

# Measuring Technology Use by U.S. Businesses

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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

- Survey of Manufacturing Technologies (1989, 1991, 1993)
  - 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

# ABS 2017 Content

## 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.*

	None	Up to 50%	More than 50%	All	Don't know	This type of information not collected by this business
A. Personnel	<input type="checkbox"/>					
B. Financial	<input type="checkbox"/>					
C. Customer Feedback	<input type="checkbox"/>					
D. Marketing	<input type="checkbox"/>					
E. Supply Chain	<input type="checkbox"/>					
F. Production	<input type="checkbox"/>					
G. Other: (specify)	<input type="checkbox"/>					

# ABS 2017 Content

## 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.**

	None	Up to 50%	More than 50%	All	Don't Know	Don't use this IT function						
A. All IT functions	<input type="checkbox"/>											
B. Security or firewall	<input type="checkbox"/>											
C. Servers	<input type="checkbox"/>											
D. Data storage and management (Examples: Amazon Web Services, IBM Bluemix, Microsoft Azure)	<input type="checkbox"/>											
E. Collaboration and file synchronization (Examples: Dropbox, OneDrive, Google Drive)	<input type="checkbox"/>											
F. Data Analysis	<input type="checkbox"/>											
G. Billing and account management	<input type="checkbox"/>											
H. Customer relationship management	<input type="checkbox"/>											
I. Other: (specify) _____	<input type="checkbox"/>											

# ABS 2017 Content

## BUSINESS TECHNOLOGIES

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

	No use	Testing, but not using in production or service	In use for less than 5% of production or service	In use for between 5% – 25% of production or service	In use for more than 25% of production or service	Don't know
A. Augmented reality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
B. Automated guided vehicles (AGV) or AGV systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C. Automated storage and retrieval systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
D. Machine learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
E. Machine vision software	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
F. Natural language processing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
G. Radio-frequency identification (RFID) inventory system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H. Robotics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I. Touchscreens/kiosks for customer interface (Examples: self-checkout, self-	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
J. Voice recognition software	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

check-in, touchscreen ordering)

# ASM 2018 Proposed Content

## **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.

# ASM 2018 Proposed Content

## 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

Exclude:

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

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

	Check if none	2018
1. Capital expenditures in 2018 for new and used industrial robotic equipment, including software, installation, and other one-time costs	<input type="checkbox"/>	

Report the number of robots. Estimates are acceptable.

	Check if none	2018
2. Number of industrial robots IN OPERATION at this plant in 2018	<input type="checkbox"/>	

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

	Check if none	2018
3. Number of industrial robots PURCHASED for this plant in 2018	<input type="checkbox"/>	

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

# ACES 2018 Proposed Content

	Check if none	2017		
	<input type="checkbox"/>	<u>Bil</u>	Mil	<u>Thous</u>
Report capital expenditures in 2017 for new and used robotic equipment, including software, installation, and other one-time costs.	<input type="checkbox"/>			