Measuring Technology Use by U.S. Businesses

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Economic Programs Directorate
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Motivation

• There are currently few official measures of technology adoption and use by U.S. businesses that support analysis of the scale and direction of the impact of technology on businesses and the workforce.

• The Census Bureau is introducing experimental measures of technology adoption and use across several surveys.

• These measures of technology may be used to estimate the impact on economic outcomes such as employment, output, and productivity.
Overview of Talk

• Technology surveys discontinued due to budgetary cuts
  • Survey of Manufacturing Technologies (SMT)
  • Information and Communication Technology Survey (ICTS)

• New survey content about technology
  • Annual Business Survey (ABS)
  • Annual Survey of Manufactures (ASM)
  • Annual Capital Expenditures Survey (ACES)
  • Economic Census (EC)
Discontinued Technology Surveys

  • Technology use and intensity
    • Design and Engineering (CAD/CAM)
    • Fabrication/Machining & Assembly (Flexible manufacturing cells, CNC, pick and place robots, other robots)
    • Automated Materials Handling (Automated Storage and Retrieval Systems, Automated Guided Vehicles Systems)
    • Automated Sensor Based Inspection and/or Testing Equipment
    • Communications and Control (Local Area Networks, intracompany network, programmable controllers, computers used on factory floor)
  • Included motivation (improved quality, increased output, lower costs) and future plans to use
Discontinued Technology Surveys (con’t.)

• Information and Communication Technology Survey (2003-2011, 2013)
  • Capitalized and non-capitalized expenditures
    • Computer hardware and peripheral equipment (PCs, servers, printers, plotters, etc.)
    • Information and communication hardware excluding computers (switches, routers, telephony equipment, GPS, etc.)
    • Electromedical and electrotherapeutic equipment (ultrasound, MRI, etc.)
    • Computer software (COTS, costs of development for in-house (salaries and wages, etc.))
    • Included purchases, leased equipment, rental payments
Developing New Content

• Identify need for new content
  • Policymakers
  • Businesses and trade associations
  • Academic researchers

• Develop new content
  • Leverage in-house expertise as well as that of outside experts
  • Consistent, appropriate, optimal

• Pre-testing
Annual Business Survey 2017

• Partnership with National Science Foundation (NSF) National Center for Science and Engineering Statistics (NCSES)
• Surveyed ~850,000 cross-sector (nonfarm) businesses
• Technology content developed with Brynjolfsson (MIT) and McElheran (Toronto)
• Two questions to indirectly measure readiness of companies to use Artificial Intelligence:
  • Digitized data by business function
  • Cloud service purchases by IT function
• One question to directly measure use of select technologies
Annual Business Survey 2018 (proposed)

• Proposed technology module developed with Acemoglu (MIT), Restrepo (BU), and NCSES
• 2018 sample ~300,000 cross-sector (nonfarm) businesses
• Proposed module asks about the use and production of technologies
  • Artificial Intelligence
  • Specialized software excluding AI
  • Robotics
  • Specialized equipment excluding robotics
  • Cloud computing
• Module asks about motivation for and factors adversely affecting adoption
ABS 2018 (con’t.)

• Module asks about the impact of use and production of these technologies:
  • Effect on the number of workers
    • Overall
    • Production/non-production
    • Supervisory/non-supervisory
    • Scientific, technological, engineering, and mathematical workers
  • Effect on the skill mix of workers
    • Increase in skills
    • Decrease in skills
    • No change in skills
Annual Survey of Manufactures 2018

• Collaborated with Seamans (NYU), Helper (Case Western) and Brynjolfsson (MIT) to develop quantitative survey questions on robotics for manufacturing plants

• Letters of support from Robotic Industries Association (RIA) and the Manufacturing Institute/National Association of Manufacturers
  • No official statistics on robotics in the U.S.
  • RIA publishes data on producers, not consumers, of robotics
  • Interest in the impact of robotics on productivity and jobs, characteristics of U.S. firms that use robotics

• Proposed content will be submitted to OMB December 2018
ASM 2018 (con’t.)

• 2018 sample ~50,000 manufacturing establishments

• Collect robotics data as Special Inquiry
  • Capital expenditures on industrial robotic equipment in 2018
  • Number of industrial robots purchased in 2018
  • Number of industrial robots in operation in 2018

• Uses scope, definition based on those used by Robotic Industries Association (RIA) in order to compare to RIA/International Federation of Robotics (IFR) published data

• If collection is successful, may be continued as part of the Capital Expenditures breakdown in the ASM
Annual Capital Expenditures Survey 2018

• 2018 ACES will survey ~50,000 employer companies across all (nonfarm) sectors

• Robotics capital expenditures question currently undergoing development and testing

• Modeled on the ASM robotics capital expenditures question and definition

• Requires scope change
  • Industrial Robotics
  • Service Robotics

• Requires definition and/or language changes and/or additional instructions

• Benchmarking to published RIA/IFR data
Economic Census 2017

- Dedicated Self Check-out Lane
- Pre-ordering or delivery services
  - Supermarkets/convenience stores
  - Pharmacies/drug stores
  - General merchandisers
  - Hardware stores
- Self-service for ordering and payment / tablet
  - Full-service restaurants
Coordination and Experimentation

• Addition of technology questions across surveys and thus Economic Directorate allows test of new change control process
  • Measuring concepts consistently across sectors
  • Tailoring concepts and definitions appropriately to sectors
• These technology questions are experimental
  • Technology is important yet difficult to measure
  • Technology data may be of uncertain quality initially and may take multiple iterations/improvements to become official, permanent collections
  • Initial collections need to be evaluated internally and as well as by external experts and data users
Questions for the Committee

• How could we improve or expand the measures that we are currently developing?

• Would a modernized SMT or ICTS be viewed as a useful development, and what would you suggest these surveys cover?

• Are there alternative approaches that you would recommend that we take to measure technology adoption and use by U.S. companies?
Backup slides
**DIGITAL SHARE OF BUSINESS ACTIVITY**

In 2017, how much of each type of information was kept in digital format at this business?  
*Select one for each row.*

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Up to 50%</th>
<th>More than 50%</th>
<th>All</th>
<th>Don’t know</th>
<th>This type of information not collected by this business</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Personnel</td>
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<tr>
<td>B. Financial</td>
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<tr>
<td>C. Customer Feedback</td>
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<tr>
<td>D. Marketing</td>
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<tr>
<td>E. Supply Chain</td>
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<tr>
<td>F. Production</td>
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<tr>
<td>G. Other: (specify)</td>
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</tbody>
</table>
## CLOUD SERVICE PURCHASES

Considering the amount spent on each of these IT functions, how much was spent on cloud services? (Cloud services are services provided by a third party that this business accesses on-demand via the internet.) **Select one for each row.**

<table>
<thead>
<tr>
<th>None</th>
<th>Up to 50%</th>
<th>More than 50%</th>
<th>All</th>
<th>Don't Know</th>
<th>Don’t use this IT function</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. All IT functions</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>B. Security or firewall</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>C. Servers</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>D. Data storage and management (Examples: Amazon Web Services, IBM Bluemix, Microsoft Azure)</td>
<td>☐</td>
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<tr>
<td>E. Collaboration and file synchronization (Examples: Dropbox, OneDrive, Google Drive)</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>F. Data Analysis</td>
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<tr>
<td>G. Billing and account management</td>
<td>☐</td>
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<td>H. Customer relationship management</td>
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<tr>
<td>I. Other: (specify)</td>
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</tr>
</tbody>
</table>
### BUSINESS TECHNOLOGIES

In 2017, to what extent did this business use the following technologies in producing goods or services? Select one for each row.

<table>
<thead>
<tr>
<th>No use</th>
<th>Testing, but not using in production or service</th>
<th>In use for less than 5% of production or service</th>
<th>In use for between 5% - 25% of production or service</th>
<th>In use for more than 25% of production or service</th>
<th>Don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Augmented reality</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>B. Automated guided vehicles (AGV) or AGV systems</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>C. Automated storage and retrieval systems</td>
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<tr>
<td>D. Machine learning</td>
<td>☐</td>
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<tr>
<td>E. Machine vision software</td>
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<tr>
<td>F. Natural language processing</td>
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<tr>
<td>G. Radio-frequency identification (RFID) inventory system</td>
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<tr>
<td>H. Robotics</td>
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<tr>
<td>I. Touchscreens/Kiosks for customer interface (Examples: self-checkout, self-</td>
<td>☐</td>
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<tr>
<td></td>
<td>check-in, touchscreen ordering)</td>
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<td></td>
<td></td>
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<tr>
<td>J. Voice recognition software</td>
<td>☐</td>
<td>☐</td>
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</tbody>
</table>
INDUSTRIAL ROBOTIC EQUIPMENT

Industrial robotic equipment (or industrial robots) are automatically controlled, reprogrammable, and multipurpose machines used in industrial automated operations.

Industrial robots may be mobile, incorporated into stand-alone stations, or integrated into a production line.

An industrial robot may be part of a robotic cell (or work cell) or incorporated into another piece of equipment.

Industrial robots are commonly used in operations such as welding, material handling, machine tending, dispensing, cleanroom, and pick and place.
## CAPITAL EXPENDITURES FOR INDUSTRIAL ROBOTIC EQUIPMENT AND NUMBER OF INDUSTRIAL ROBOTS

In [1], report capital expenditures in 2018 for new and used industrial robotic equipment for this plant. Include other one-time costs, including software and installation.

In [2] and [3], report the number of industrial robots in operation at this plant and purchased for this plant in 2018.

For robots purchased as part of a work cell or other integrated robotic equipment, it may not be possible to report the expenditures on only the robots. In this case, report the expenditures on the integrated robotic equipment.

Examples of operations industrial robotic equipment can perform may include:

- Palletizing
- Pick and place
- Machine tending
- Material handling
- Dispensing
- Welding
- Packing/repacking

Excludes:

- Automated guided vehicles (AGVs)
- Driverless forklifts
- Automatic storage and retrieval systems
- CNC machining equipment

Report capital expenditures in thousands of dollars. Estimates are acceptable.

### CAPITAL EXPENDITURES FOR INDUSTRIAL ROBOTIC EQUIPMENT AND NUMBER OF INDUSTRIAL ROBOTS

<table>
<thead>
<tr>
<th></th>
<th>Check if none</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Capital expenditures in 2018 for new and used industrial robotic equipment, including software, installation, and other one-time costs</strong></td>
<td>☐</td>
<td></td>
</tr>
</tbody>
</table>

Report the number of robots. Estimates are acceptable.

### NUMBER OF INDUSTRIAL ROBOTS

<table>
<thead>
<tr>
<th></th>
<th>Check if none</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. Number of industrial robots IN OPERATION at this plant in 2018</strong></td>
<td>☐</td>
<td></td>
</tr>
</tbody>
</table>

If you are unable to provide the number of industrial robots IN OPERATION in 2018, please explain.

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### NUMBER OF INDUSTRIAL ROBOTS PURCHASED

<table>
<thead>
<tr>
<th></th>
<th>Check if none</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3. Number of industrial robots PURCHASED for this plant in 2018</strong></td>
<td>☐</td>
<td></td>
</tr>
</tbody>
</table>

If you are unable to provide the number of industrial robots PURCHASED in 2018, please explain.

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**U.S. Department of Commerce**  
**Economics and Statistics Administration**  
**U.S. CENSUS BUREAU**  
census.gov
ACES 2018 Proposed Content

<table>
<thead>
<tr>
<th>Check if none</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report capital expenditures in 2017 for new and used robotic equipment, including software, installation, and other one-time costs.</td>
<td>□</td>
</tr>
<tr>
<td></td>
<td>Bil</td>
</tr>
</tbody>
</table>

United States Census Bureau
U.S. Department of Commerce
Economics and Statistics Administration
U.S. CENSUS BUREAU
census.gov