It’s Been a Great Ride!

After over five years of leading this wonderful organization, program, and community, I suppose I am allowed a few reflections and some emotion regarding my retirement as President of the Hertz Foundation.

First, there can be no doubt about the value of John Hertz’s vision. The need to find the most creative and unleash their abilities is as vital for the nation and world today as it was in the 1950s and perhaps more than ever. Second, we are unique and uniquely good at what we do. Others are amazed at the depth of the Hertz selection process, and I remain amazed at the care, concern and focus that all participants involved bring to assuring equity and accuracy in the assessment of candidates. The fact that we find more qualified candidates than we can fund is a problem of success. This remains a challenge for the future.

Mary and I have been lucky in our life together to be part of three vital communities: the national laboratory research world, the operational military world, and now the Hertz Community. We saved the best for last I suppose. To know that we will remain engaged with you at many levels is a pleasure and a comfort as I step out of this task and help Robbee Kosak, former Vice President for Advancement at Carnegie Mellon University, take Hertz to the next level. We will welcome Robbee at the Hertz office in June. I am looking forward to even more time with the young hooligans who called me their “Fantasy Grandfather” whenroasting me at the March Board Dinner.

With gratitude to the Hertz Community,
In 2014, the Fields Medal, which is awarded every four years by the International Mathematical Union to mathematicians under 40, was presented to Manjul in Seoul. The award credited Manjul with “developing powerful new methods in the geometry of numbers, which he applied to count rings of small rank and to bound the average rank of elliptic curves.” The award committee called him a “mathematician of extraordinary creativity (with) a taste for simple problems of timeless beauty, which he has solved by developing elegant and powerful new methods that offer deep insight…. He surely will bring more delights and surprises to mathematics in the years to come.”

Manjul’s range of interests are remarkably diverse. He is a professional-quality player of the tabla, an Indian percussion instrument. Visiting the Jaipur region of India, he learned Sanskrit from his grandfather and has published research in Sanskrit. At Princeton, he introduced new approaches to mathematics for beginning students. Princeton mathematics department chair David Gabai said, “Beyond being a great researcher and adviser to graduate students, Manjul is an extraordinary teacher.”

The US Senate confirmed the promotion of Lt. General Ellen M. Pawlikowski USAF, Hertz Fellow, to the rank of general on March 27, 2015. Effective July 2015, she will become commander of the Air Force Materiel Command. She is the third woman to earn the rank of general in Air Force history. She currently serves as Military Deputy, Office of the Assistant Secretary of the Air Force for Acquisition, the Pentagon, Washington, D.C. She is responsible for research and development, test, production, and modernization of Air Force programs worth more than $32 billion annually.

Ellen Pawlikowski completed her PhD education in chemical engineering at the University of California, Berkeley, with the support of a Hertz Fellowship. At the Hertz Foundation 50th Anniversary Symposium in 2013, she was a featured speaker at the University of Maryland on “The Changing Landscape in National Security Space.”

Ellen is nationally recognized for her leadership in the US science and technology community. She is a Fellow of the American Institute of Aeronautics and Astronautics and an elected member of the National Academy of Engineers. Previously, she has served as commander of the Space and Missile Systems Center at the Los Angeles Air Force Base, and as commander of the Air Force Research Laboratory managing scientific research and development operations of the Air Force.

‘Freedom, Security, and Encouragement’ Led To Fields Medal for Bhargava

The Fields Medal – the most prestigious prize in mathematics – is only the most recent math award won by Manjul Bhargava, professor at Princeton University and Hertz Fellow. He credits the “freedom, security and encouragement” provided by the Hertz Foundation Fellowship nearly two decades ago for allowing him to pursue unconventional but productive topics in mathematics.

During his Hertz Fellowship years, from 1996-2001 at Princeton University, Manjul was able to pursue topics that he found fascinating and that bore fruit only later. This work might have been impossible in a conventional graduate program. He was able “to work on many different topics during those years, some of which were wildly nonstandard and out of the mainstream, and out of fashion for decades, if not centuries. Those nonstandard topics were the ones that bore the most fruit and shaped the kinds of work I do,” he told Hertz Foundation President Jay Davis.

Manjul’s field is number theory, which means that he explores relationships between whole numbers that often appear abstract but sometimes reveal patterns of reality. One famous example of number theory is the Pythagorean Theorem.

After growing up on Long Island, Manjul went to Harvard, where he won the American Mathematics Society’s Morgan Prize for outstanding undergraduate mathematics research. He proceeded next to Princeton under the Hertz Fellowship, where he worked toward his PhD and astounded even his faculty advisor, the eminent mathematician Andrew Weil, by extending the work of the legendary 19th Century mathematician Carl Friedrich Gauss.

Manjul has won a number of awards since then; for example, the Blumenthal Award from the American Mathematical Society in 2005, the SASTRA Ramanujan Prize from India in 2005, the Fermat Prize from France in 2011, and the Infosys Prize in 2012.
Katie Bodner
Massachusetts Institute of Technology
Biological Engineering
Hollywood, Florida

Examining Cell Environments Surrounding Tumors

“I’ve always been fascinated by the medical applications of synthetic biology. I want to tackle problems relating to drug resistance in cancer – specifically, how the cell environment surrounding a tumor can influence how that tumor develops resistance to treatment. I want to understand all of these interactions, and then engineer better therapeutics.”

Katie Bodner’s research spans applying synthetic biology to cancer diagnostics, HIV vaccination, muscular dystrophy and biologics pharmaceutical production resulting in a publication and a patent. She co-founded MIT’s first biotechnology student initiative. Katie’s work on bringing DNA computing to mammalian cells led to a gold medal for MIT’s iGEM team, a global undergraduate competition in synthetic biology. As an Amgen Scholar, Katie developed a programmable, RNA platform for use as a vaccine for HIV and a therapeutic for Duchenne muscular dystrophy. She won the US Biologics Technical Development Outstanding Student Award and interned at Genentech. As a PhD student in bioengineering at Stanford, Katie will focus on applying systems biology to improve drug development.

Jordan Cotler
Massachusetts Institute of Technology
Physics and Mathematics
Northbrook, Illinois

Finding Magical Properties in Quantum Systems

“I discovered that unlike magic, the tricks of nature are even more miraculous when you know their secrets. My passion is understanding how our universe works at the most fundamental level. I am interested in leveraging insights about the interplay between quantum mechanics and time to enable experimentalists to explore new corners of the quantum world.”

Jordan Cotler discovered his passion for theoretical physics in high school when he performed summer research at Northwestern and Stanford. While still in high school, Jordan developed an original quantum cryptography protocol, earning him tenth place in the 2012 Intel Science Talent Search. At MIT, Jordan has performed research in theoretical physics, mathematics and neuroscience, resulting in several publications. His ongoing collaboration with Nobel Laureate Frank Wilczek includes the discovery of entanglement enabled intensity interferometry. A magician since the age of eight, Jordan is internationally known for creating original card effects, sold worldwide. Jordan will pursue his PhD at Stanford, focusing on the intersection of high energy physics and quantum information theory.

Cole Graham
Massachusetts Institute of Technology
Mathematics and Physics
Olympia, Washington

Building Equations to Understand Our World’s Physical Systems

“One real world application of my research is that the more equations we can get a handle on, the better we can understand the physical systems that govern our world – such as understanding heat flow in metals and phase changes in magnets.”

Encouraged by his parents at a young age, Cole Graham studied eagerly between scientific disciplines until high school, when he participated in the 2009 Summer Institute for Mathematics at the University of Washington. He became enchanted by mathematical analysis, and resolved to study the field in greater depth. He is proud of his contributions to reaction-diffusion theory and the study of polynomial zeros. Cole will pursue a PhD in mathematics at Stanford University. His research interests include the theory of stable polynomials, partial differential equations on manifolds, and harmonic analysis. Cole says, “The Hertz Fellowship will give me flexibility in my own research and the resource of the community of Hertz Fellows across disciplines.”

Adam Jermyn
California Institute of Technology
Physics
Longmeadow, Massachusetts

Investigating Complex Interactions in Biological Feedback and Neural Systems

“An important part of my work is understanding how the variety of phenomena we see all around us comes from the steady operation of simple rules. The laws are simple and compact, which makes the complexity with which they unfold fascinating to me.”

A Goldwater Scholar, a Marshall Scholar, and the recipient of numerous Caltech research awards, Adam Jermyn studied physics at Caltech. While there, he conducted research in the biochemistry of Alzheimer’s disease, solar energy, astrophysics, and quantum computing, and has begun writing a textbook on wave mechanics. As a Marshall Scholar, Adam will investigate planet formation in binary star systems at the University of Cambridge. He will return to the US for graduate work on emergent phenomena in condensed matter and biophysics. He was the opening speaker at Caltech’s first teaching conference, and established a seminar series for freshmen pursuing research at the Jet Propulsion Laboratory.
Ben Mildenhall

Stanford University

Computer Science and Mathematics

Oak Park, Illinois

Designing with Human Perception in Mind

"With the Hertz Fellowship, I’m immensely excited and grateful to not have to worry about funding for my research. It feels like a weight has been lifted. I’m motivated by the intellectual freedom this will provide for collaboration and exploration in my work to bring human spatial awareness and intuition into graphics."

As an undergraduate at Stanford, Ben Mildenhall worked on applying probabilistic inference techniques to various problems, including reinforcement learning, handwriting recognition, and procedural content generation. Ben worked in the Pixar research group on methods for prefiltering geometric data in order to decrease rendering times. As a graduate student at UC Berkeley, Ben will be developing new methods for computationally capturing, analyzing, and displaying spatial and geometric data as these problems become increasingly relevant with the rise of new technologies, such as virtual reality headsets and self-driving cars. He says, “Taking how we actually look at the world and integrating that into the future design of algorithms and hardware for capturing and displaying visual information would be a huge leap forward.”

Sabrina Pasterski

Harvard University

High Energy Physics

Chicago, Illinois

Pushing the Boundaries of Engineering with Theoretical Physics

"After internships at Blue Origin, NASA, and Boeing, I saw that the biggest limitations to what I could achieve had answers that could only be found with a thorough understanding of fundamental physics. The point of what we study is not to be ‘right’ per some absolute metric, but for our results to be useful."

Sabrina Pasterski is a proud first-generation Cuban-American and Chicago Public Schools alumna who, by 16, had built and flown her own airplane. She became the first MIT freshman named to the NASA January Operational Internship and earned the inaugural MIT Freshman Entrepreneurship Award. After a summer at Phantom-Works, excelling at MIT and being hired by CERN-CMS, she was named a Lindau Nobel Young Researcher. She graduated #1 at MIT-Physics, matriculated into Harvard’s PhD program and was awarded her SB while still a teenager. Sabrina was named to Scientific American’s 30 under 30 in 2012 as well as the 2015 Forbes 30 under 30 Science list.

Maxim Rabinovich

University of California, Berkeley

Computer Science

St. Petersburg, Florida

Creating Tools to Extend Human Reasoning

“The scientific community needs tools, and that’s a big part of what artificial intelligence can offer. I’m interested in building more efficient ways to gather and process information. One of the great things about the Hertz Fellowship is that it puts an emphasis on going out in the world and using science to do interesting things.”

Born in Ukraine, Maxim Rabinovich earned his AB in mathematics (with highest honors) from Princeton University. There he developed new techniques for analyzing topic-specific opinion in large document collections – winning him the Middleton Miller Prize for Best Senior Thesis. He then obtained an MPhil in information engineering from the University of Cambridge, where he designed novel statistical estimation algorithms with applications to automated question answering and fact database construction. Now a PhD student in computer science at UC Berkeley, Maxim is researching machine learning and natural language processing. He is interested in developing artificial intelligence tools that support and extend human reasoning.

Ben Shababo

University of California, Berkeley

Systems and Computational Neuroscience

Havertown, Pennsylvania

Uncovering the Mysteries of Learning and Memory

“I find it fascinating that the world we perceive around us is constructed inside each of our heads. In my research, I want to map out how information flows through the nervous system from input to output. I’m excited because through the Hertz Foundation Community I can collaborate with peers across disciplines.”

Ben Shababo has edited television commercials with million dollar budgets and recorded from neurons no more than ten microns in diameter. He has created interactive art installations and built a system where a user can control a robotic hand simply by moving their eyebrows. At Columbia University, Ben’s work on a computational method for inferring monosynaptic connectivity in neural circuits earned Ben the Young Computational Neuroscientist Award. He is a first-year graduate student in the Helen Wills Neuroscience Institute at UC Berkeley, where he is devoted to uncovering the mysteries of how the nervous system learns about the world and uses that information to change behavior. Ben says, “The Hertz Fellowship will provide me with the freedom to coordinate projects that require ambitious, interdisciplinary collaboration.”
Ravi Sheth

Rice University
Bioengineering and Synthetic Biology
Cincinnati, Ohio

**Engineering Bacteria as Precise Therapeutics and Diagnostics**

“The overarching question I want to explore is: what are the design rules for engineering communities of bacteria for useful purposes? The first real applications for this field are just beginning, and I’m deeply excited to have the freedom of the Hertz Fellowship to be creative and innovative in pushing it forward.”

Ravi Sheth developed a new research direction for his synthetic biology lab at Rice University to precisely engineer synthetic probiotic bacteria that can sense and respond to disease in the mammalian gut. Ravi published a second author paper, and has one first author manuscript in preparation. He helped write nine grants on his projects, receiving over $1.4 million in funding, and mentored ten students (postdocs, grad students and undergrads) towards his research aims. Ravi co-founded a VC-funded startup (STEAMtrax LLC) with Rice’s Provost that provides 3D printing curriculum to over 50,000 K12 students nationwide. He served as Rice’s Student Association President.

Alexander Siegenfeld

Massachusetts Institute of Technology
Physics, Condensed Matter Theory
Westport, Connecticut

**Understanding the Physics and Chemistry of Exotic Materials with Useful Properties**

“I want to bring chemical thinking into research models in physics so that we can better understand where on the periodic table to look for materials with desirable properties. This field can be very counterintuitive, and I find that interesting. I want to use my research to develop better tools and materials for society.”

Alex Siegenfeld is interested in combining chemical intuition with mathematical rigor to further the understanding of materials with exotic and useful properties. In 2010, Alex represented the United States at the International Chemistry Olympiad, where he won a gold medal. As an undergraduate at MIT, he created a model that explained an unusual inverse melting electronic phase transition in strontium-doped lanthanum nickelate, a material similar in structure to the cuprate superconductors. He also conducted research on topological insulators, a recently discovered class of substances that have great technological potential due to their being insulating in the interior but conducting on the surface.

Charles Tschirhart

California Institute of Technology
Physics, Experimental Condensed Matter Physics
Naperville, Illinois

**Exploring at the Boundary of Physics and Chemistry**

“The long lasting and useful benefit of the Hertz Fellowship is the Hertz Community of Fellows. They are brilliant people doing exciting things and will be great scientists to know and work with in the future. A lot of the theoretical framework behind my research in nanotechnology and fluid dynamics bridges into chemistry, and it’s important to me to have a community to collaborate with.”

Charles Tschirhart’s interests include nanotechnology and fluid dynamics. At Caltech, he has done work applying fabrication techniques from the microelectronics industry to problems in biological sensing, which resulted in a patent application (currently pending). More recently he has been working on an experiment designed to investigate how the equations of hydrodynamics break down at extremely small scales. Such experiments can be used to produce models which allow scientists and engineers to understand and predict how liquids flow at the nanoscale, which has applications for problems in many fields. He is also an avid amateur fossil-hunter.

Katherine Xue

University of Washington
Biology, Genome Sciences
Knoxville, Tennessee

**Using Genomics to Study the Evolutionary Past and Present**

“Scientific literacy is incredibly important in today’s society—it informs decisions ranging from everyday choices to issues of international importance. I think that scientists have a responsibility to communicate to the public not only about scientific findings, but also about scientific ways of thinking.”

Katherine Xue is broadly interested in evolutionary biology and has worked on research projects in biochemistry, microbiology, and molecular genetics. As a graduate student, Katherine is applying frameworks from theoretical evolutionary biology to problems in medicine and ecology. She hopes to harness the power of genomic technologies to understand evolutionary forces and their lasting effects. Katherine is dedicated to science communication; she was an undergraduate fellow and later associate editor for Harvard Magazine. She has written over 50 articles covering academic research and university news, and received Harvard University’s Bowdoin Prize for her writing.
In the Words of Hertz Fellows… Wide Reaching Influence and Leverage

Inspire

“The Hertz network is now as valuable as the Hertz Fellowship.”
– Chris Loose
Co-Founder, Semprus BioSciences

“Having attended every Summer Workshop since their inception, I can honestly say that they have all been very rewarding. The workshop was started by a Hertz alumnus wanting to foster collaboration amongst Hertz Fellows across all generations, and that spirit permeates the workshop experience with its very informal format.

The Hertz Summer Workshop has been a very good opportunity to learn the latest ideas across a wide variety of scientific disciplines. It has also been a very good way to establish connections both with in-school Fellows and alumni. It’s probably the only place in the world where such a diverse set of top-notch technical talent sits in the same room, mostly in shorts and flip-flops, listening to a technical talk by a famous speaker.”
– Ed Richley
Chief Scientist, Zebra Technologies

Innovate

“The Hertz Fellowship was absolutely key, I believe the term is transformational, in my early career. My life would have been very different without it. In 1995 in a leap of faith, I switched my field from combustion to combustion-and-atmosphere. I could not have predicted that the work I wanted to do would not be traditionally fundable for another eight years. It was the Hertz Fellowship that gave me the freedom to pursue my work.

There’s an enormous difference between inquiry that is pre-directed, and inquiry that simply encourages the following of one’s nose. Hertz allowed me the intellectual license not only to succeed, but also to explore, go down blind alleys, fail, and learn from it.”
– Tami Bond
Professor, University of Illinois
MacArthur Fellow

Impact

“As a PhD student, the Hertz Fellowship gave me freedom to fuse different disciplines and help drive the new field of neuro-engineering, which yielded optogenetic tools now used throughout the field of neuroscience.”
– Ed Boyden
Associate Professor, MIT Media Lab

“I was awarded a Hertz Fellowship midway in my graduate studies at MIT. It let me not only pursue a thesis problem of my choosing – on the attenuation of seismic waves in Earth’s mantle – but also let me publish work on problems in marine geophysics and lunar geophysics unrelated to my thesis. The oceanographic and planetary work that the Fellowship enabled opened directions for the scientific research I’ve continued to pursue throughout my professional career.”
– Sean Solomon
Director, Lamont Doherty Earth Observatory
National Medal of Science
Imbued with a passion for science and engineering from a young age, Joseph Rosenthal, Hertz Fellow 2010, has never lost sight of his love for solving mysteries, and building new things to save lives. Today, he is on the cutting edge of vaccine research, manufacturing nanoparticles able to mimic disease-causing pathogens, in essence “hacking” the body’s immune system to better ward off illnesses.

“We’re reprogramming biology to do the work for us,” Joseph describes, “It’s a huge revolution in vaccine technology.” Joseph, age 26, earned his PhD in biomedical engineering from Cornell University in May 2014 and now he is taking what he’s learned to Harvard Medical School, where he intends to apply his knowledge to the fight against cancer. “We’ve been manipulating the immune system to attack a lot of things. Similar strategies, if applied to cancer, can be used in the same way,” he added. “You could design a personalized vaccine to fully activate the immune system, so every time a tumor tries to grow back, it’s attacked.”

The basis for Joseph’s latest research is his graduate work at Cornell, where he learned to harness the interaction between bacteria and the immune system to engineer “smart vaccines” that could prevent infectious diseases and allergies instead of treating them after the fact. During the latter part of his doctoral studies, Joseph focused his attention on one of the most common causes of food-related deaths – peanut allergies. “Our thinking was that the whole problem is in an incorrect programming of the immune system,” he explains. “So what if we programmed the immune system in the right way?”

Through bioengineering, Joseph found it was possible to permanently “educate” the immune system to respond to the allergen in peanuts in a measured, appropriate fashion, instead of triggering the hypersensitive response that causes the most serious health problems for sufferers. A vaccine, he details, could be given to infants to prevent peanut allergies from ever forming, in the same way physicians treat a number of serious diseases. While it will take some time for allergy experts to warm up to the idea, Joseph is hopeful immunotherapy will be more commonly used to prevent allergies in the next ten to twenty years.

Born and raised in Houston, Texas, Joseph grew up in an environment supportive of science. He developed an early interest in combining technology with biology to heal people. At Rice University as an undergraduate, Joseph was exposed to bioengineering, where he found his calling to explore research in bioengineering and medicine. “For me, the frontier was clear,” he said. “We’d been building things rationally on every imaginable scale, except the smallest scale. That was very exciting for me.”

Editors: Diann Callaghan & Amanda O’Connor; Design: Lori Barnett Design