

1. Technician involvement with engineering
2. Critical thinking
3. Integrating systems
4. Interdisciplinary skills
5. Diagnostics and understanding the full process
## Future Research

<table>
<thead>
<tr>
<th><strong>SKILLS MISSING</strong> in the FDOE Framework Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>data integrity</td>
</tr>
<tr>
<td>data interpretation</td>
</tr>
<tr>
<td>basic understanding of databases &amp; networks</td>
</tr>
<tr>
<td>cloud</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>QUESTIONABLE</strong> - assumed from standards or might need more and more clarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>data interpretation</td>
</tr>
<tr>
<td>building/ assembling prototypes</td>
</tr>
<tr>
<td>integration of engineering tech/advanced manufacturing mfg/computing</td>
</tr>
<tr>
<td>interdisciplinary skills</td>
</tr>
<tr>
<td>write technical reports and data</td>
</tr>
</tbody>
</table>
Questions we asked ourselves about the gaps

Are these skills really 2-yr graduate (entry level technician skills) or are they higher level (post 2-yr)?

• Are any of these Bachelor level skills?

• Are they for more experienced or possibly more specialized technicians - (moved up, changed focus, etc) and now are working more with data/IT?

• Other options?
Circling back to the Industry 4.0 Technologies

37 Skills

Industry 4.0

Nine Technologies Transforming Industry
NEXT: Implementing Change

EDUCATION OPTIONS
• 2-year program reviews are every 3 years (state level)
• College Credit Certificate
• Special topic electives

SPECIFIC TRAINING OPTIONS
• Interact with FloridaMakes to meet manufacturers needs
• Education equipment suppliers
• OEM training
FLATE’s Future of Work Caucus Update

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Richard Gilbert: gilbert@usf.edu

Caucus webpage: http://fl-ate.org/programs/nsf-ate-future-of-work-caucus/

Preparing Technicians for the Future of Work site: www.preparingtechnicians.org