THE INCREDIBLE, INCOMPARABLE ROI OF R&D

FEDERAL FUNDING FUELS THE INNOVATIONS THAT TRANSFORM OUR LIVES

Science and technology innovations drive the U.S. economy. Entire industries employing millions of Americans are the result of comparatively small federal investments in research and development (R&D). From the development of the microchip to the mapping of the human genome to the recent fusion energy breakthrough, the return on investment (ROI) of federal R&D is incredible and incomparable. Federally funded R&D not only creates new industries, it fuels the innovations that improve the health and well-being of all Americans and offers the promise to overcome the biggest challenges of our time.

In a recent House Science, Space & Technology hearing on China, Rep. Frank Lucas (R-Okla.) attributed more than 60% of America's economic growth over the past 100 years to scientific discoveries and technological advances.

In the same hearing, Rep. Suzanne Bonamici (D-Ore.) noted the U.S. has become complacent as its commitment to non-defense R&D has waned. That insufficient commitment to research and domestic manufacturing has created an opening in the past few decades — one that **China has seized** as it tries to take the lead in the global innovation race.

Today, the U.S. government spends **just 0.7%** of the nation's GDP on research and development, a far cry from the 1.9% it spent during the 1960s space race, which helped fuel many of the scientific and technological innovations we now take for granted. Foreign competitors are already making significant headway on their own R&D investments, and China is on track to surpass U.S. spending on research and development within the decade. If we wish to drive the United States to lead the world for the next half-century and beyond, we must — at a minimum — double federal spending relative to GDP to 1.4% by 2026.

While measuring the ROI of all federal R&D investments is nearly impossible, understanding its role in the astronomical growth of the U.S. economy over the past 75 years by examining key scientific and technological advances is not. To illustrate our point, we picked federally funded innovations that went on to transform the health, safety and prosperity of the United States.

GDP GROWTH (1950-2022)

1950

IBM HARD DRIVE

Building off the earlier invention of a model for a disk-based storage unit at the National Bureau of Standards (NBS) — today known as the National Institute of Standards and Technology (NIST) — **IBM** developed the first commercial hard disk drive (HDD) in 1956. The company released the first HDD **capable of storing an entire gigabyte** in 1980 — it was the size of a refrigerator. Today, HDDs are used in laptops and computers everywhere, and most drives have at least a full terabyte of data storage, with some high-capacity drives offering as much as 16TB of space. In 2022, experts estimated the worth of the **Global Hard Disk Drive Market** at $39.95 billion and predicted that value would increase to $56.34 billion by 2027.

1956

1960

1961

APOLLO PROJECT

The **Apollo space missions**, which culminated in landing the first humans on the moon in 1969, did more than just establish the United States' technological expertise for exploring space. The **Apollo program** paved the way for **thousands of inventions** we use on a daily basis such as microwaves, satellites and computing, as well as countless other spinoff technologies, ultimately launching new industries with huge economic impacts. Today, **NASA** supports hundreds of thousands of jobs and, in 2021, its $23.3 billion budget generated $71.2 billion in economic activity nationwide, creating 339,600 jobs and pulling in nearly $7.7 billion in federal, state, and local taxes. Of that impressive figure, its Artemis program — which aims to put astronauts back on the moon by the end of this decade — contributed nearly $20 billion to the economy, generating $2.2 billion in tax revenue and producing 37,000 jobs nationwide.

1969

1970

ARPANET

At the height of the **Cold War**, military commanders needed a computer communications system that couldn't be taken out in a single attack. At the time, these systems were housed in large terminals run by governments, universities and companies, making them vulnerable. That led the Defense Advanced Research Projects Agency (DARPA) to fund the development of the Advanced Research Projects Agency Network (ARPANET), initially to link computers at Pentagon-funded research institutions over telephone lines. After several years of work, the **first computer-to-computer message** took place in 1969. Ultimately, ARPANET became the first experimental computer network and a **forerunner of the internet** as we know it today. From e-mail to social media, the technology we use every day can all be traced back to ARPANET. Today, the internet is a major driver of job creation, business development and **economic growth**.

1978

1980

GPS

The launch of the first modern Navstar Global Positioning System (GPS) satellite in 1978 marked the culmination of more than 20 years of development that kicked off in response to Russia's **launch of Sputnik**. Over the next two decades, DARPA scientists developed a precursor to the modern-day GPS system called TRANSIT, which was only used for military applications. Eventually, the military opened up the **technology to the public**, and by the late 1980s, commercial development of GPS was in full force as the first commercially available handheld GPS units hit the market at a cost of $3,000. Today, GPS helps billions of people around the world navigate via their smartphones every day.

1990

1994

RQ-1 PREDATOR DRONE

The RQ-1 Predator's **origins** go back to a garage project by an Israeli emigrant named Abraham Karem, who in 1983 developed a small, long-endurance prototype for DARPA. Five years later, this led to the development of the GNAT 750. The Department of Defense then invested in a larger, more capable version of the prototype, leading to the creation of the RQ-1 Predator, a long-endurance, medium-altitude, turboprop-powered, multi-mission, **unmanned aircraft system (UAS)** that first flew in 1994. The development of the drone led to a monumental shift from "manned" to Remotely Piloted Aircraft Systems (RPAS), dramatically changing the strategy and tactics of warfare in the 21st century.

2000

2003

HUMAN GENOME PROJECT

Started in 1990 under the leadership of American geneticist Francis Collins with support from the U.S. Department of Energy and the National Institutes of Health (NIH), **the project** successfully determined, stored and rendered publicly available information on the sequences of the three billion chemical base pairs that make up human genomic DNA. Arguably the **single most influential** investment in modern science and a foundation for progress in the biological sciences moving forward, scientists declared the project complete in 2003. In the 20 years since then, the database has helped enable the identification of a variety of genes that are associated with disease while also revolutionizing the fields of forensics and anthropology. The **federal government invested $3.8 billion** in the Human Genome Project, which is estimated to have created more than 300,000 jobs and generated an economic output of $796 billion, thus showing a return on investment (ROI) to the U.S. economy of 141 to 1.

2010

2020

FUSION ENERGY BREAKTHROUGH

2022

In December 2022, the U.S. Department of Energy (DOE) and DOE's National Nuclear Security Administration (NNSA) **announced the achievement** of an energy positive fusion reaction, a major scientific breakthrough decades in the making that will pave the way for advancements in national defense and the future of clean power. While big challenges still exist and commercialization is decades away, fusion power's promise is unmatched in overcoming many of society's greatest challenges. And if the U.S. can commercialize fusion energy production, the economic, national security and quality-of-life benefits for every American will be incredible.

DECADES OF BIG — AND LITTLE — STEPS

One of the key principles of scientific progress is how discoveries both big and small build upon each other over the years, leading to phenomenal breakthroughs that wouldn't have been possible without decades of work. Two key innovations — semiconductors and biotechnology advances — highlight this concept as their development spans many decades and only continues to grow today.

SEMICONDUCTOR TECHNOLOGY (1950S-2020S)

When the first **microchip** was created in 1958, it would have been difficult to anticipate the significance **these tiny but essential components** would have on the electronic devices or economic growth over the past 65 years. Responsible for enabling advances in communications, computing, health care, space exploration, military systems, transportation, clean energy and countless other applications, the **discovery of semiconductor** materials transformed electronics. Without semiconductors, the miniaturization of computers and computer parts would not be possible, nor would the manufacturing of important electronic parts like diodes, advanced transistors and many photovoltaic cells. **Semiconductors**, first developed in far simpler form in the late 1800s, are the brains of modern electronics, enabling technologies critical to U.S. economic growth, national security and global competitiveness. The U.S. semiconductor industry is the worldwide industry leader in semiconductor R&D, with **about half of global market share** and sales of nearly $208 billion in 2020. **McKinsey** projects that the semiconductor industry will become a trillion-dollar industry by 2030. The importance of semiconductors led to the drafting of the CHIPS and Science Act, which **directs some $280 billion in spending** over the next 10 years to boost domestic research and manufacturing of semiconductors in the United States.

BIOTECHNOLOGY (1970S-2010S)

Initially driven by research in microbiology and DNA chemistry, the biotechnology and biomanufacturing industry today is booming and expected to reach $4 trillion by 2030. Along the way, it's powering innovations that can address societal challenges as wide-ranging as climate change, food insecurity and improving human health, and holds the capability to **transform the foundation of our physical world** – everything from clothing, to plastics, to fuels, to concrete. This revolutionary bioeconomy didn't happen overnight, however; it's the result of decades of key discoveries starting with a breakthrough in the early 1970s by a scientist who utilized a **restrictive enzyme to cut DNA into fragments**, resulting in the first recombinant DNA molecule ever synthesized in a lab. This technology fueled additional research into the structure of DNA, which opened the floodgates for DNA sequencing by the late 1970s. A few years later, the invention of the polymerase chain reaction allowed for multiplying DNA sequences, a breakthrough heralded as **one of the most important scientific advances** in molecular biology. Decades later, innovations in CRISPR gene-editing technologies today are opening up new avenues and applications in biomedical research and hold the potential to **reshape the detection and treatment** of cancer, genetic diseases such as sickle cell anemia and cystic fibrosis, and viral infections such as HIV.

FEDERAL INVESTMENT FUELED THESE INNOVATIONS

It's difficult to provide a specific return on investment for most of the federally funded R&D that led to the innovations highlighted here. That's because many of these technologies spawned other innovations and industries, and they also provide far more than an economic boost — they are essential for the intangible aspects of everyday life. What is absolutely clear is that government spending on R&D has a remarkable impact on the health, safety and quality of life of every American.

If the United States hopes to be as prosperous over the next 75 years, lawmakers must prioritize increasing federal investment in R&D and STEM education. With that goal in mind, the Science & Technology Action Committee recommends — at a bare minimum — doubling federal investment in these areas from **0.7% of GDP to 1.4%**. Failure to reach that level would leave the United States vulnerable to losing the innovation race against foreign competitors, limiting our ability to address national challenges and making us less competitive in the global economy.

Download the **Science & Technology Action Committee fact sheet** to learn more.