“Every scientific discovery travels its own path from inspiration to success,” says Dr France A Córdova, Director of the National Science Foundation – an agency that has supported researchers in discovering some of the most prominent scientific innovations over the last several decades. Providing financial support to conduct fundamental research, which leads over time to applied research, and ultimately to technological advances in the marketplace, NSF is an integral part of the journey to scientific discovery.

This issue of International Innovation celebrates scientific breakthroughs and discoveries in the last 200 years. Could you provide some insight into the National Science Foundation (NSF)’s achievements?

It’s tough to single out a few breakthroughs among the thousands of discoveries NSF has fostered. For more than 60 years, NSF investments in fundamental research have fuelled innovation across all sectors of science, engineering and technology. Collectively, NSF-funded researchers have won more than 210 Nobel Prizes for their work in the fields of physics, chemistry, physiology and medicine, and economics. Because of this comprehensive commitment to science, NSF has helped keep our nation at the very forefront of the science and engineering research and education enterprise.

How has the Foundation evolved since its establishment in 1950?

One amazing – but also sometimes frustrating – aspect of science is that you don’t know where the next huge discovery, like the internet, will come from. NSF has always supported fundamental scientific research, but such work takes time, inspiration, dedication – and funding support. As a result, more recently NSF has been developing new approaches focused on bringing the results of basic research into the broader scientific and engineering community. We call it ‘faster discovery to delivery’.

We were the first US federal agency to start the small business innovation research and technology transfer programmes. A few years ago, we launched the Innovation Corps programme – or I-Corps – which enables young graduate researchers to identify valuable product opportunities that emerge from NSF-funded research. I-Corps uses public-private partnerships to create a national ecosystem for innovation that couples scientific discovery with technology development and societal needs. It’s a fast track from innovation to market.

As one of the largest independent funding agencies, and with an annual budget of US $7.3 billion (FY 2015), how does NSF maintain its...
sterling reputation? What factors are taken into consideration when distributing funds across the scientific areas?

NSF funds fundamental research and education across all fields of science and engineering, reaching all 50 states and US territories through grants to nearly 2,000 colleges, universities and other institutions. Each year, NSF receives over 50,000 competitive requests for funding and makes about 11,000 new funding awards. We provide funding for a highly diverse population of investigators, who contribute to literally thousands of journals, articles, books, juried papers, filings for patents, instructional videos, testing and calibration devices, and so on.

NSF’s approach to accomplishing strategic goals is based on investing in fundamental research and education projects that are recommended for NSF support by the science and engineering communities using our merit review selection process, widely regarded as a gold standard among science funding agencies around the world. NSF’s policies and procedures maintain an open system of competition that identifies and enables pursuit of the most promising ideas for major advances.

You were nominated by President Barack Obama to head NSF and sworn in as Director on March 31, 2014. What skills and experience do you bring to this role?

I have about 150 scientific papers to my credit, many in journals like The Astrophysical Journal, as well as Science and Nature. I have also participated in many satellite-born telescope projects and used large ground-based telescope facilities all over the world.

My earlier background, however, was broader than strictly science. I didn’t have science role models as a young girl, and it wasn’t until I graduated from Stanford University with a degree in English that I realised I could be anything that I wanted to be. I received a doctorate in Physics from Caltech in 1979. Then, I spent a decade at Los Alamos National Laboratory in New Mexico, before making my first foray into administration at Penn State, where I served as Head of the Astronomy and Astrophysics Department.

My subsequent moves included becoming the first female – and youngest – Chief Scientist of NASA, and later serving as Vice-Chancellor for Research and a professor of Physics at the University of California at Santa Barbara, and as Chancellor and Distinguished Professor of Physics and Astronomy at the University of California at Riverside. At Riverside, I initiated the process for the first new medical school in California in over 40 years.

In 2007, I became President of Purdue University, where I presided over the establishment of Purdue’s College of Health and Human Sciences and its Global Policy Research Institute. I was appointed to the National Science Board in 2008, and then also chaired the governing board of the Smithsonian Institution in Washington, DC, the world’s largest museum complex. I have also served on the Board of the Mayo Clinic.
What innovative educational and training resources are implemented by NSF?

NSF’s work has contributed greatly to the nation’s reservoir of STEM human capital. The Foundation works to provide evidence-based models to improve STEM teaching and learning by investing in strategic areas such as: understanding how and under what conditions people learn STEM most effectively; preparing groups underrepresented in STEM and strengthening the institutions that serve them; training excellent STEM teachers and administrators; and providing engaging opportunities to learn STEM in community or virtual settings. On average, our Education and Human Resources Directorate supports more than 160,000 researchers, teachers and students through about 900 merit-based awards each year. Collectively, this work equips many more students and educators with the skills and infrastructure necessary to excel in science and engineering.

I should also add that NSF’s Graduate Research Fellowship (GRF) programme is the country’s oldest fellowship programme directly supporting graduate students in STEM fields. To date, approximately 50,000 promising graduate students have received GRFs, including 40 who eventually became Noble laureates. GRFs are also well-represented among government leaders, business executives, writers and members of the National Academy of Sciences – from former Secretary of Energy Steven Chu, to Google Co-Founder Sergey Brin, to Freakonomics Co-Author Steven Levitt.

Another popular education programme NSF has launched is NSF Days. These day-long workshops are held throughout the country on college campuses to provide basic insight and instruction on how to compete for funding for science, engineering and education research.

How has the political landscape changed in the past 10 years? Has this affected NSF’s ability to seek, encourage and promote new scientific discoveries?

The findings from NSF-funded research may be transformative in ways that can have important implications for policy and ultimately impact upon it. This is particularly true for research supported by our Directorate for Social, Behavioral and Economic Sciences. For example, basic research in economics led to the Federal Communications Commission’s current policy for spectrum auctions to apportion the airwaves. I am told that these auctions have brought in well over $60 billion in revenue to the Federal Government. Fundamental research on emotion recognition using nonverbal cues such as facial expression, tone of voice and body language has led the Army Research Institute to incorporate education in nonverbal communication into soldier training. This education has enhanced troops’ interpersonal skills, enabling them to anticipate and diffuse conflict, as well as facilitating cooperation, negotiation and compromise.

Research that produces computer simulations of water availability and demand is informing public policy for water management in Phoenix, Arizona, a desert city challenged by an expanding population, increased demands on land and water use, and expectations of a warmer and drier climate future. Similarly, research funded in our Directorate for Education and Human Resources in such areas as measuring STEM teacher knowledge and assessing student understanding of complex STEM concepts can provide useful background for education policy makers. These are but a few of many examples I could cite.

Although the political landscape changes over time, science is not a partisan issue. NSF’s highly regarded merit review process and criteria – intellectual merit and broader impact – also change very little.

FOUR PILLARS OF PROGRESS

Dr France A Córdova highlights why discovery, learning, research infrastructure and stewardship are the Foundation’s top priorities

DISCOVERY

Every scientific discovery travels its own path from inspiration to success. As many have noted, there’s no return on investment without investment. National Science Foundation (NSF) has always been there to fund ideas at the very beginning, and those great ideas can produce partnerships that lead to even more transformations. Take the mobile phone, for example, which has several different kinds of technologies embedded within it. None of those technologies would have had the same impact without all of them being put together in one convenient, reliable, transformative device. NSF helped researchers develop several of those breakthrough discoveries – and more recently, we have been proactive in encouraging researchers to bring their discoveries into the marketplace.

LEARNING

The research that NSF supports is thoroughly integrated with education to help expand the scientific literacy of all citizens; cultivate a world-class, broadly inclusive science and engineering workforce prepared to contribute to emerging scientific, engineering and technological fields; and develop a cadre of knowledgeable teachers to educate the next generation. Through our outreach, we make the point that it is essential to keep investments in research flowing, we need to constantly replenish the wellspring of new ideas and train new talent, drawing from the rich diversity of our nation.

RESEARCH INFRASTRUCTURE

Our recent Budget Request to Congress states that among NSF’s performance goals is to ‘ensure programme integrity and responsible stewardship of major research facilities and infrastructure’. Having concluded the construction of the Advanced Laser Interferometer Gravitational-wave Observatory and the Ocean Observatories Initiative, NSF is turning its attention to continuing construction of three major projects: the Daniel K Inouye Solar Telescope, the National Ecological Observatory Network and the Large Synoptic Survey Telescope (LSST). I might add that LSST was ranked the number one priority for ground-based astronomical facilities in the National Academies’ most recent Decadal Survey of Astronomy and Astrophysics. So NSF is demonstrating its continuing commitment to investing in major research infrastructure.

STEWARDSHIP

In order for science to be viewed as impartial, we must ensure that it is truthful. The public and those who fund research must know that we have put safeguards into place to ensure integrity in research; fund research that seeks to reproduce results; facilitate open access to data and publications; and conduct proper reviews. Plus, we consistently make the case that the types of investments we make are central to the agency’s mission and reflect a wise stewardship of taxpayer dollars while ensuring a strong return on taxpayers’ investments.
NSF FUNDING HAS FACILITATED MULTIPLE TECHNOLOGICAL LEAPS THAT HAVE DIRECTLY IMPROVED OUR DAILY LIVES

- Modern computers, the internet and web browsers
- Doppler radar
- Magnetic resonance imaging (MRI) scanning technology
- Improved laser eye surgery
- Barcodes
- Radio-frequency identification (RFID)
- Fibre optics
- Speech recognition
- Computer-aided design (CAD)
- The Global Positioning System (GPS)
- 3D printing
- Touch-screen technology
- DNA fingerprinting
- Screening for counterfeit pharmaceuticals
- Reducing blood infections
- Improved accuracy of 911 calls
- Improved detection of improvised explosive devices (IEDs)
- Search-and-rescue robots

Non-partisan panels of scientists provide fair and thorough reviews of proposals, ensuring that the research we fund is of the highest quality. While we can never predict with certainty whether a research project will generate findings that have transformative implications, we do know that the NSF process results in discoveries that have had important implications for policy and practice, and I am confident that this will continue into the future.

What is your vision for the future of NSF, and what mark do you hope to leave at the end of your tenure at the Foundation?

We never know where the next discoveries will come from, that’s why we are always looking for flexibility in funding. Making sure people understand the vital role of NSF as an investment in fundamental research – supporting a stronger economy, enhancing our quality of life, protecting national security and bringing that message to a wider audience. This is a role unique to us. Industry doesn’t invest in early stage research. Other government agencies utilise our basic research discoveries to further their missions. We need to make sure we maintain a stable foundation for discovery and innovation.