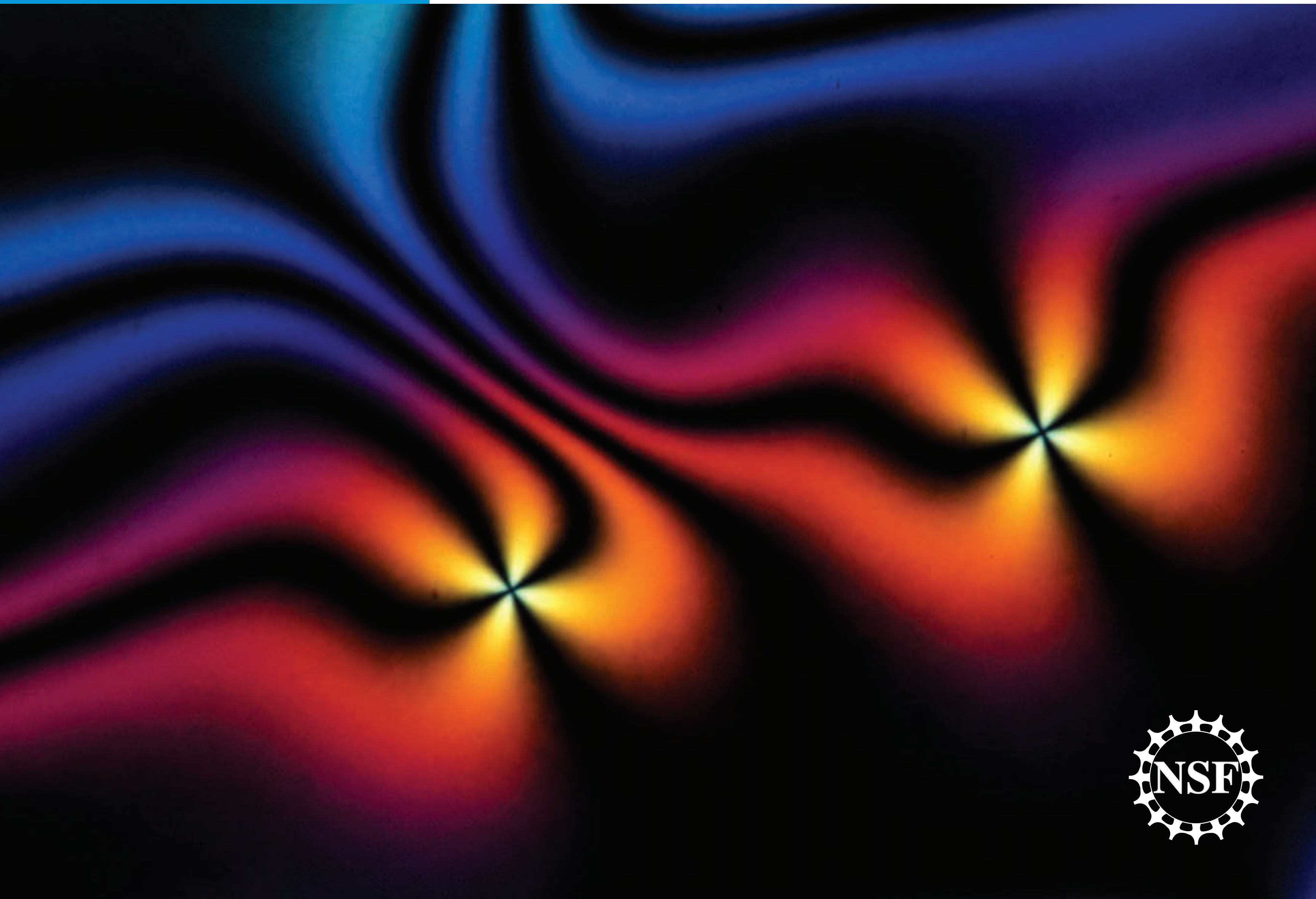
2018 DIGEST

NATIONAL SCIENCE BOARD

SCIENCE & ENGINEERING INDICATORS



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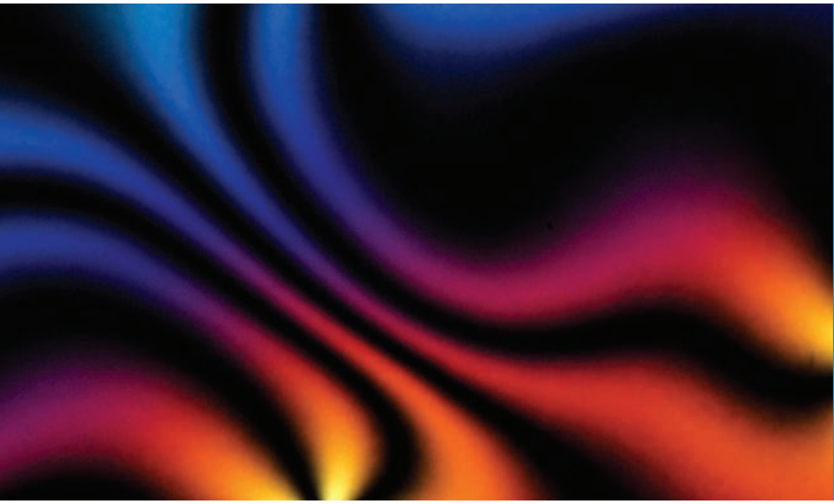


2018 DIGEST

JANUARY 2018 • NSB-2018-2

PREFACE

The National Science Board (Board) is required under the National Science Foundation (NSF) Act, 42 U.S.C. § 1863 (j) (1) to prepare and transmit the biennial *Science and Engineering Indicators* report to the President and to the Congress every even-numbered year. The report is prepared by NSF's National Center for Science and Engineering Statistics (NCSES) under the guidance of the Board. It is subject to extensive review by Board members, outside experts, interested federal agencies, and NCSES internal reviewers for accuracy, coverage, and balance.

Indicators are quantitative representations relevant to the scope, quality, and vitality of the science and engineering (S&E) enterprise. *Indicators* is a factual and policy-neutral source of high-quality U.S. and international data; it neither offers policy options nor makes policy recommendations. The indicators included in the report contribute to the understanding of the U.S. S&E enterprise within a global context.

TABLE OF CONTENTS

INTRODUCTION

The United States holds a preeminent position in S&E in the world, derived in large part from its long history of public and private investment in S&E research and development and education. Investment in R&D, science, technology, and education correlate strongly with economic growth and with the development of a safe, healthy, and well-educated society.

Many other nations, recognizing the economic and social benefits of such investment, have increased their R&D and education spending. These trends are by now well-established. S&E capabilities, until recently located mainly in the United States, Western Europe, and Japan, have now spread to other parts of the world, notably to China and other Southeast Asian economies that are heavily investing to build their scientific and technological capabilities.

Major S&E indicators

The National Science Board has selected 42 S&E indicators for inclusion in this digest. These indicators have been grouped into seven themes. Although each stands alone, collectively these seven themes are a snapshot of U.S. S&E in the context of global trends affecting them. As economies worldwide grow increasingly knowledge-intensive and interdependent, capacity for innovation becomes ever more critical. Three themes provide a worldwide view of R&D spending, research outputs, and science, technology, engineering, and math (STEM) education. Four others share a domestic focus, providing information on U.S. R&D funding and performance, the U.S. S&E workforce, invention, knowledge transfer, and innovation, and public attitudes and understanding of science and technology. Indicators may vary in successive volumes of the *Science and Engineering Indicators* series as different S&E issues emerge.

What these indicators tell the nation

By selecting a set of indicators, the Board seeks to contribute to the assessment of the state of U.S. S&E and to highlight issues of current opportunity or concern. These measures address an emerging set of trends of particular interest to planners and policymakers at all levels whose decisions affect our national S&E enterprise.

GLOBAL R&D: ONE MEASURE OF COMMITMENT TO INNOVATION

Innovation in the form of new or significantly improved goods, services, or processes has the capacity to build new knowledge and technology, contribute to national competitiveness, and improve living standards and social welfare. R&D is a major driver of innovation. R&D expenditures indicate the priority given to advancing science and technology relative to other national goals.

HOW MUCH

R&D expenditures worldwide are estimated to have reached nearly $2 trillion in 2015, doubling from $984 billion a decade earlier and $722 billion in 2000 (figure A).

WHERE

Global R&D expenditures are concentrated in three regions: East/Southeast and South Asia, North America, and Europe (figure B).

The eight countries with the largest R&D expenditures—the United States, China, Japan, Germany, South Korea, France, India, and the United Kingdom—together accounted for nearly three-fourths of total global R&D in 2015. The United States remains the largest R&D performer and accounted for 26% of the worldwide R&D total in 2015. China is now the second largest R&D performing nation, accounting for 21% of the worldwide total (figure C).

GROWTH

Asian countries have heavily contributed to the overall increase in worldwide R&D expenditures, with China accounting for nearly one-third of the total global growth between 2000 and 2015. The United States and the European Union (EU) together accounted for approximately another one-third (36%) of the global growth during this period (figure D).

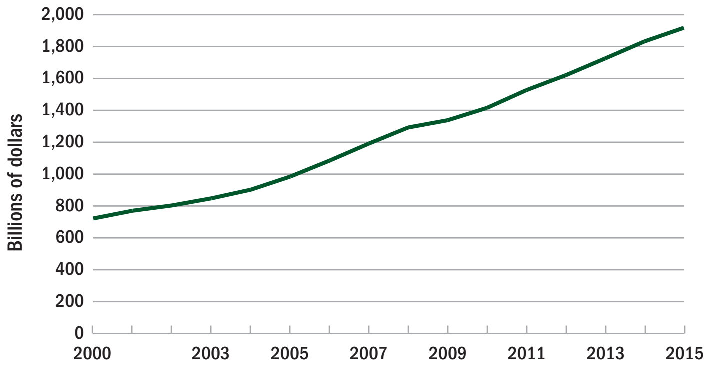
Asian countries have led the pace of R&D expansion as well. Between 2000 and 2015, China's R&D expanded the most rapidly, followed by India and South Korea. By comparison, the pace of growth has been much more moderate in the United States and the EU (figure E).

INTENSITY

R&D intensity is the proportion of a country's economic activity (gross domestic product) devoted to R&D investment. China's R&D intensity has increased sharply over time, as growth in R&D outpaced a rapid expansion in GDP. China's R&D intensity has exceeded that of the EU, but it remains well below that of South Korea—which has also sharply increased its R&D intensity over time—and that of the United States (figure F).

A

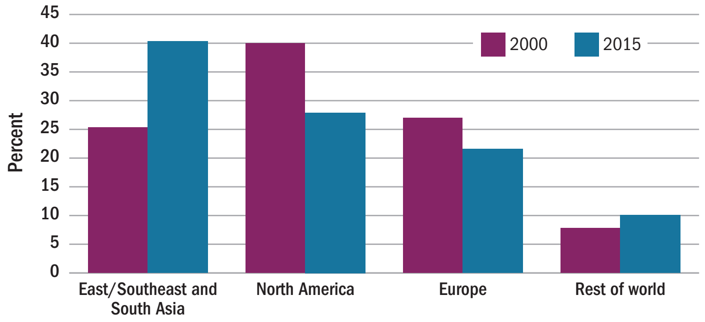
Estimated R&D expenditures worldwide: 2000–15



Indicators 2018: Cross-National Comparisons of R&D Performance, Chapter 4.

B

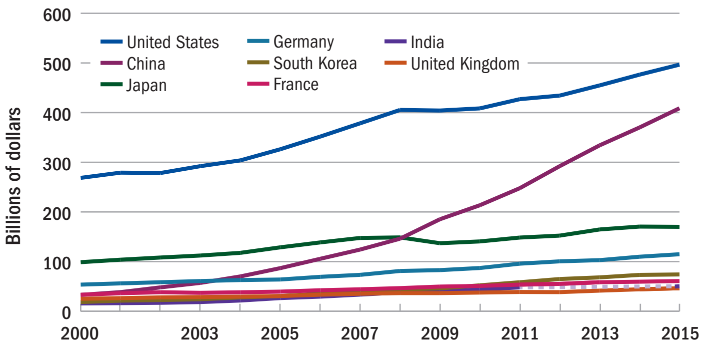
Regional share of worldwide R&D expenditures: 2000 and 2015



NOTE: East/Southeast and South Asia includes China, Taiwan, Japan, South Korea, Singapore, Malaysia, Thailand, Indonesia, Philippines, Vietnam, India, Pakistan, Nepal, and Sri Lanka.
Indicators 2018: Cross-National Comparisons of R&D Performance, Chapter 4.

C

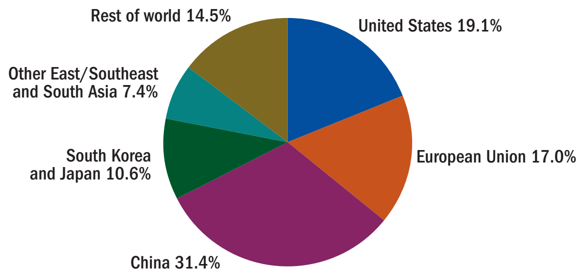
Domestic R&D expenditures, by selected country: 2000–15



NOTES: Data are not available for all countries for all years. Dotted line connects across missing values.
Indicators 2018: Cross-National Comparisons of R&D Performance, Chapter 4.

D

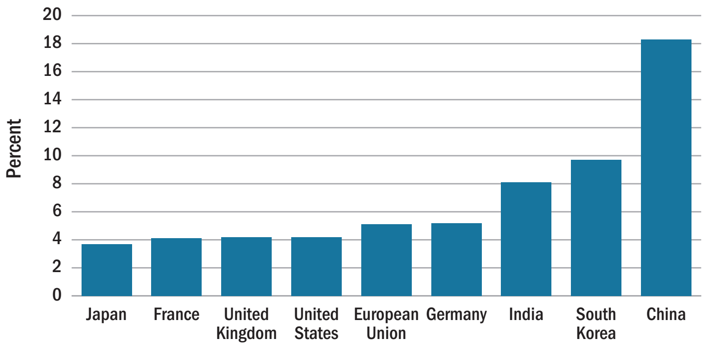
Contributions to growth of worldwide R&D expenditures, by selected region, country, or economy: 2000–15



NOTE: Other East/Southeast and South Asia includes Taiwan, Singapore, Malaysia, Thailand, Indonesia, Philippines, Vietnam, India, Pakistan, Nepal, and Sri Lanka.
Indicators 2018: Cross-National Comparisons of R&D Performance, Chapter 4.

E

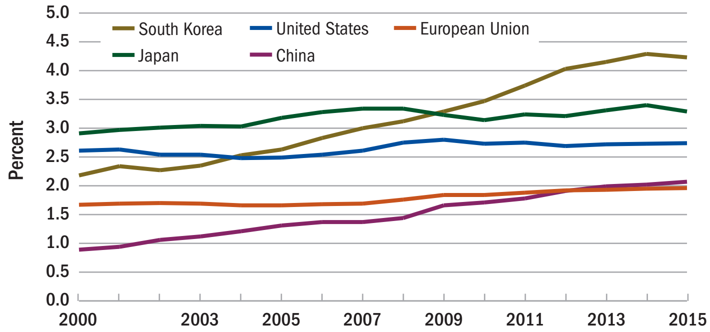
Average annual growth in domestic R&D expenditures, by selected region, country, or economy: 2000–15



Indicators 2018: Cross-National Comparisons of R&D Performance, Chapter 4.

F

R&D intensity, by selected region, country, or economy: 2000–15



Indicators 2018: Cross-National Comparisons of R&D Performance, Chapter 4.

U.S. R&D PERFORMANCE AND FUNDING

Businesses, governments, academia, and nonprofit organizations all perform and fund R&D. The outcomes and benefits depend not only on the total funds devoted to R&D but also on the types of R&D these funds support—basic research, applied research, and development. The distribution of R&D funds by the U.S. federal government provides insight into the nation's broad mission priorities for public expenditures.

PERFORMANCE TRENDS

U.S. R&D performance totaled nearly $500 billion in 2015. The business sector accounted for more than two-thirds of the total. Academia and the federal government are the next largest performers (figure A).

Business R&D in the United States is concentrated in selected areas: chemicals manufacturing; computer and electronic products manufacturing; transportation equipment manufacturing; and information and professional, scientific, and technical services. These industries account for the clear majority (83%) of business R&D performance (figure B).

BASIC AND APPLIED RESEARCH

More than 80% of U.S. R&D performance comprises development and applied research, work that focuses on practical, specific objectives and on developing new or improved products and processes. About 17% of the U.S. R&D performance is basic research—work that primarily involves gaining knowledge of underlying phenomena without a particular application in mind.

Different institutions bring different perspectives and approaches to R&D. Academia, with its symbiotic relationship of advanced graduate education and R&D, performs the most basic research (49%). Business, with its focus on new and improved products, services, and processes, dominates both development (88%) and applied research (58%) (figure C).

FEDERAL R&D TRENDS

The federal budget environment affects the R&D performance of different sectors. Academic and other nonprofit institutions have generally received steady or increasing federal support, and they focus on basic science. However, since peaking around 2010 and 2011, federal support to these sectors has been on a generally downward trend (figure D). The business sector, while increasing overall performance, experienced a decline in federal support since the peak in 2009.

FEDERAL R&D FOCUS

Defense has long been the largest federal R&D budget priority. Since the beginning of the 2010s, however, the defense share of the federal R&D budget has gradually declined. Nearly half of the federal nondefense R&D budget is devoted to health and funded primarily through the National Institutes of Health (figure E).

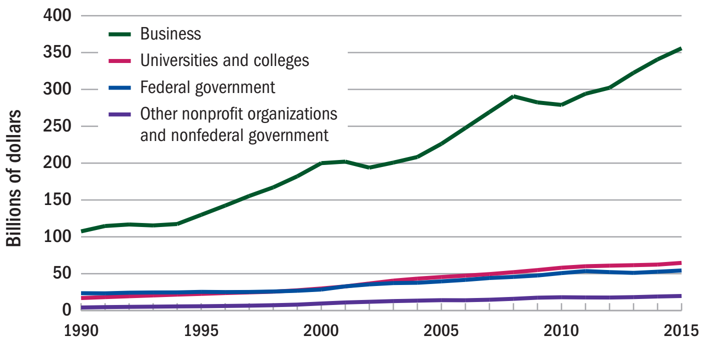
The Department of Defense focuses mostly on development, which includes new major systems and advanced technology. The other federal agencies with large R&D portfolios—the Departments of Health and Human Services, Energy, Commerce, and Agriculture, as well as the National Aeronautics and Space Administration and the National Science Foundation—focus primarily in the areas of basic and applied research. These six departments and agencies account for 95% of federal nondefense R&D spending.

FEDERAL RESEARCH PORTFOLIO BY S&E FIELDS

Life sciences account for nearly one-half of the basic and applied federal research portfolio, while together engineering and physical sciences comprise nearly 30% (figure F).

A

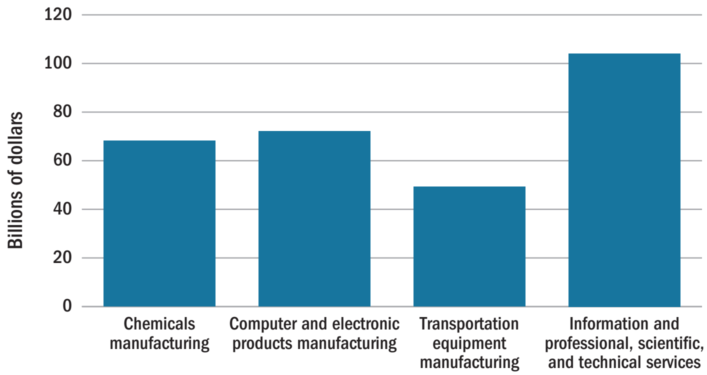
U.S. R&D performance, by performing sector: 1990–2015



Indicators 2018: Recent Trends in U.S. R&D Performance, Chapter 4.

B

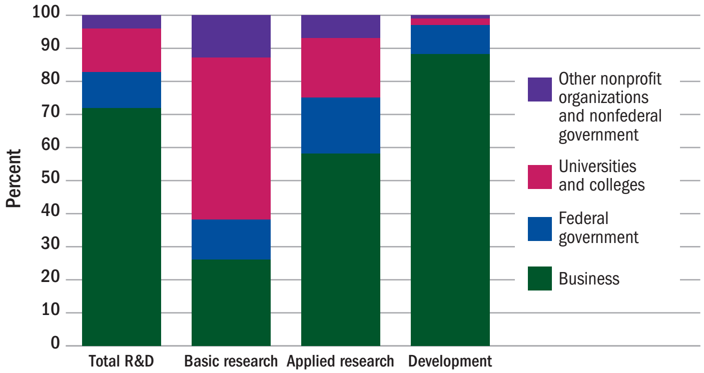
Business R&D performed in the United States, by selected industry: 2015



Indicators 2018: U.S. Business R&D, Chapter 4.

C

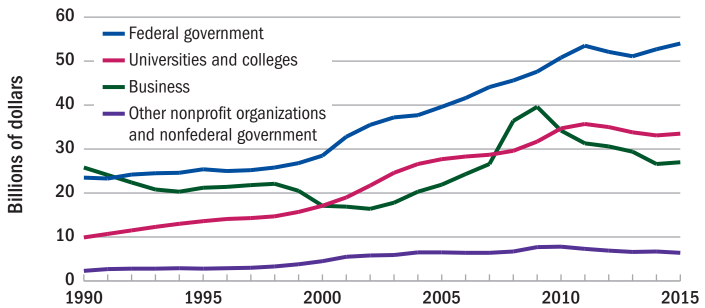
U.S. R&D performance, by type of R&D and performing sector: 2015



Indicators 2018: Recent Trends in U.S. R&D Performance, Chapter 4.

D

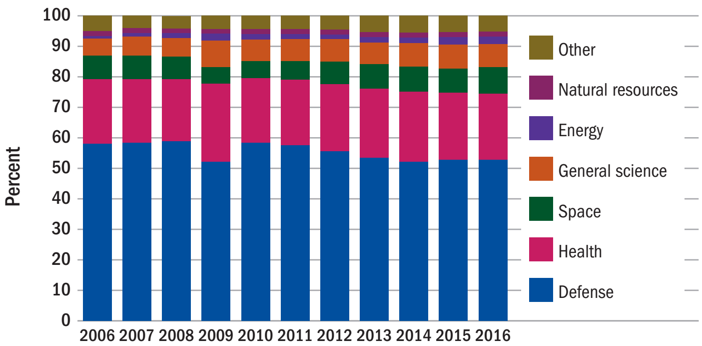
R&D performance supported by federal funding, by performing sector: 1990–2015



NOTE: Data for federal government include intramural and federally funded research and development centers.
Indicators 2018: Recent Trends in U.S. R&D Performance, Chapter 4.

E

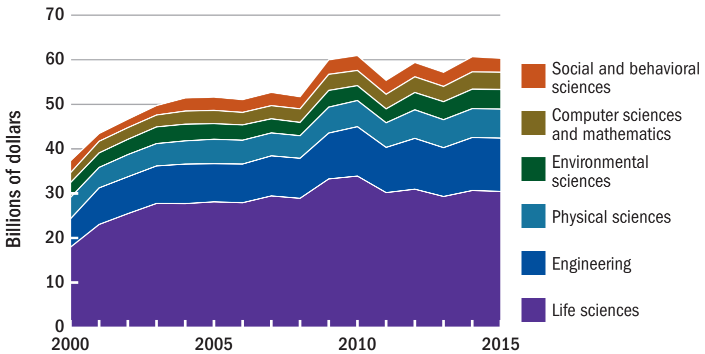
Federal budget authority for R&D, by national objectives: FYs 2006–16



NOTES: R&D data include R&D plant. Data for 2016 are preliminary.
Indicators 2018: Recent Trends in Federal Support for U.S. R&D, Chapter 4.

F

Federal funds for basic and applied research, by S&E field: 2000–15



NOTES: Categories do not sum to total. Other categories made up 5% of the total in 2015.
Indicators 2018: Recent Trends in Federal Support for U.S. R&D, Chapter 4.

GLOBAL SCIENCE AND TECHNOLOGY CAPABILITIES

Research produces new knowledge, both broadly focused and directed toward practical and specific applications. Research publications reflect contributions to knowledge. The research and knowledge base also leads to knowledge- and technology-intensive production processes, both in product manufacturing and services, that help countries compete in and integrate into the global marketplace.

PUBLICATIONS

The United States and China are the two countries that publish the most S&E articles (figure A). The rising number of publications in China reflects the country's rapid development of its scientific capabilities.

BIOMEDICAL SCIENCES AND ENGINEERING ARTICLES

The subject emphasis of scientific research varies somewhat across the globe. Biomedical sciences (biological sciences, medical sciences, and other life sciences) and engineering—two fields that are vital to knowledge-intensive and technologically advanced economies—account for 57% of the worldwide total of S&E publications. The United States and the EU produce a significant number of global biomedical sciences articles, each larger than China's production. However, China produced the largest number of engineering articles, more than the production in the United States as well as the EU (figure B). As in other fields, however, U.S. and European articles continue to receive more citations than those from China, but China's articles are increasingly cited internationally (figure C).

KNOWLEDGE- AND TECHNOLOGY-INTENSIVE INDUSTRIES

Industries that intensively embody new knowledge and technological advances in their production account for 31% of global economic output. They span both manufacturing sectors (air- and spacecraft, electrical machinery and appliances, motor vehicles and parts, pharmaceuticals, scientific instruments, and semiconductors) and services sectors (education, health, financial, business, and communications).

Thirty-eight percent of the U.S. gross domestic product derives from knowledge- and technology-intensive manufacturing and service industries, higher than any other large economy.

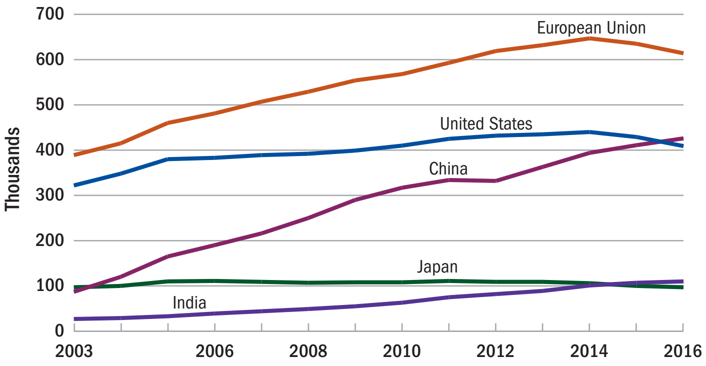
In commercial knowledge-intensive (KI) services (financial, business, and communications), the United States continues to be the largest provider, while output in the EU and Japan has declined in the aftermath of the Great Recession. China has grown very rapidly, surpassing Japan in 2012 to become the third largest provider (figure D).

In medium-high-technology manufacturing industries, the United States and the EU are roughly tied as the second largest global producer. China has grown rapidly and has become the largest producer. The motor vehicle and parts industry drove overall growth of these industries in the United States and in China, with output rising nearly 60% in the United States between 2011 and 2016 and nearly six-fold in China over the last decade (figure E).

In high-technology (HT) manufacturing industries, the United States is the largest global producer. China has grown rapidly and is now the second largest producer (figure F). Information and communications technologies have driven China's increased output. Historically, China's HT manufacturing has largely been in lower value-added activities, such as the assembly of HT foreign components. China has made recent progress in moving to more advanced HT manufacturing activities in certain areas, such as supercomputers and smaller jetliners.

A

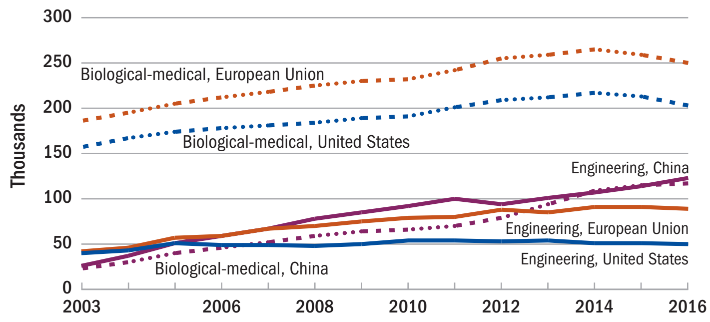
S&E articles, by selected region, country, or economy: 2003–16



Indicators 2018: **S&E Publication Output, Chapter 5.**

B

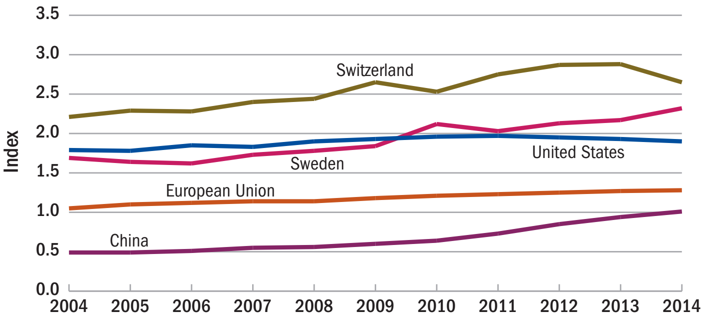
Engineering and biological-medical articles, by region, country, or economy: 2003–16



NOTE: Biological-medical includes biological sciences, medical sciences, and other life sciences.
Indicators 2018: **S&E Publication Output, Chapter 5.**

C

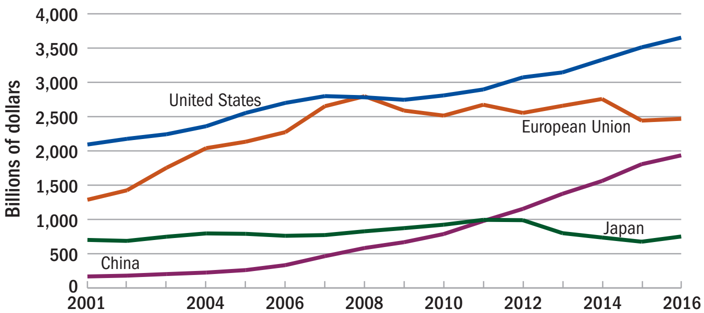
S&E publication output in the top 1% of cited publications, by selected region, country, or economy: 2004–14



NOTES: An index of 1.00 indicates that articles are cited at their expected level. An index of 2.00 indicates that articles are cited at twice their expected level.
Indicators 2018: **S&E Publication Output, Chapter 5.**

D

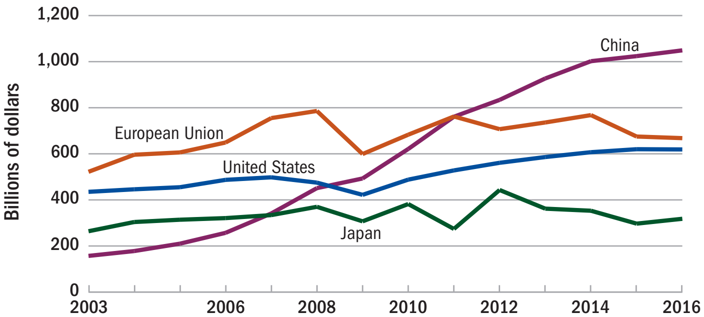
Output of commercial knowledge-intensive services industries, by selected region, country, or economy: 2001–16



NOTE: Data are not available for European Union members Cyprus, Estonia, Latvia, Lithuania, Luxembourg, Malta, and Slovenia.
Indicators 2018: **Worldwide Distribution of Knowledge- and Technology-Intensive Industries, Chapter 6.**

E

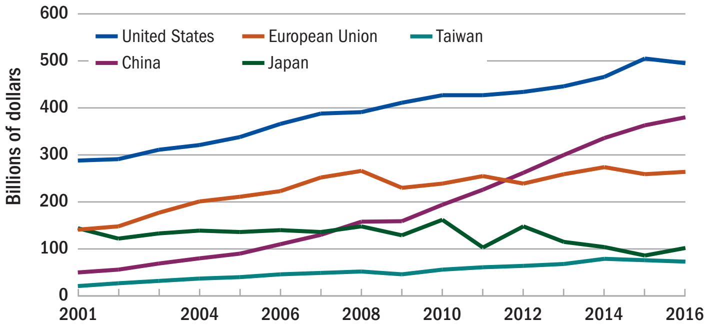
Output of medium-high-technology manufacturing industries, by selected region, country, or economy: 2003–16



NOTE: Data are not available for European Union members Cyprus, Estonia, Latvia, Lithuania, Luxembourg, Malta, and Slovenia.
Indicators 2018: **Global Trends in Medium-High-Technology Industries, Chapter 6.**

F

Output of high-technology manufacturing industries, by selected region, country, or economy: 2001–16



NOTE: Data are not available for European Union members Cyprus, Estonia, Latvia, Lithuania, Luxembourg, Malta, and Slovenia.
Indicators 2018: **Worldwide Distribution of Knowledge- and Technology-Intensive Industries, Chapter 6.**

INVENTION, KNOWLEDGE TRANSFER, AND INNOVATION

Creativity and scientific discovery produce broad economic and social benefits through an interrelated system of invention, knowledge transfer, and innovation. Government, businesses, universities and nonprofits, and individuals all play an important role in these activities. Internationally, both the developed and the developing world are key actors in this system.

INVENTION

Invention is the development of a new process or product that is potentially useful, previously unknown, and nonobvious. Patent data reveal a subset of inventions that have been granted a property right in exchange for public disclosure of the invention when the patent is granted. Patent awards are often used by inventors to protect their intellectual property. According to data from the U.S. Patent and Trademark Office (USPTO), the number of U.S. patents granted to both U.S. and international inventors in recent years rose to slightly more than 300,000 in 2016. Inventors from around the globe increasingly seek patent protection in the United States. Over the past decade, U.S. inventors annually received about half of all U.S. granted patents; inventors in Japan and the EU received most of the rest. However, a growing number of inventors in South Korea have received U.S. patents, while U.S. patents granted to inventors in China and India remain modest despite growing rapidly from small bases (figure A).

U.S. knowledge- and technology-intensive industries receive most USPTO patents granted to U.S. industries. U.S. high-technology manufacturing industries received slightly more than 60% of the 61,000 U.S. patents granted to manufacturing industries in 2015; medium-high-technology manufacturing industries accounted for almost a quarter. Commercial knowledge-intensive services received 87% of the 30,000 patents granted to nonmanufacturing industries in 2015.

Although patenting by academic inventors is increasing, it is still relatively limited with only about 6,600 U.S. patents granted in 2016. Five technology areas receive over one-half of the U.S. patents granted to U.S. academic institutions—pharmaceuticals (15%), biotechnology (14%), medical technology (11%), organic chemistry (7%), and measurement (7%) (figure B).

KNOWLEDGE TRANSFER

Knowledge transfer is the process by which technology or knowledge developed in one place or for one purpose is applied elsewhere for a similar or different purpose. This transfer can take place freely, through knowledge sharing, as well as through exchange, for example by licensing or consulting. Citations from patents to S&E articles are one measure of knowledge transfer from research to patented inventions. These citations are overwhelmingly to articles from academic institutions, accounting for over 60% of citations across all S&E research fields. This dominance is not surprising, given the important role of academic institutions in producing peer-reviewed research. For patent citations to literature from nonacademic institutions, industry publications contribute the most to patenting in computer sciences (27%), physics (23%), and engineering (21%) (figure C).

Federal agencies transfer technology through a variety of channels. Most measures of federal technology transfer track the number of activities, such as inventions disclosed, patent applications filed, and patents issued (figure D). Three federal agencies lead technology transfers—the Department of Energy, the Department of Defense, and the National Aeronautics and Space Administration. Federal government research publications also measure federal technology transfer and accounted for 7% of total U.S. S&E articles in 2016.

INNOVATION

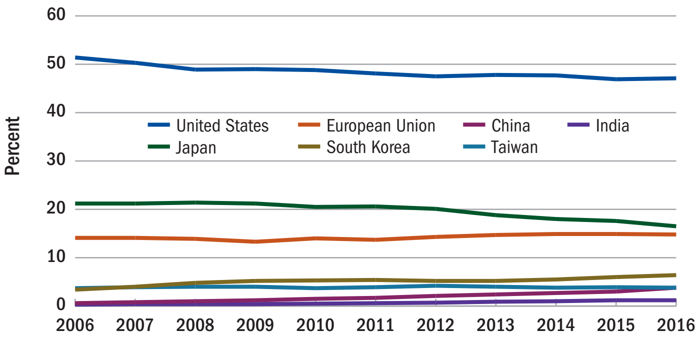
Businesses implement innovation through the introduction of new or significantly improved products and processes. Product innovations can include goods or services. Among U.S. companies, 17% report introducing a new or significantly improved product or process between 2013 and 2015.

Manufacturing firms reported higher rates of product and process innovations than did nonmanufacturing firms during that period (33% versus 15%). The lead innovators among manufacturing industries are computer and electronic products (57%) and electrical equipment and components (48%) (figure E).

Nonmanufacturing companies report the highest rates of innovation among computer system and design services (44%), scientific R&D services (44%), electronic shopping and auctions (40%), and information (31%) (figure F).

A

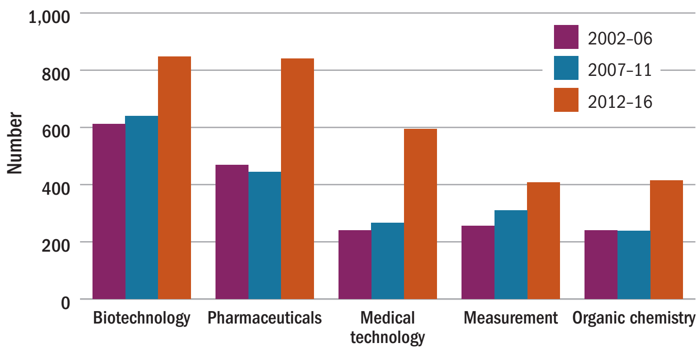
U.S. patents granted, by selected region, country, or economy of inventor: 2006–16



Indicators 2018: Global Patent Trends and Cross-National Comparisons, Chapter 8.

B

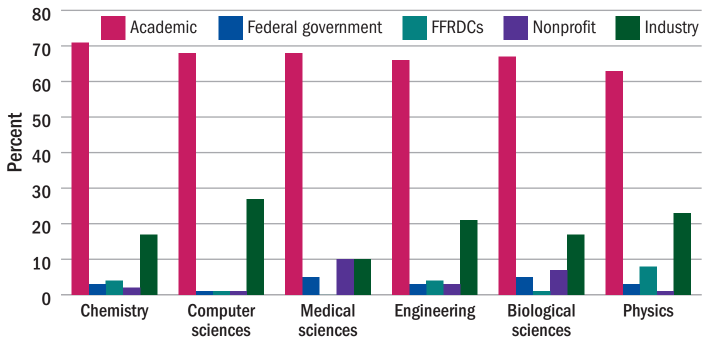
U.S. academic patents, by selected technology area: 5-year averages, 2002–16



Indicators 2018: Trends and Patterns in Academic Patenting, Chapter 8.

C

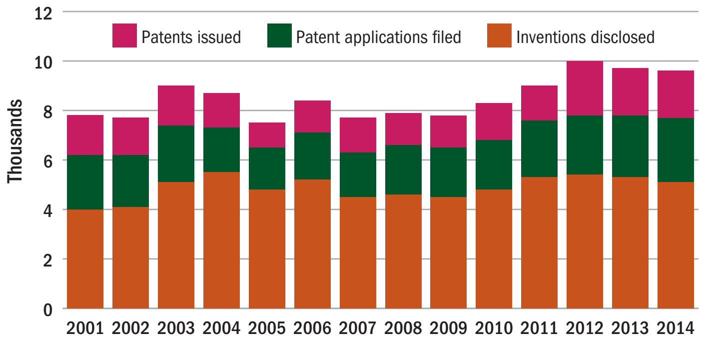
Citation to U.S. S&E articles in U.S. patents, by selected S&E field and sector of author: 2016



FFRDCs = federally funded research and development centers.
Indicators 2018: Citations of S&E Articles and USPTO Patents, Chapter 8.

D

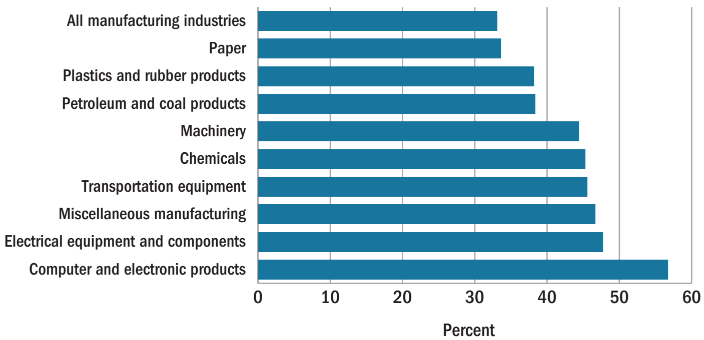
Federal technology transfer activity indicators for U.S. agencies with federal laboratories: FYs 2001–14



Indicators 2018: Knowledge Transfer Activities by Federal R&D Facilities, Chapter 8.

E

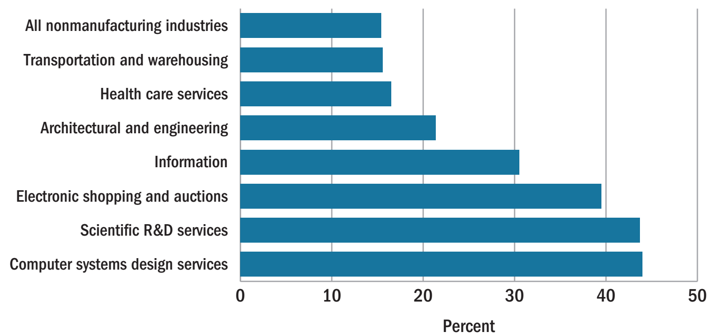
U.S. manufacturing companies reporting product or process innovation, by selected industry: 2013–15



Indicators 2018: Innovation Activities by U.S. Business, Chapter 8.

F

U.S. nonmanufacturing companies reporting product or process innovation, by selected industry: 2013–15



Indicators 2018: Innovation Activities by U.S. Business, Chapter 8.

U.S. AND GLOBAL STEM EDUCATION

Education in science, technology, engineering, and mathematics—STEM—develops, preserves, and disseminates knowledge and skills that convey personal, economic, and social benefits. Higher education provides the advanced work skills needed in an increasingly knowledge-intensive, globally integrated, and innovation-based landscape.

K–12 MATHEMATICS AND SCIENCE

Over the past two decades, U.S. students' mathematics scores on national assessments have modestly improved.

However, on international assessment tests, U.S. 15-year-olds tend to score below the international average in mathematics and have science scores at or slightly above the international average (figure A).

S&E ASSOCIATES DEGREES

The United States awards many associate's degrees (over 1 million in 2015), nearly one-quarter of which are in S&E fields (9%) and S&E technologies (14%). The latter, which have a more applied focus, grew by 72% since 2000, and are concentrated in health and engineering technologies (figure B).

Since 2000, women earned about 60% of associate's degrees in all fields. But their proportion in S&E fields was less than half (44%) in 2015, reflecting primarily a drop in women's participation in computer science during this period (42% to 21%).

BACCALAUREATES

U.S. output of bachelor's degrees has increased by more than one-half over the past 2 decades. S&E degrees have consistently accounted for over one-third of the total.

Globally, S&E bachelor's degree awards totaled more than 7.5 million. Almost half of these degrees were conferred in India (25%) and China (22%); another 20% were conferred in the EU (10%) and the United States (10%). The number of S&E degrees has risen much faster over the past 15 years in India and China than in the United States and many European countries (figure C).

S&E fields account for a larger proportion of all bachelor's degrees in China than in the United States. In 2014, these fields accounted for 48% of all bachelor's degrees in China, compared with 39% of all bachelor's degrees in the United States.

INTERNATIONAL DOCTORATES

Advanced training toward the doctorate has expanded in recent years. The number of doctoral degrees in S&E has risen dramatically in China, whereas the numbers awarded in the United States, South Korea, and the eight EU countries with the most doctorate awards have risen more modestly.

In 2014, the United States graduated the largest number of S&E doctorate recipients of any individual country, followed by China. In the United States, more than one-third (37%) of these doctorates were earned by temporary visa holders (figure D).

INTERNATIONALLY MOBILE STUDENTS

The United States remains the destination of choice for the largest number of internationally mobile students worldwide. Yet the share of the world's internationally mobile students enrolled in the United States fell from 25% in 2000 to 19% in 2014, due to efforts by other countries to attract more foreign students and to growing higher education capacity around the world. Other popular destinations for internationally mobile students are the United Kingdom, Australia, France, Russia, and Germany (figure E).

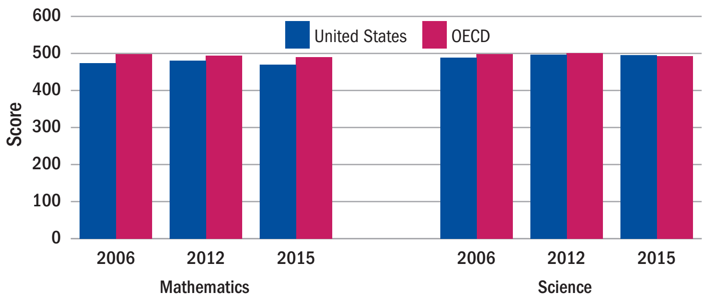
TUITION AND REVENUE

Public institutions in the United States, as part of their mission, have traditionally offered access to high-quality education for students, where in-state students generally pay a lower tuition than out-of-state students. Between 2000 and 2015, the cost of attending U.S. public research universities has risen, coinciding with a decline in state and local appropriations, a considerable source of institution revenue (figure F).

Among dependent undergraduate students attending public research universities, out-of-pocket tuition and fees vary across families in different income brackets and have increased for families at both the lower and higher income brackets.

A

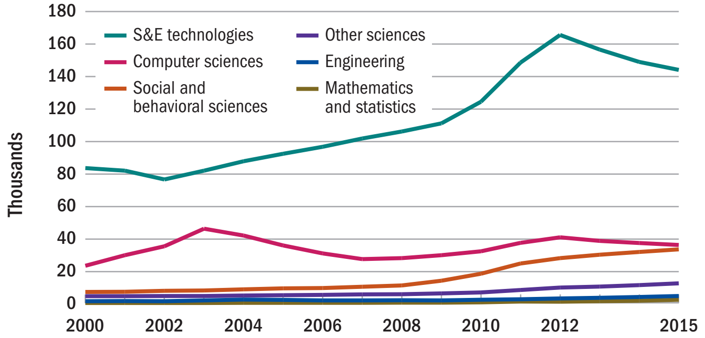
Average mathematics and science PISA test scores of 15-year-olds in the United States and OECD countries: 2006, 2012, and 2015



OECD = Organisation for Economic Co-operation and Development; PISA = Program for International Student Assessment.
Indicators 2018: **Mathematics and Science Performance in Grades 4, 8, and 12, Chapter 1.**

B

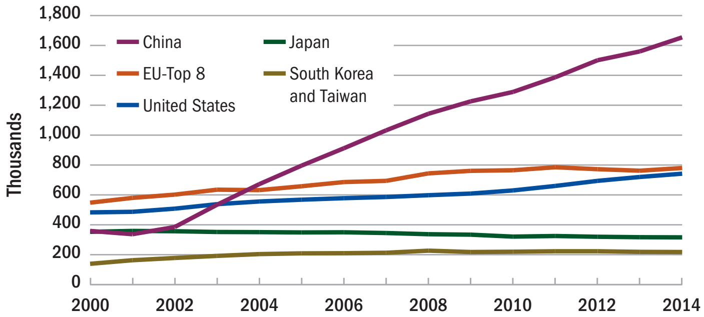
Associate's degree awards in S&E fields and S&E technologies: 2000–15



NOTES: Other sciences includes agricultural, biological, earth, atmospheric and ocean, and physical sciences. S&E technologies includes engineering, health science, and other S&E technologies.
Indicators 2018: **Institutions Providing S&E Education, Chapter 2.**

C

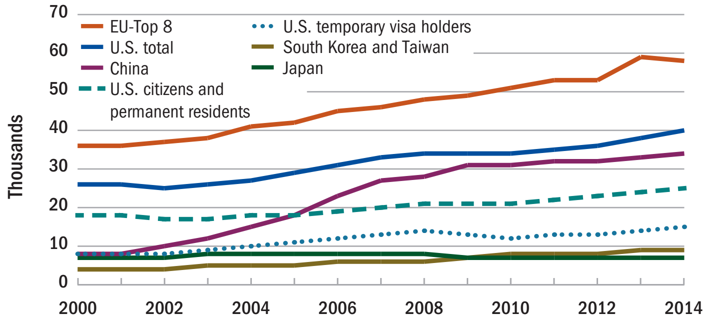
Bachelor's degree awards in S&E fields, by selected region, country, or economy: 2000–14



NOTE: EU-Top 8 is the eight European Union countries with the most bachelor's degree awards in 2014: UK, Germany, France, Poland, Italy, Spain, Romania, and the Netherlands.
Indicators 2018: **First University Degrees in S&E Fields, Chapter 2.**

D

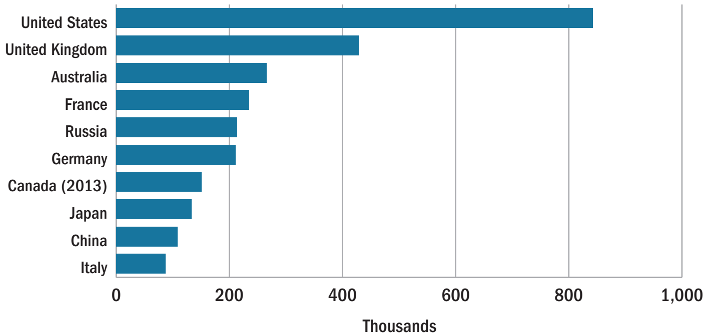
Doctoral degree awards in S&E fields, by selected region, country, or economy: 2000–14



NOTE: EU-Top 8 is the eight European Union countries with the most doctoral degree awards in 2014: Germany, UK, France, Spain, Italy, Portugal, Sweden, and Romania.
Indicators 2018: **International Comparison of S&E Doctoral Degrees, Chapter 2.**

E

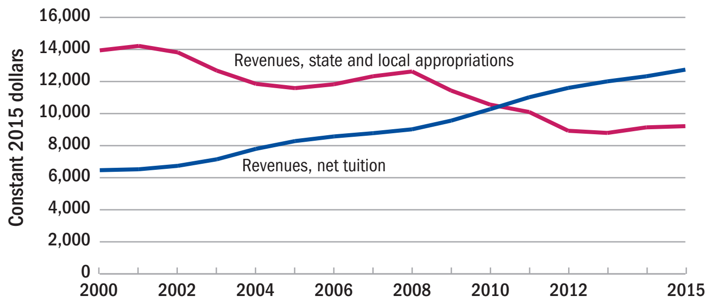
International students enrolled in tertiary education, by selected country of enrollment: 2014



Indicators 2018: **International Student Mobility, Chapter 2.**

F

Tuition and state and local appropriations in U.S. public research universities: 2000–15



NOTES: Data are per full-time equivalent student and for the most research-intensive universities. Net tuition data reflect tuition after subtracting institutional grant aid.
Indicators 2018: **Trends in Higher Education Expenditures and Revenues, Chapter 2.**

U.S. S&E WORKFORCE: TRENDS AND COMPOSITION

Workers with S&E expertise are an integral part of a nation's innovative capacity. Their high skill level and inventiveness provide them with the ability to not only advance basic scientific knowledge but to also transform that knowledge into useful products and services.

WORKFORCE GROWTH AND EMPLOYMENT SECTOR

The U.S. S&E workforce—made up of occupations like chemists, mathematicians, economists, and engineers—has grown faster over time than the workforce overall and now represents 5% of all U.S. jobs. However, many others with S&E training are employed in and apply their S&E expertise in occupations not formally classified as S&E jobs. This suggests that the application of S&E knowledge and skills is widespread across the U.S. economy and not just limited to jobs classified as S&E.

Individuals in S&E occupations work for a wide variety of employers. Businesses are by far their largest employer. Among those with doctorates, educational institutions and businesses together are the largest employers (figure A).

UNEMPLOYMENT

For decades, workers in S&E occupations have almost always had lower unemployment levels than workers in other types of jobs. The unemployment rate for college-graduate workers in S&E occupations is generally lower than it is for college-graduate workers in non-S&E occupations, and it is far lower than the overall unemployment rate. However, S&E workers are not immune to overall business cycles, as the spikes in S&E unemployment in the 2001 and the 2007–09 recessions illustrate (figure B).

SKILLED TECHNICAL WORKFORCE

The skilled technical workforce is a substantial component of an S&E-capable workforce. Comprised of individuals who use S&E expertise in their jobs but who do not have a bachelor's degree, skilled technical workers face better job market conditions in S&E and S&E-related occupations relative to their non-S&E counterparts. S&E-related workers include those employed in the health industry and those working as S&E technicians, such as computer network managers. In 2015, the median earnings of skilled technical workers in S&E or S&E-related occupations were significantly higher and their unemployment rates were lower than those of workers in non-S&E occupations who also do not have a bachelor's degree (figure C).

WOMEN AND UNDERREPRESENTED MINORITIES

Despite accounting for one-half of the college-educated workforce, women in 2015 accounted for less than one-third of S&E employment. Although the number of women in S&E jobs has risen significantly in the past 2 decades (from 755,000 in 1993 to 1,818,000 in 2015), the disparity has narrowed only modestly (figure D).

Similarly, underrepresented minorities—blacks, Hispanics, and American Indians or Alaska Natives—have made substantial strides in S&E employment, increasing from 217,000 S&E workers in 1993 to 705,000 in 2015. However, their representation in S&E jobs (11%) remains below their share of the population (27%) (figure E).

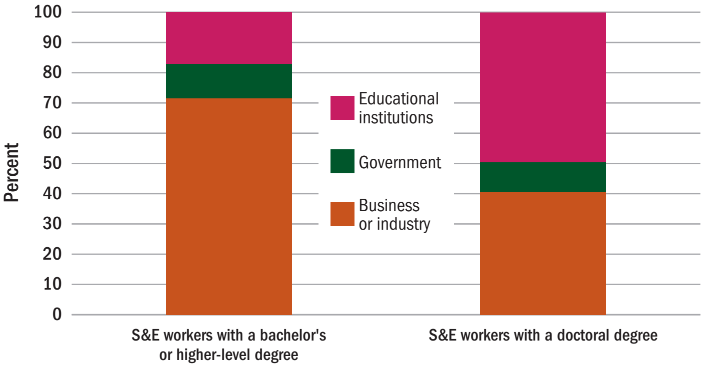
Women's presence varies widely across S&E occupations, with high concentrations in the life sciences and social and behavioral sciences. For underrepresented minorities, variation among occupations is much less pronounced.

FOREIGN-BORN SCIENTISTS AND ENGINEERS

Foreign-born scientists and engineers are a critical part of the U.S. S&E workforce. Among individuals working in S&E occupations, 41% of master's degree holders and 36% of doctorate holders are foreign born. The presence of foreign-born scientists and engineers is greatest in engineering occupations and in computer sciences and mathematics occupations. More than one-half of doctorate holders in these occupations are foreign born (figure F).

A

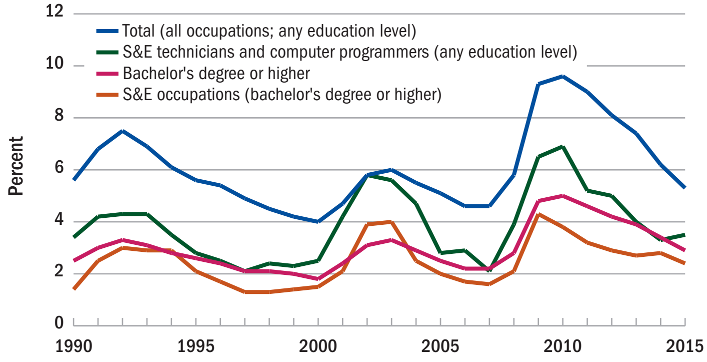
U.S. employment sector of individuals in S&E occupations: 2015



Indicators 2018: S&E Workers in the Economy, Chapter 3.

B

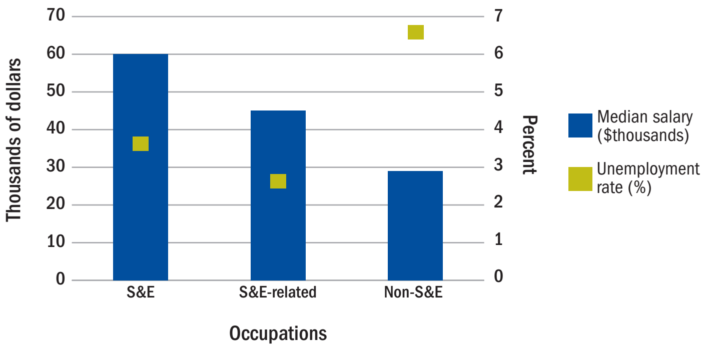
U.S. unemployment rate, by selected groups: 1990–2015



Indicators 2018: S&E Labor Market Conditions, Chapter 3.

C

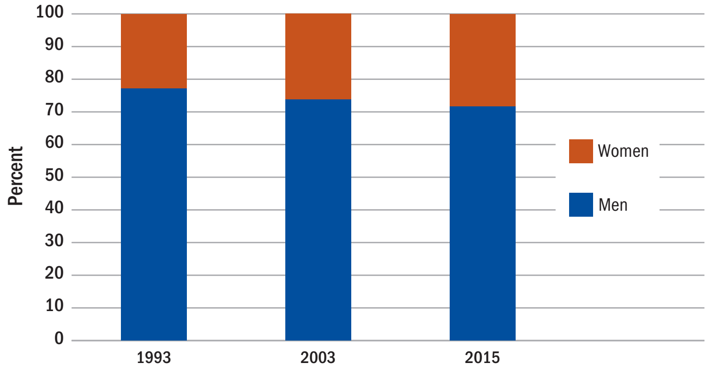
Median salary and unemployment rate of U.S. skilled technical workers, by S&E, S&E-related, or non-S&E occupations: 2015



Indicators 2018: S&E Workers in the Economy, Chapter 3.

D

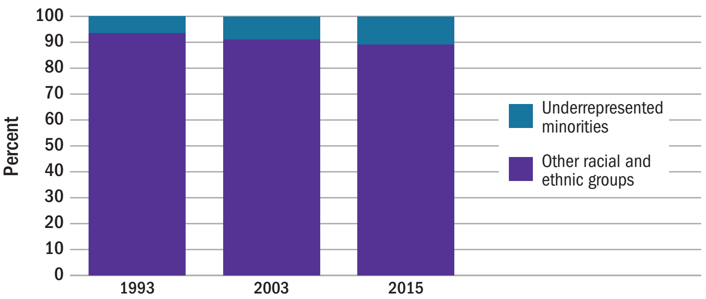
U.S. men and women in S&E occupations: 1993, 2003, and 2015



Indicators 2018: Women and Minorities in the S&E Workforce, Chapter 3.

E

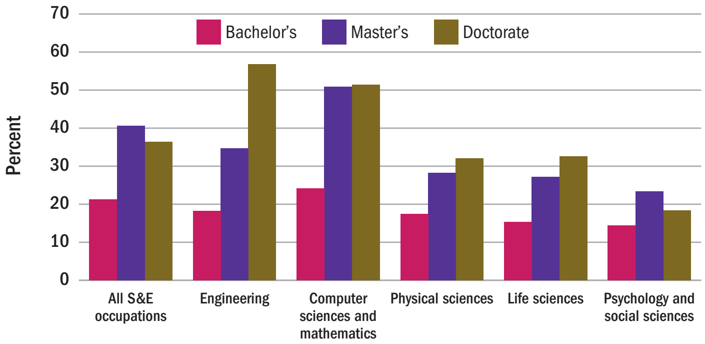
U.S. underrepresented minorities and other racial and ethnic groups in S&E occupations: 1993, 2003, and 2015



NOTE: Underrepresented minorities comprises blacks, Hispanics, and American Indians and Alaska Natives in 2003 and 2015 and blacks and Hispanics in 1993.
Indicators 2018: Women and Minorities in the S&E Workforce, Chapter 3.

F

Foreign-born individuals in U.S. S&E occupations, by level of degree and occupation: 2015



Indicators 2018: Immigration and the S&E Workforce, Chapter 3.

PUBLIC ATTITUDES AND UNDERSTANDING OF SCIENCE AND TECHNOLOGY

Advances in science and technology drive the rapid transformation of the global economy, with deep effects on people's lives and cultures. Perceptions of science and technology can shape the progress of science by shaping social acceptance of these innovations and the questions scientists study.

CONFIDENCE IN INSTITUTIONAL LEADERS

Americans have high confidence in the scientific community. Amid a long decline in public confidence in several U.S. institutions, many Americans continue to have a "great deal of confidence" in the scientific community. This perception has endured over 3 decades and is second only to confidence in the military (figure A).

VIEWS ABOUT SCIENCE

Americans overwhelmingly believe that science creates more opportunities for the next generation, that its benefits outweigh risks, and that the federal government should provide funds for scientific research. A substantial percentage also think science makes life change too fast (figure B).

VIEW OF SCIENTISTS

Americans have a positive view of scientists. The clear majority of respondents agree or strongly agree that scientists work for the good of humanity, help to solve problems, and want to make life better for the average person. These views have remained mostly unchanged since 2001 (figure C).

KNOWLEDGE ABOUT SCIENCE

Americans' knowledge of basic scientific facts remains incomplete but appears to be generally stable over the past 2 decades, as measured by a set of nine knowledge items that respondents answered over several decades. In recent years, however, the scores have fluctuated within a relatively narrow range (figure D).

INFLUENCE OF EDUCATION

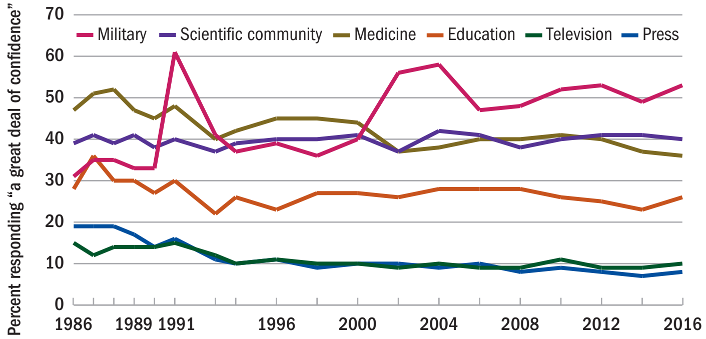
Attitudes toward and knowledge of science are influenced by level of education. Perceived benefits of science for future generations and favorability toward federal support for science are shared by the bulk of respondents at all education levels. However, interest in new scientific discoveries and confidence in scientific leaders are higher among those with more advanced education (figure E).

CONCERN FOR HEALTH AND ENVIRONMENTAL ISSUES

A considerable proportion (43% to 79%) of Americans think that specific health and environmental issues are "extremely" or "very" dangerous, and these percentages are higher than they have been since the early 1990s. Over half believe that climate change and nuclear power stations pose such danger, along with 43% who believe similarly regarding modifying the genes of certain crops. Water and air pollution are the environmental issues that most concern Americans (figure F).

A

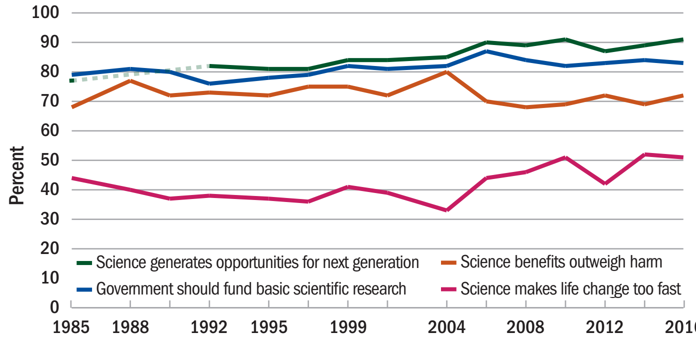
Public confidence in institutional leaders, by selected institution: 1986–2016



Indicators 2018: **Confidence in the Science Community's Leadership, Chapter 7.**

B

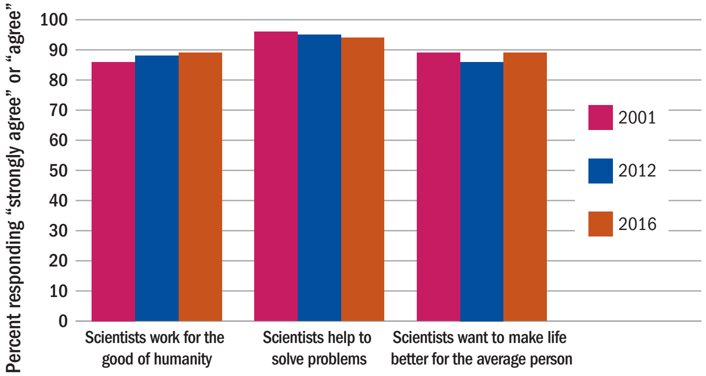
Americans' views of science: Selected years, 1985–2016



NOTES: Data are not available for all items for all years. Dotted line connects across missing values.
Indicators 2018: **Public Attitudes about S&T in General, Chapter 7.**

C

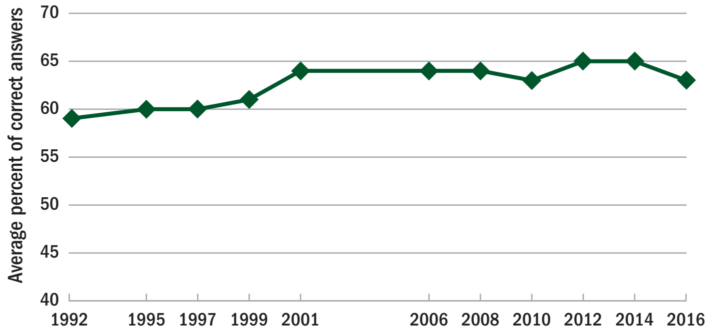
Americans' views about scientists: 2001, 2012, and 2016



Indicators 2018: **Public Attitudes about S&T in General, Chapter 7.**

D

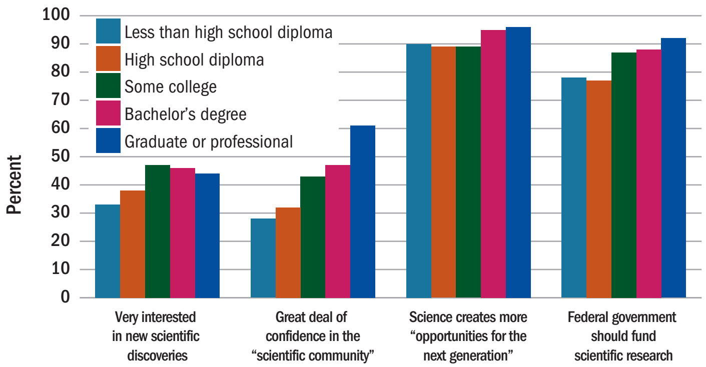
Americans' responses to the factual knowledge of science scale: 1992–2016



Indicators 2018: **Understanding Scientific Terms and Concepts, Chapter 7.**

E

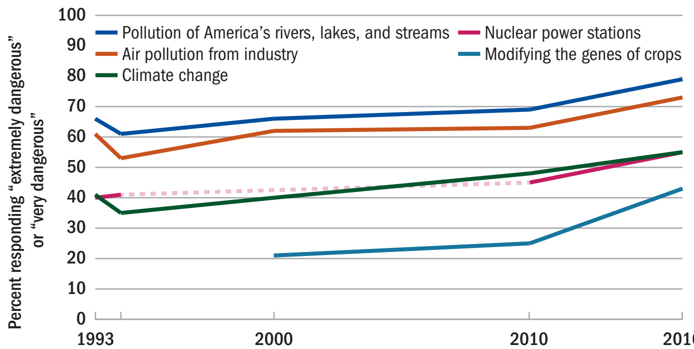
Americans' attitudes toward science, by education level: 2016



Indicators 2018: **Public Attitudes about S&T in General, Chapter 7.**

F

Perceived danger of specific health and environmental issues: 1993–2016



NOTES: Data are not available for all items for all years. Dotted line connects across missing values.
Indicators 2018: **Assessment of Specific Environmental Problems, Chapter 7.**

GLOSSARY AND KEY TO ACRONYMS

Applied research. Systematic study to gain knowledge or understanding to meet a specific, recognized need.

Basic research. Systematic study to gain more comprehensive knowledge or understanding of the subject under study without specific applications in mind.

Development. Systematic use of the knowledge or understanding gained from research directed toward the production of useful materials, devices, systems, or methods, including the design and development of prototypes and processes.

European Union (EU). The EU comprises 28 member nations: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. Unless otherwise noted, data on the EU include all 28 member countries.

FFRDC. Federally funded research and development center.

GDP. Gross domestic product. The market value of all final goods and services produced within a country within a given period of time.

Innovation. The implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organization method in business practices, workplace organization, or external relations. Indicators uses the definition developed by OECD/Eurostat in 2005.

Invention. The development of something new that has a practical bent—potentially useful, previously unknown, and nonobvious.

Knowledge- and technology-intensive (KTI) industries. Industries that have a particularly strong link to science and technology. These industries include high-technology (HT) manufacturing and knowledge-intensive (KI) service industries. HT manufacturing industries include those that spend a relatively high proportion of their revenue on R&D, consisting of aerospace, pharmaceuticals, computers and office machinery, semiconductors and communications equipment, and scientific (medical, precision, and optical) instruments. Medium-high-technology manufacturing industries include motor vehicles and parts, electrical machinery, machinery and equipment, chemicals excluding pharmaceuticals, and railroad and other transportation equipment. KI service industries include those that incorporate science, engineering, and technology into their services or the delivery of their services, consisting of business, information, education, financial, and health services. Commercial KI services are generally privately owned and compete in the marketplace without public support. These services are business, information, and financial services.

NCSES. National Center for Science and Engineering Statistics, a federal statistical agency within the National Science Foundation.

NSB. National Science Board.

NSF. National Science Foundation.

Organisation for Economic Co-operation and Development (OECD). An international organization of 35 countries headquartered in Paris, France. The member countries are Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States. Among its many activities, the OECD compiles social, economic, and science and technology statistics for all member and selected non-member countries.

R&D. Research and development.

R&D intensity. R&D as a proportion of gross domestic product.

Research university. The Carnegie Classification of Institutions of Higher Education considers doctorate-granting universities that award at least 20 doctoral degrees per year to be research universities. The 2010 Carnegie Classification includes three subgroups of research universities based on the level of research activity: very high research activity (108 institutions), high research activity (99 institutions), and doctoral/research universities (90 institutions).

S&E. Science and engineering.

S&E occupations. Biological, agricultural, and environmental life scientists; computer and mathematical scientists; physical scientists; social scientists; and engineers. S&E managers and technicians and health-related occupations are categorized as S&E-related and are not included in S&E.

S&T. Science and technology.

STEM. Science, technology, engineering, and mathematics.

Technology transfer. The process by which technology or knowledge developed in one place or for one purpose is applied and exploited in another place for some other purpose. In the federal setting, technology transfer is the process by which existing knowledge, facilities, or capabilities developed under federal R&D funding are used to fulfill public and private needs.

EXPLORE FURTHER

To read more about the themes presented in this digest, please see the Overview chapter as well as the more detailed analysis and fuller discussion of the related topics presented in *Science and Engineering Indicators 2018*. Each theme is matched with its source *Indicators 2018* chapter or chapters in the list below. The State Indicators data tool also provides a wealth of detailed information on U.S. state-level comparisons of selected science and engineering indicators.

Global R&D: One Measure of Commitment to Innovation

- Chapter 4. Cross-National Comparisons of R&D Performance

U.S. R&D Performance and Funding

- Chapter 4. Recent Trends in U.S. R&D Performance
- Chapter 4. U.S. Business R&D
- Chapter 4. Recent Trends in Federal Support for U.S. R&D

Global Science and Technology Capabilities

- Chapter 5. S&E Publication Output
- Chapter 6. Worldwide Distribution of Knowledge- and Technology-Intensive Industries
- Chapter 6. Global Trends in Medium-High-Technology Industries

Invention, Knowledge Transfer, and Innovation

- Chapter 8. Global Patent Trends and Cross-National Comparisons
- Chapter 8. Trends and Patterns in Academic Patenting
- Chapter 8. Citations of S&E Articles and USPTO Patents
- Chapter 8. Knowledge Transfer Activities by Federal R&D Facilities
- Chapter 8. Innovation Activities by U.S. Business

U.S. and Global STEM Education

- Chapter 1. Mathematics and Science Performance in Grades 4, 8, and 12
- Chapter 2. Institutions Providing S&E Education
- Chapter 2. First University Degrees in S&E Fields
- Chapter 2. International Comparison of S&E Doctoral Degrees
- Chapter 2. International Student Mobility
- Chapter 2. Trends in Higher Education Expenditures and Revenues

U.S. S&E Workforce: Trends and Composition

- Chapter 3. S&E Workers in the Economy
- Chapter 3. S&E Labor Market Conditions
- Chapter 3. Women and Minorities in the S&E Workforce
- Chapter 3. Immigration and the S&E Workforce

Public Attitudes and Understanding of Science and Technology

- Chapter 7. Confidence in the Science Community's Leadership
- Chapter 7. Public Attitudes about S&T in General
- Chapter 7. Understanding Scientific Terms and Concepts
- Chapter 7. Assessment of Specific Environmental Problems

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Proprietary data in "Global Science and Technology Capabilities" were provided by Elsevier, Scopus abstract and citation database (https://www.scopus.com) and LexisNexis patent data, with analytical support from Science-Metrix (http://www.science-metrix.com/) and SRI International (https://www.sri.com), and by the databases of IHS Global Insight (https://www.ihs.com): World Industry Service database and World Trade Service database.

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Cover image

The cover for the *Science and Engineering Indicators 2018 Digest* shows a polarization microscope image of liquid crystals. Liquid crystals revolutionized how we present information, giving rise to the liquid crystal display (LCD) industry. Modern devices including smart phones, laptop screens, and flat-panel television sets all feature LCDs, in which so-called nematic ("threadlike") liquid crystals realign in an electric field, thus changing the appearance of the pixelated screen.

In the cover photo, the two dark centers with emerging streamers are called "boojum," point defects in the molecular orientation of the liquid crystal. The defects form at the surface of a thin film of nematic fluid, the simplest form of a liquid crystal. The bands of different colors show the varying orientation of liquid crystal molecules around the defect.

This image was created by Oleg D. Lavrentovich, Trustees Research Professor, Liquid Crystal Institute and Chemical Physics Interdisciplinary Program, Kent State University. Work at the Liquid Crystal Institute explores the physical mechanisms behind the complex, three-dimensional molecular architectures and the practical applications of these materials. Research in liquid crystals at Kent State University has been supported by a series of National Science Foundation grants, (the most recent is NSF award number 17-29509).

Credit: *Oleg D. Lavrentovich, Liquid Crystal Institute, Kent State University*

Errata—*Science and Engineering Indicators 2018 Digest*

On page 15 of the print edition, in the theme U.S. S&E Workforce: Trends and Composition, the Y-axis label of the figure “Foreign-born individuals in U.S. S&E occupations, by level of degree and occupation: 2015” should say “Percent.” The label has been corrected in the web version and in the downloadable PDF.

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