



**U.S. DEPARTMENT OF COMMERCE
BUREAU OF INDUSTRY AND SECURITY
OFFICE OF TECHNOLOGY EVALUATION (OTE)**

**ASSESSMENT OF THE U.S. INTEGRATED
CIRCUIT DESIGN AND MANUFACTURING INDUSTRY**
DATA FROM 2013-2016

Overview



2017 Assessment Overview

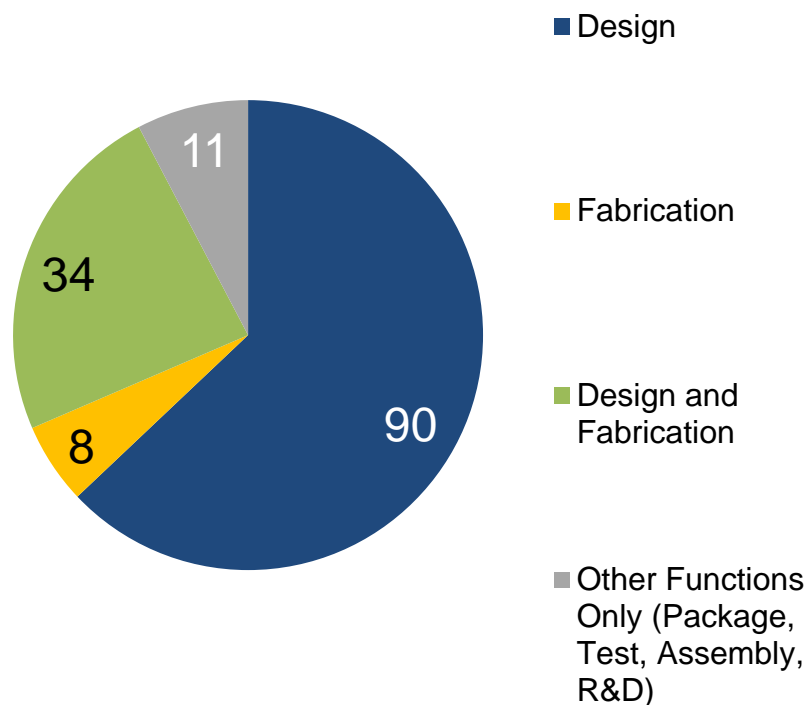
- In 2017, BIS conducted a survey and assessment of the health and competitiveness of the U.S. integrated circuit design and fabrication industry
- The assessment was completed by 143 organizations operating 401 facilities in the United States that engaged in the design or manufacture of integrated circuits between 2013 and 2016
- Data from the assessment has informed Department of Commerce policy. Select portions of the data have also been shared with the Department of Defense, and BIS has briefed select results to stakeholders across results the U.S. Government.



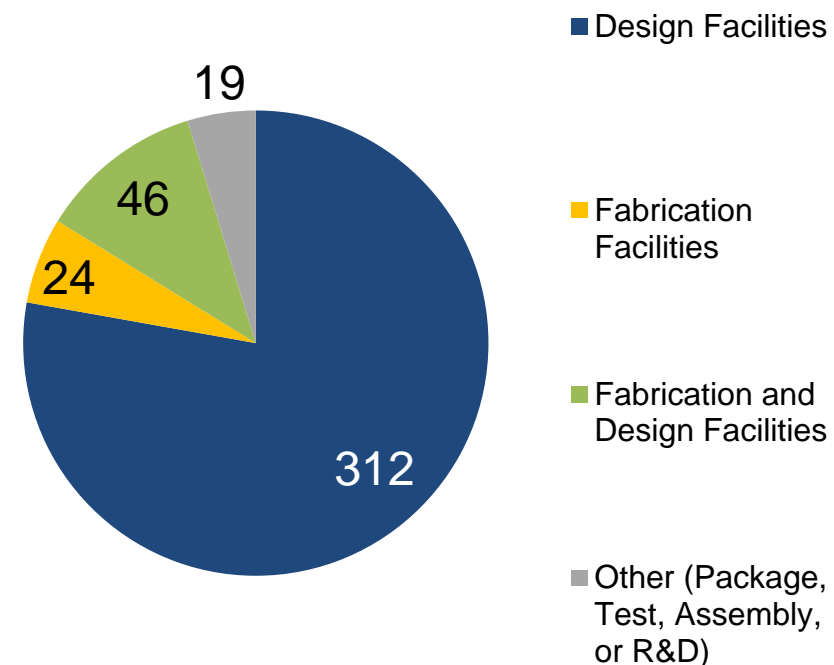
U.S. IC Design and Manufacturing Assessment Profile by Companies and Facilities

42 Organizations with fabrication capabilities at 70 facilities

Organizations - 143

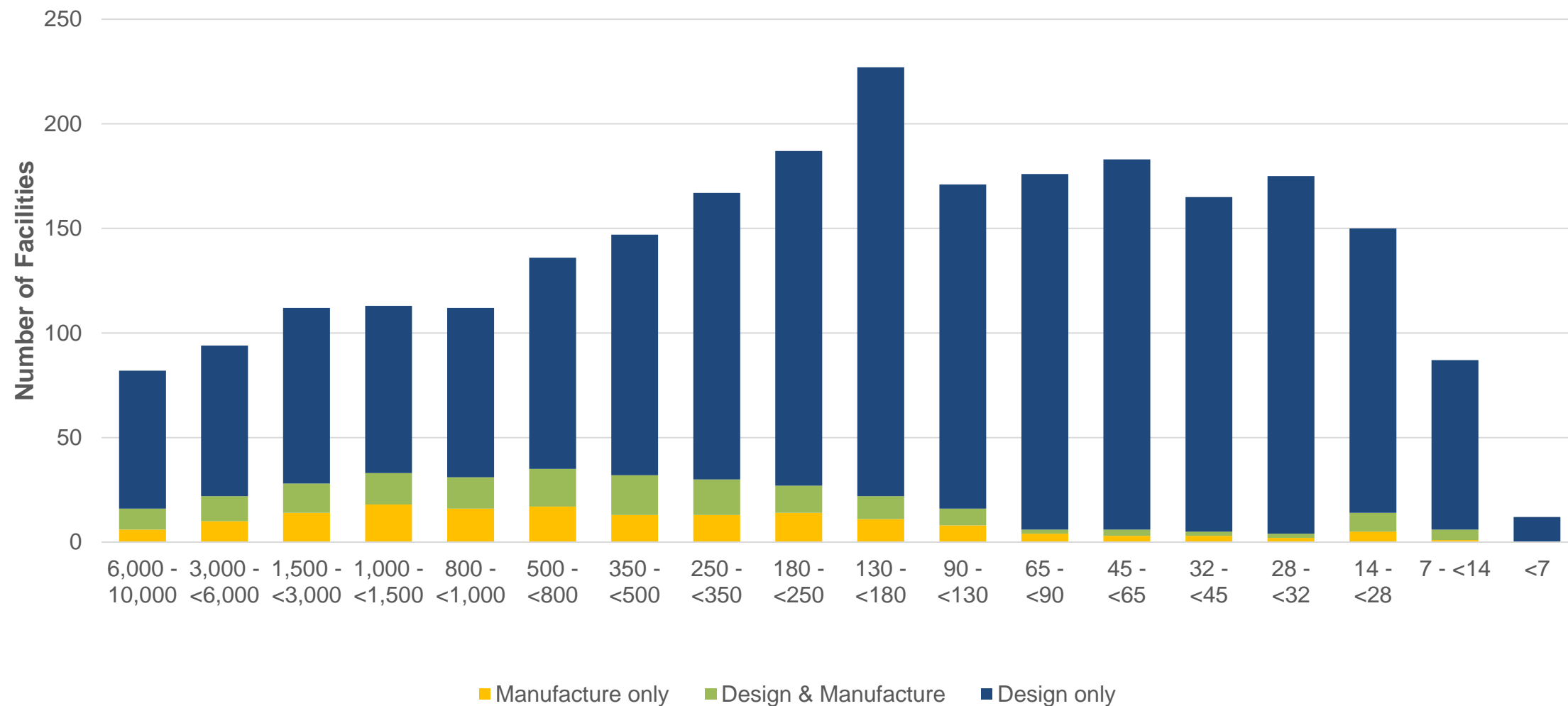


Facilities - 401





Design & Manufacturing Capabilities by Facility: Technology Node





U.S. Manufacturing Capabilities by Node and Material

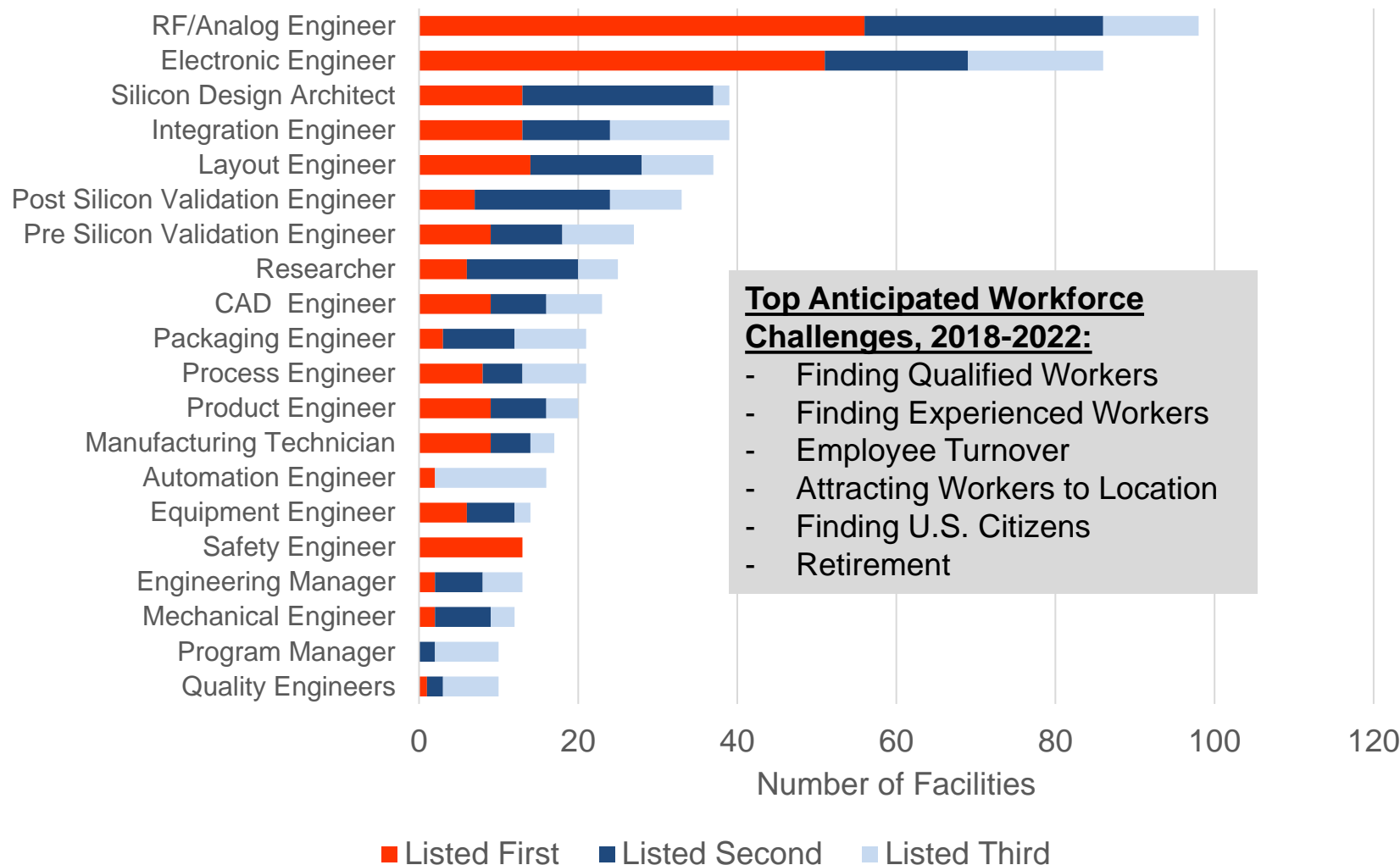
Approximate weekly wafer start capacity, in 8-inch wafer equivalents

Node	Antimonides	Carbon Based Technologies	Gallium Arsenide	Gallium Nitride	Indium Phosphide	Organic Technologies	Silicon - Amorphous	Silicon - Bulk	Silicon Carbide	Silicon Germanium	Silicon on Insulator	Silicon on Sapphire	Superconducting Materials
6,000 - 10,000			*	*		*	*	30,000			4,000		*
3,000 - <6,000			*	*		*	*	45,000			4,000		*
1,500 - <3,000	*		4,500	*	*	*	*	55,000		*	4,500		*
1,000 - <1,500	*		5,500	*	*	*	*	55,000			5,000		*
800 - <1,000	*		*	*	*		*	55,000			5,500	*	*
500 - <800	*		*	*	<500			45,000	*	*	11,000		*
350 - <500	*	*	1,500	<500	*			50,000	*	8,000	10,000		*
250 - <350			3,000	<500	*			60,000	*	*	*		*
180 - <250			1,500	<500				45,000		*	16,000		*
130 - <180			*	<500	*		*	20,000		*	9,000		*
90 - <130		*	500	<500	*		*	20,000		*	*		
65 - <90							*	*					
45 - <65								*			*		
32 - <45				*				*			*		
28 - <32				*				*					
14 - <28				*	*			100,000					
7 - <14								*					
<7													

* Areas with 3 or fewer respondents have been obscured to protect business proprietary information. Data rounded for additional protection



Occupations Facilities Have The Most Difficulty Hiring



Top Anticipated Workforce

Challenges, 2018-2022:

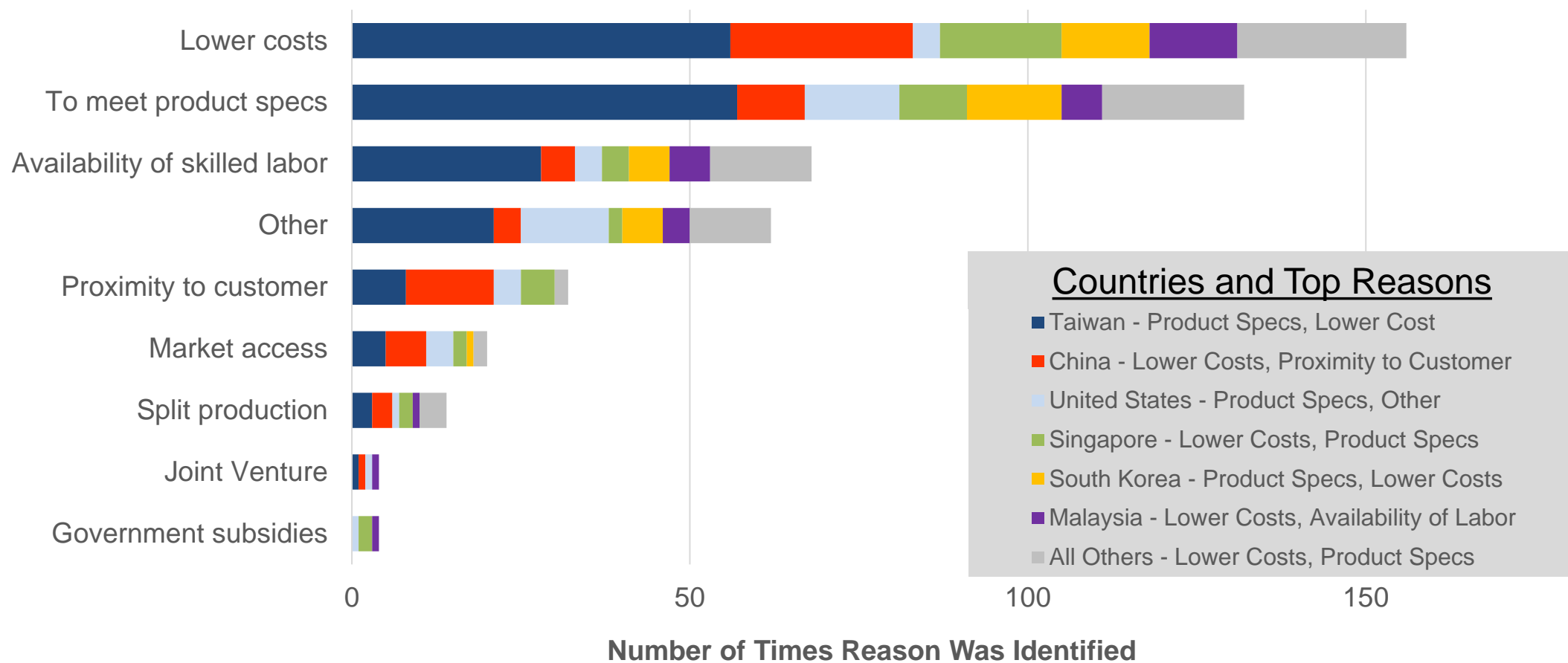
- Finding Qualified Workers
- Finding Experienced Workers
- Employee Turnover
- Attracting Workers to Location
- Finding U.S. Citizens
- Retirement

Average Age and Retirement Expectations:

- Average Employee Age: **45**
- Average Percent of Employees Expected to Retire between 2017 and 2022: **9%**
- Facilities with higher percentages of non-U.S. citizen workers – above the median level of 13% – had a marginally lower average employee age (**43.5 v. 46.5**) and a lower expected retirement rate (**6% v. 12%**)



Reasons Organizations Outsourced Integrated Circuit Manufacturing



Expected Change in U.S. Design/Manufacturing Capabilities, 2018-2022

Organizations indicating an expected increase in function as a percentage of those with capability in 2017

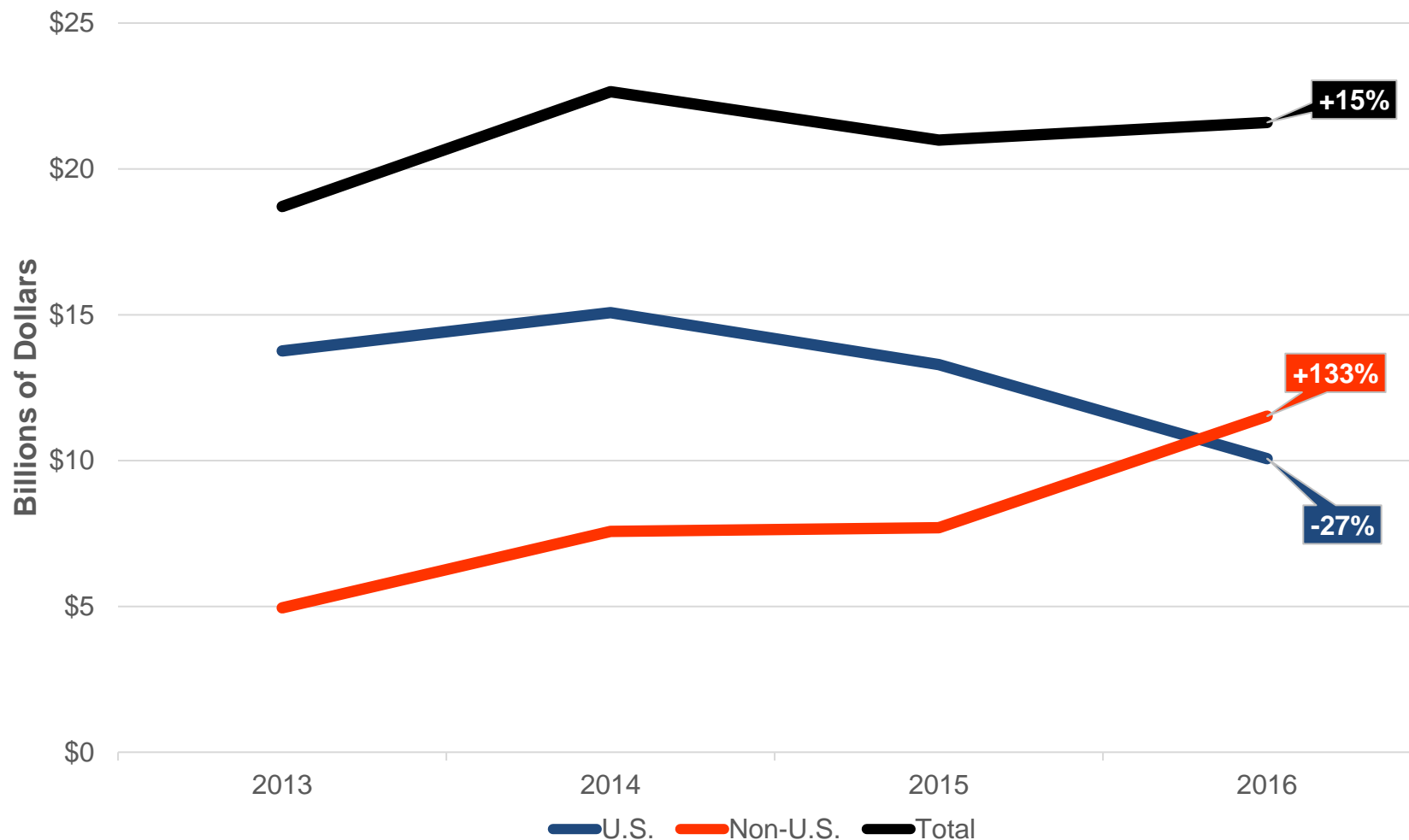
Design	
3-D Nonvolatile Memory	88%
DRAM - DDR4	64%
3D/2.5 ASICs	61%
Optical/Photonic Technologies	55%
DRAM - DDR3	53%
MMIC Technologies	52%
MEMS Technologies	46%
System-on-Chip	43%
Anti-Tamper Technology	43%
Field Programmable Gate Arrays	41%
Other RF Technologies	40%
Mixed Signal Technologies	39%
Nonvolatile Memory	39%
Digital Logic Technologies	38%
Analog/Linear Technologies	38%
Digital Signal Processors	37%
Other Processors	37%
Custom ASICs	32%
SRAM	31%
IR-Focal Plane Arrays	31%
Standard Cell ASICs (a.k.a. cell-based ASICs)	27%
Structured ASICs (a.k.a. Structured Arrays; Platform ASICs)	26%
Display Electronics	21%
One-time, Electrically Programmable Gate Arrays	14%
Mask Programmable Gate Arrays	13%

Manufacture	
DRAM - DDR4	*
DRAM - DDR3	*
3-D Nonvolatile Memory	150%
3D/2.5 ASICs	100%
MMIC Technologies	80%
Display Electronics	80%
Anti-Tamper Technology	67%
Other RF Technologies	61%
One-time, Electrically Programmable Gate Arrays	60%
Field Programmable Gate Arrays	57%
System-on-Chip	54%
Optical/Photonic Technologies	50%
IR-Focal Plane Arrays	50%
Mixed Signal Technologies	46%
Analog/Linear Technologies	43%
SRAM	38%
Mask Programmable Gate Arrays	38%
Digital Logic Technologies	37%
Other Processors	36%
Digital Signal Processors	35%
Nonvolatile Memory	33%
MEMS Technologies	32%
Custom ASICs	30%
Standard Cell ASICs (a.k.a. cell-based ASICs)	25%
Structured ASICs (a.k.a. Structured Arrays; Platform ASICs)	15%

* Insufficient 2017 capability to report



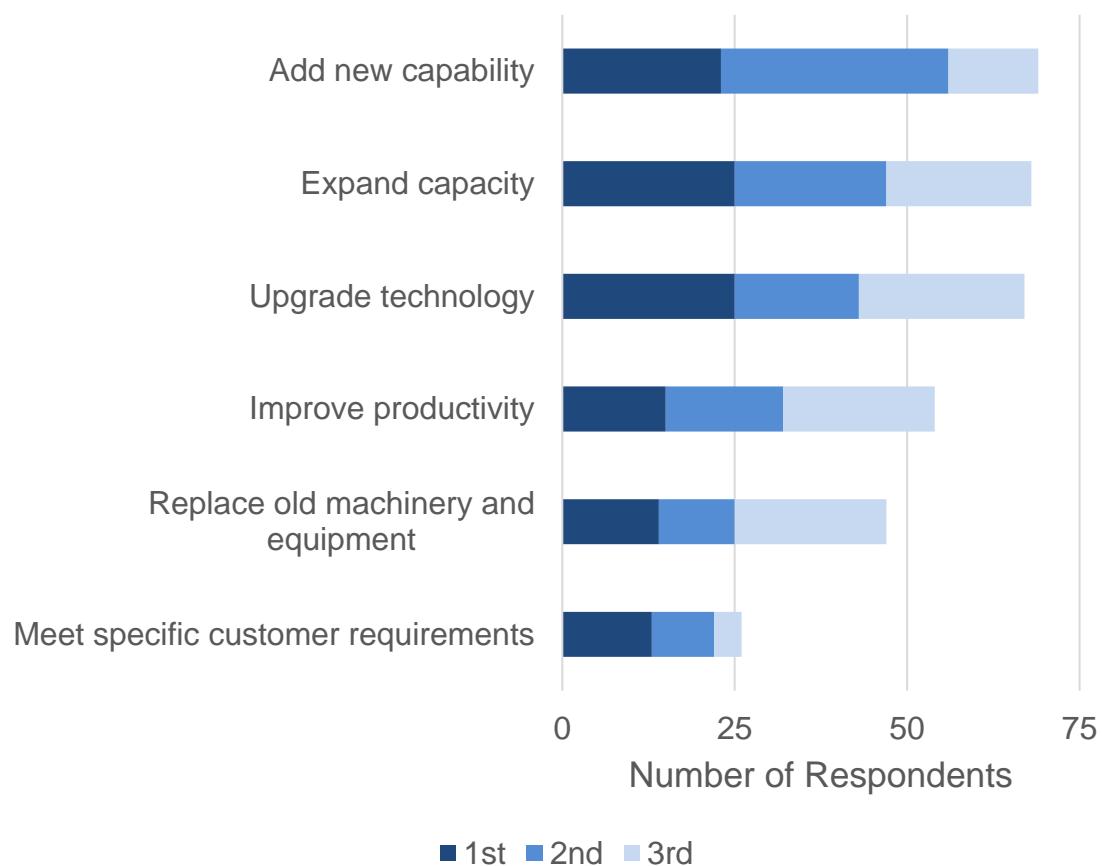
Integrated Circuit-Related Capital Expenditures



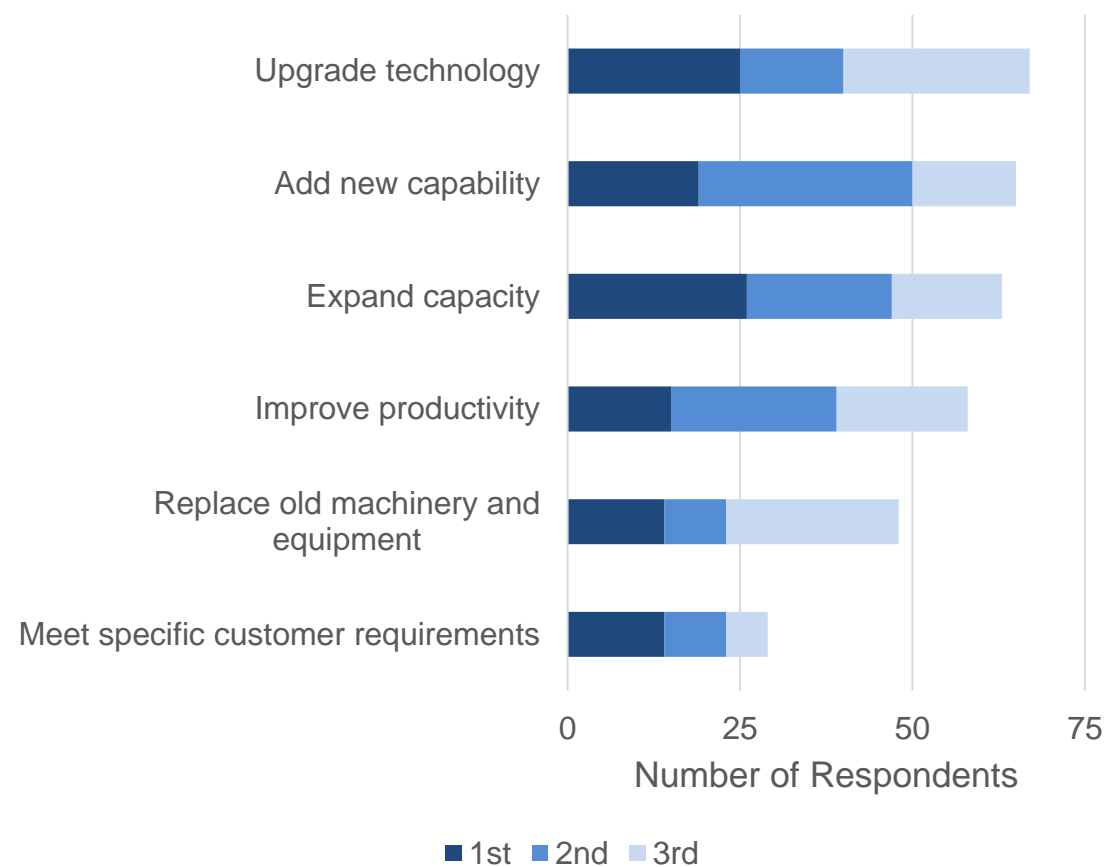


Capital Expenditure Priorities

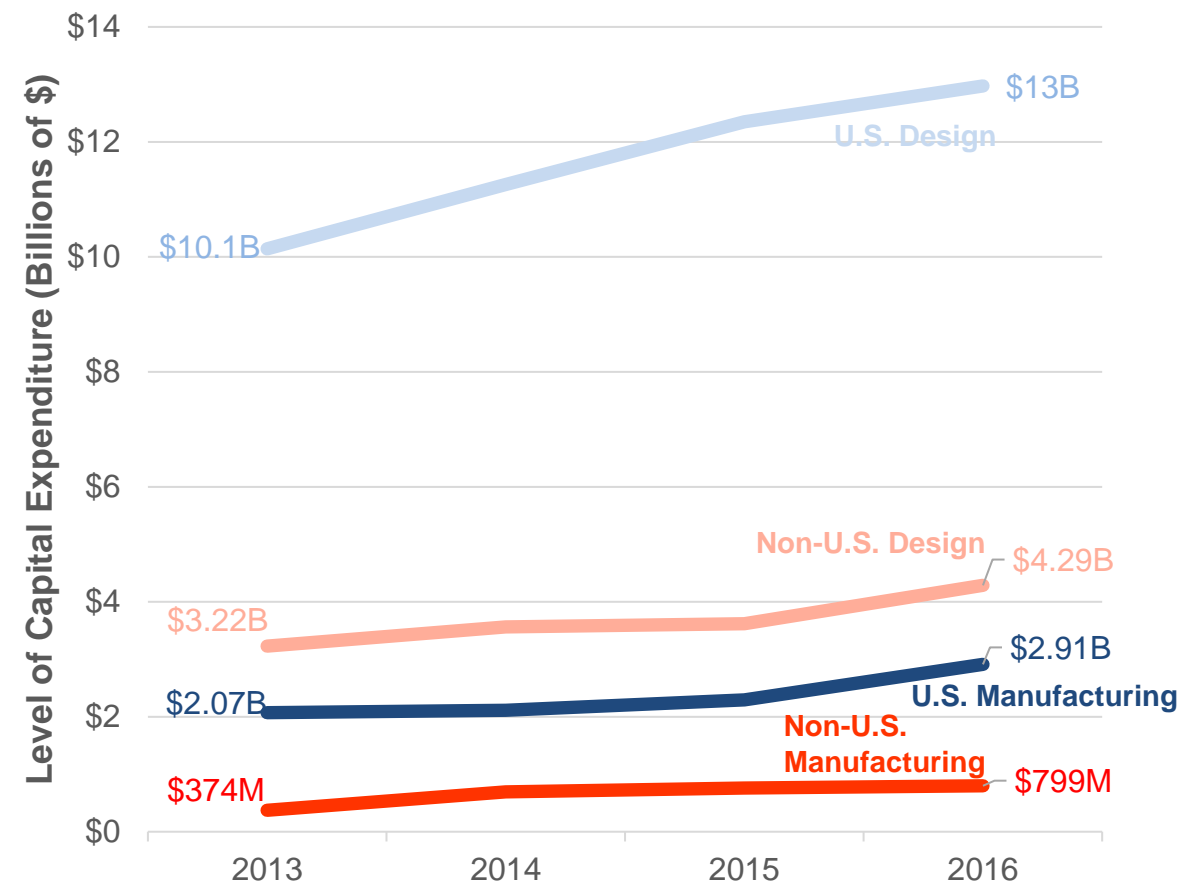
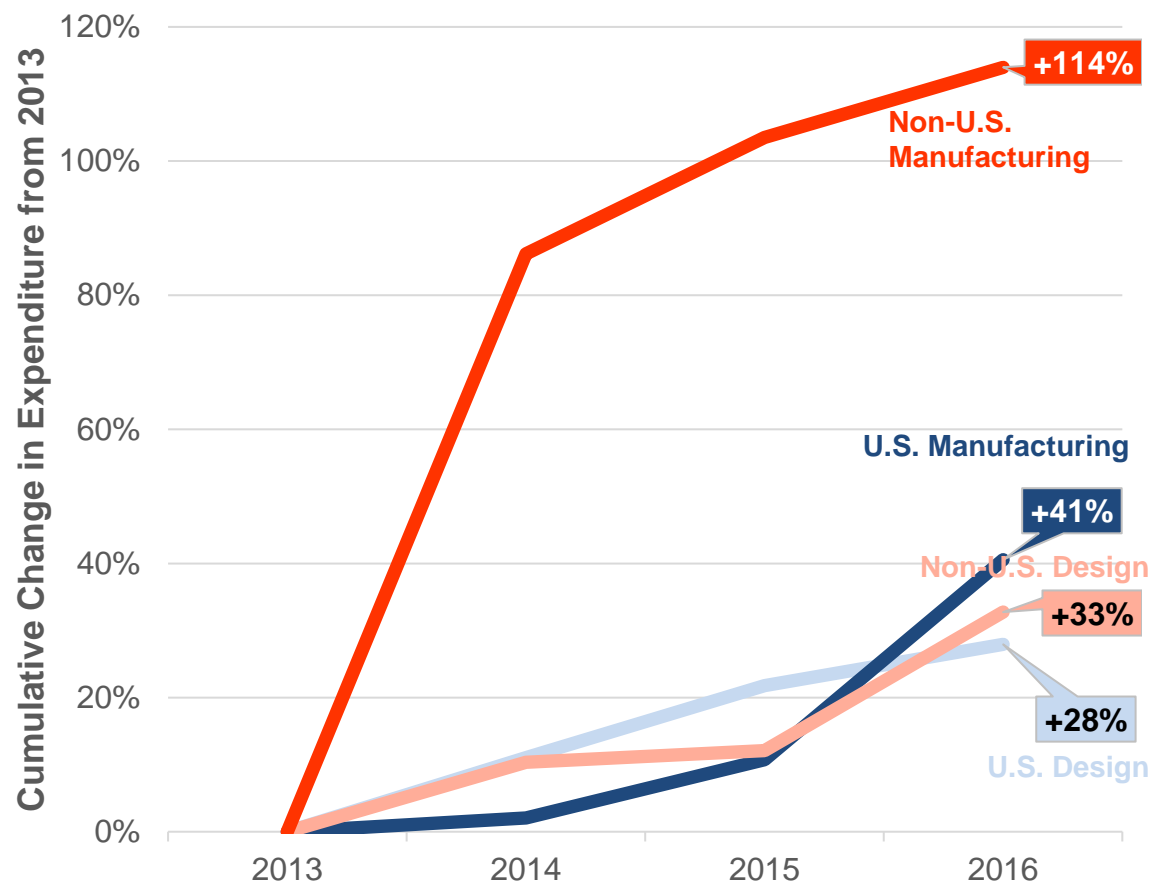
Priorities, 2013-2016



Expected Priorities, 2017-2022



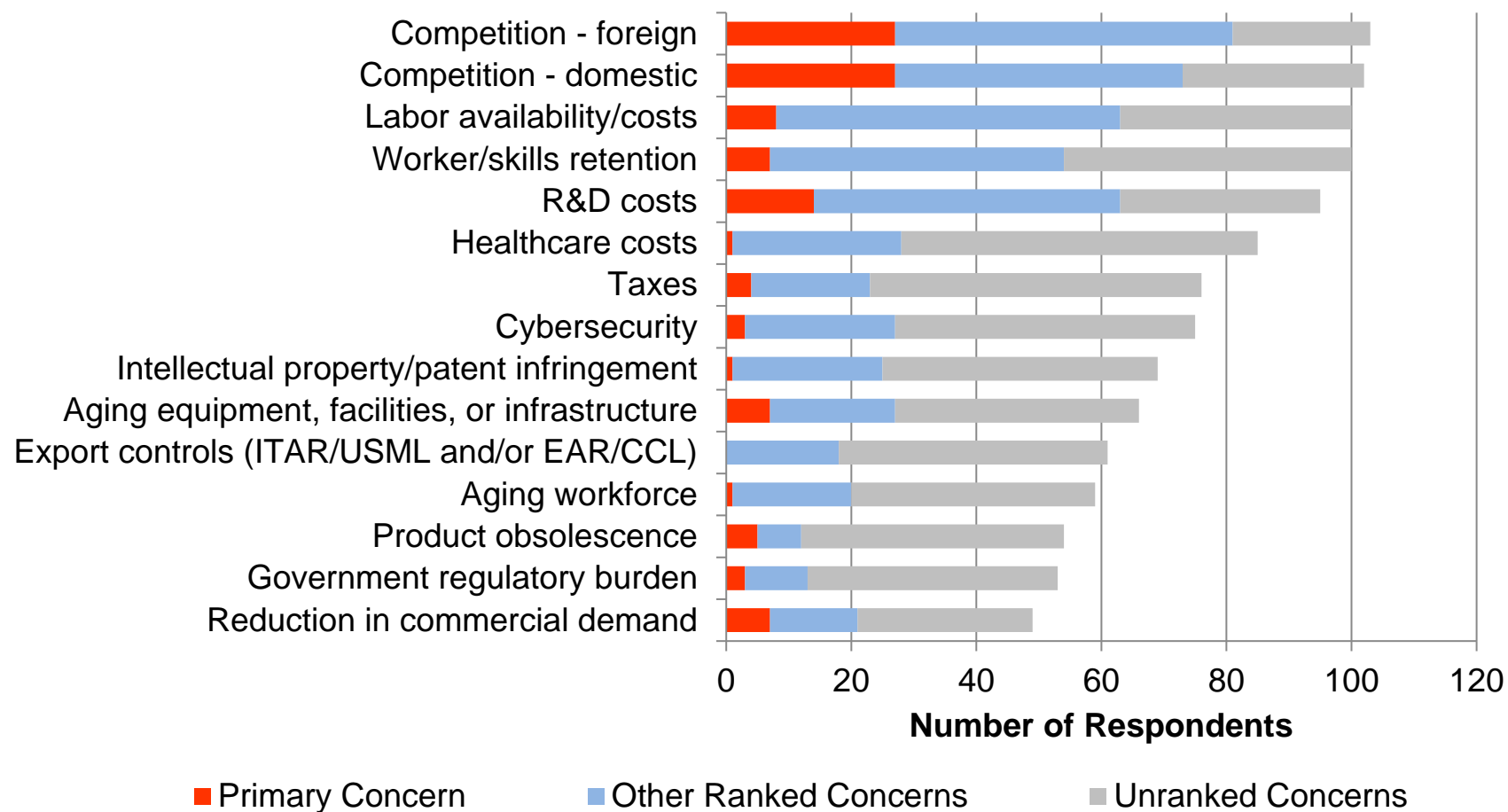
Integrated Circuit-Related R&D Expenditures: Change in Expenditure by Research Location





Top Expected Organizational Challenges – 2018-2022

Respondents identified all challenges to operations from a list of 30 and ranked their top five challenges

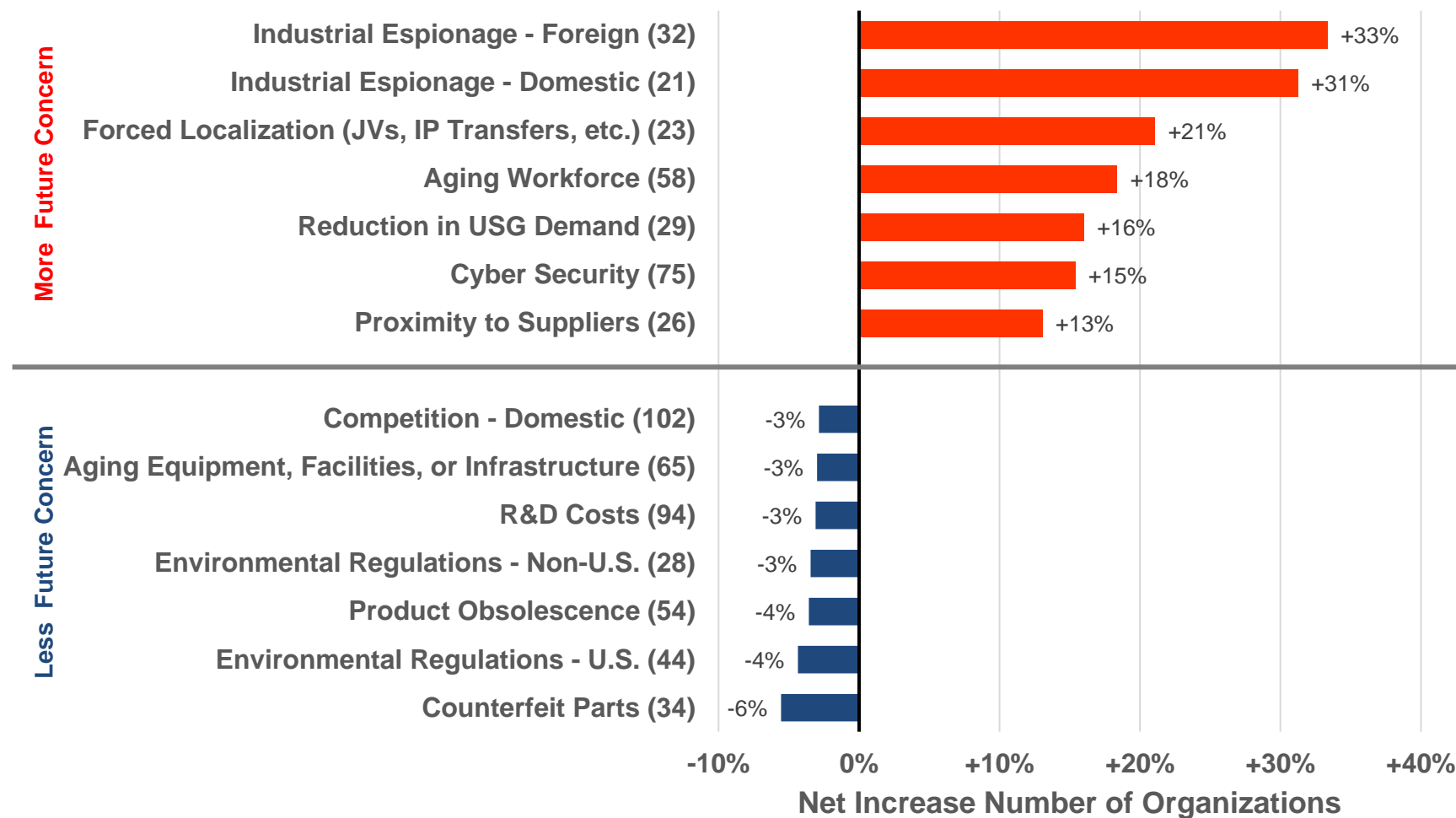




Largest Expected Change in Business Challenges

Percentage difference between expected challenges (2018-2022) and past challenges (2013-2017)

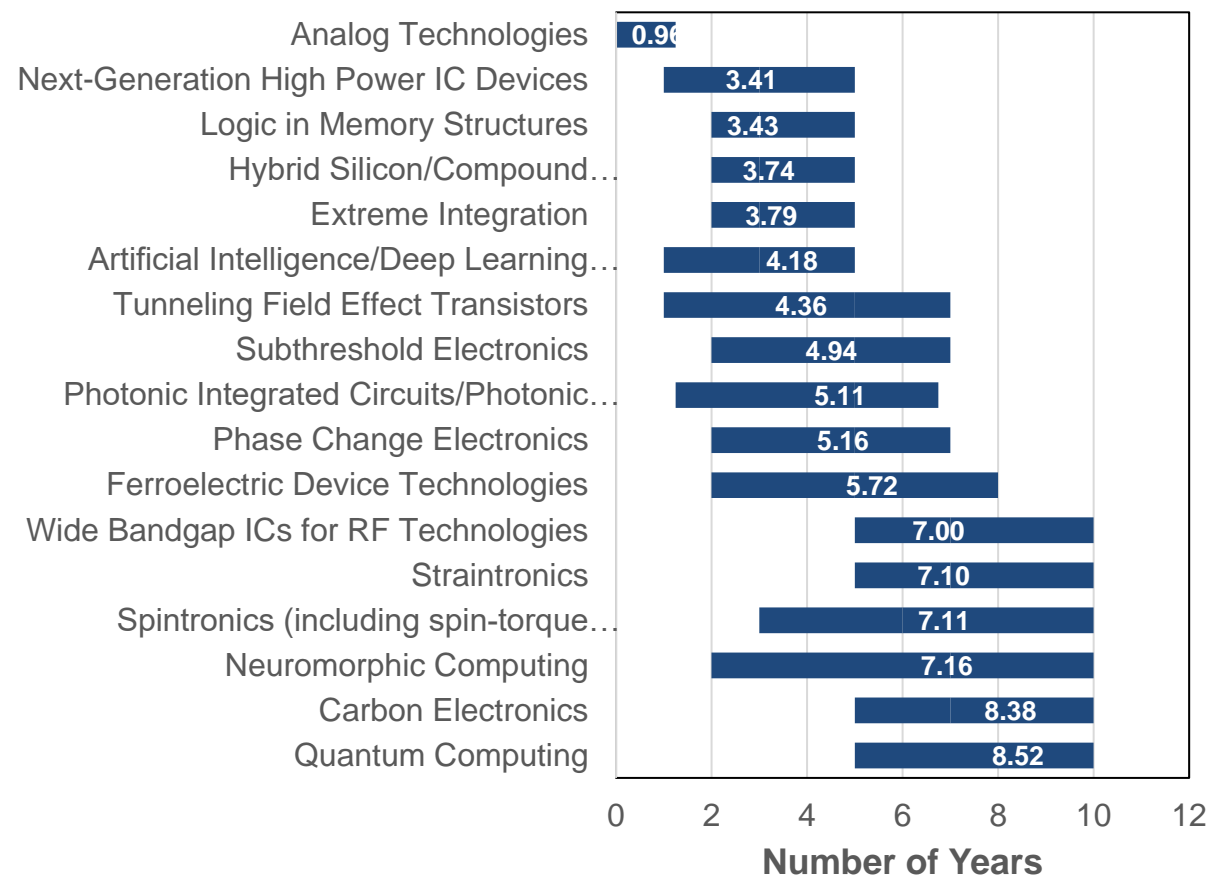
Number of organizations identifying future challenge in parentheses



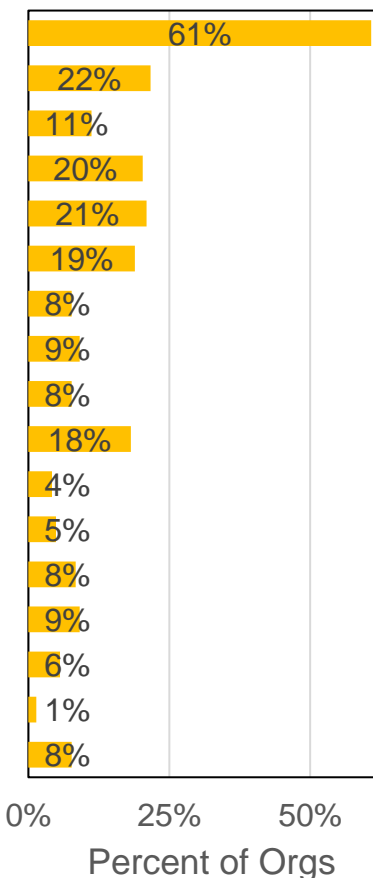


Advanced Integrated Circuit Technologies: Expected Years to Market Readiness

Average and Interquartile Range of Expected Years for Each Technology to be Market



Percent Performing R&D





Key Results

Capabilities

- The United States maintained a robust integrated circuit design ecosystem across all materials and technology nodes, but manufacturing capabilities were significantly more limited, particularly in the 28 to 90 nanometer range
- Respondents outsourced manufacturing primarily for cost and product specification reasons
 - Respondents outsourced fabrication to locations in Taiwan primarily to meet product specifications, as well as for lower costs, while foundries in China were most noted for lower costs and proximity to customers

Workforce

- Organizations expected to have significant problems finding qualified and experienced workers, with Analog and Electronic Engineers being particularly noted
- Respondents using higher rates of non-U.S. citizen labor had somewhat lower average employee ages and significantly lower 5-year expected retirement rates



Key Results

Investments and Expenditures

- Capital expenditures by U.S. companies outside the U.S. trended significantly higher and exceeded those inside the U.S. for the first time
- Similar trends were apparent in R&D, with non-U.S. expenditures growing significantly faster than U.S. expenditures, though still at lower absolute levels

Challenges

- Foreign and domestic competition were nearly equally reported as the top expected challenges, followed closely by workforce-related challenges of labor availability and worker retention.
- Respondents indicated increasing concerns surrounding industrial espionage and forced localization

Innovation

- Device types with the highest rates of increased expected participation included 3D technologies for memory and ASICs, as well as MMIC Technologies
- Respondents were more focused on carrying out R&D in technologies perceived to be nearer to market readiness, with few respondents performing R&D on areas seen as more than 5 years away