



NATIONAL ACADEMY OF ENGINEERING

2017 ANNUAL MEETING

October 8–9, 2017
Washington, DC



AUTONOMOUS SYSTEMS

The National Academies of
SCIENCES • ENGINEERING • MEDICINE



NATIONAL ACADEMY OF ENGINEERING 2017 ANNUAL MEETING

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SUNDAY, OCTOBER 8

10:00 am–4:00 pm

Registration

NAS 120

11:00 am–12:15 pm

Brunch Buffet

West Lawn

11:00 am–12:15 pm

Financial, Gift, and Estate Planning in a New Tax Law Environment: What It Might Mean (advance registration encouraged; brunch included) **Members' Room**



Led by Cindy Sterling, ChFC & RL, Sterling Financial Planning

Tax law changes may be coming. This session will review the potential changes and how they may affect your financial, gift, and estate planning goals.

Cindy Sterling is the founder and president of Sterling Financial Planning, a fee-only financial planning firm in New York City. She is also a consultant with Washburn & McGoldrick, advising educational institutions on advancement and philanthropy since 2000. She earned both her bachelor's degree in economics and master's degree in psychological services at the University of Pennsylvania. She also holds the chartered financial consultant designation from the American College of Financial Services and is a registered life planner from the Kinder Institute. Before starting her financial planning firm in 2004, she was director of gift planning at Vassar College. She is an author and award-winning speaker on financial planning topics such as women's philanthropy.

12:30–2:00 pm

PUBLIC PROGRAM

**Fred Kavli
Auditorium**

Chair's Remarks

Mr. Gordon R. England

Chair, National Academy of Engineering



Gordon R. England is chair of the board of PFP Cybersecurity and a partner of Dyno-Tech, LLC. Previously, he served as deputy secretary of defense (2005–09) and, as secretary of the Navy (2001–06), was credited with developing successful surge plans for America's fleet, strengthening the ties between the Navy and the US Coast Guard, and increasing assistance to the US Marines on the front lines in Iraq. He was the first deputy secretary of the Department of Homeland Security (2003).

Mr. England's business career spanned over 40 years as an engineer and senior executive, largely at General Dynamics, where he was executive vice president of the Information Systems & Technology Sector (1997–2001); president of the GD Fort Worth Aircraft Company (later Lockheed) (1991–95), responsible for all domestic and international aircraft programs, including the F-16 fighter; president (1990–91) and vice president, engineering, of GD Land Systems Company (1986–90); and director of avionics of the Fort Worth Company (1980–86). He began his career at Honeywell, where he was an engineer on the Project Gemini space program.

Mr. England was elected to the NAE in 2012 for advances in digital avionics for aircraft, land, and naval platforms. He cochairs the academies' Government-University-Industry Research Roundtable and served on the NAE Aerospace Engineering Peer Committee, the Workshop on Trends in the Innovation Ecosystem: Can Past Successes Help Inform Future Strategies?, the Mobility Systems Panel, and the Committee on Fault Isolation.

He has been active in a variety of civic, charitable, and government organizations, including serving as a city councilman. He is chair of the board of the US Naval Institute Foundation, serves on the boards of the Community Learning Center and Gillet Capital Partners, the advisory council of Business Executives for National Security, Inc., and the University of Maryland trustees board, and is an honorary trustee on the board of directors of the National Museum of the Pacific War. He is vice president of the Academy of Medicine, Engineering, and Science of Texas. He served on the USO board of governors, DOD Defense Science Board, MERRA—Michigan R&D Cooperative (chair), Michigan Chapter of ADPA (president), Defense Manufacturing Board on Concurrent Engineering, Engineering Board of Advisors of the Universities of Texas and Michigan and Oakland University, Board of Goodwill (vice chair), and CACI board of directors.

Mr. England has been recognized for numerous professional and service contributions, with an Honorary Doctor of Science, Oakland University (2003); IEEE Centennial Award; Commander Cross—Republic of Poland; Silver Knight of Management Award from the National Management Association; DOD Distinguished Public Service Award; Henry M. Jackson Award; NIDA Dwight Eisenhower Award; USCG Distinguished Public Service Award; Navy League David M. Thompson Award; Naval Order of US Admiral George Dewey Award; 2005 Charles Francis Adams Award; Department of VA Exceptional Service Award; Armed Forces Foundation Award; Boy Scouts of America Distinguished Citizen Award Silver Beaver; Union League Lincoln Award; Goodwill Industries Person of the Year; and USO Distinguished Citizen Award. He is a member of Beta Gamma Sigma (business), Omicron Delta Kappa (leadership), and Eta Kappa Nu (engineering).

He received a BS degree in electrical engineering from the University of Maryland, College Park in 1961, and an MBA from Texas Christian University in 1975.



President's Address

Dr. C. D. Mote, Jr.

President, National Academy of Engineering and
Vice Chair, Governing Board of the National Research Council

C. D. Mote, Jr. is president of the National Academy of Engineering and Regents' Professor on leave from the University of Maryland, College Park.

Dr. Mote is a native Californian who earned his BS, MS, and PhD degrees at the University of California, Berkeley in mechanical engineering between 1959 and 1963. After a postdoctoral year in England and three years as an assistant professor at the Carnegie Institute of Technology in Pittsburgh, he returned to Berkeley to join the faculty in mechanical engineering for the next 31 years. He and his students investigated the dynamics, stability, and control of high-speed rotating and translating continua (e.g., disks, webs, tapes, and cables) as well as biomechanical problems associated with snow skiing. He coined the area called "dynamics of axially moving materials" encompassing these systems. Fifty-eight PhD students earned their degrees under his mentorship.

He held an endowed chair in mechanical systems at Berkeley and chaired the Mechanical Engineering Department from 1987 to 1991, when the National Research Council (NRC) ranked its graduate program effectiveness highest nationally. Because of his success at raising funds for mechanical engineering, in 1991 he was appointed vice chancellor to create and lead a \$1 billion capital campaign, which raised \$1.4 billion.

In 1998 Dr. Mote was recruited to the presidency of the University of Maryland, College Park, a position he held until 2010 when he was appointed Regents' Professor. His goal for the university was to elevate its self-expectation of achievement and its national and global positions through proactive initiatives. During his tenure the number of Academy members on the faculty tripled, three Nobel laureates were recognized, and an accredited school of public health and a new department of bioengineering were created. He also founded a 130-acre research park next to the campus, faculty research funds increased by 150 percent, and partnerships with surrounding federal agencies and with international organizations expanded greatly. The number of students studying abroad tripled, and he created an annual open house day that attracts over 100,000 visitors, founded a charitable foundation for the campus whose board of trustees launched and led a successful \$1 billion capital campaign, and took to lunch every student that wanted to go. The Academic Ranking of World Universities ranked the campus #36 in 2010 and its Engineering School #13.

The NAE elected him to membership in 1988 and to the positions of councillor (2002–08), treasurer (2009–13), and president for a six-year term beginning July 1, 2013. He has served on the NRC governing board executive committee since 2009.

Dr. Mote's recognitions include the NAE Founders Award, the American Society of Mechanical Engineers (ASME) Medal, and the Humboldt Prize of the Federal Republic of Germany. He is an honorary fellow of ASME, honorary member of the American Society for Engineering Education, and fellow of the American Academy of Arts and Sciences, American Academy of Mechanics, Acoustical Society of America, and American Association for the Advancement of Science. He holds four honorary doctorates and three honorary professorships. He was elected to the Chinese Academy of Engineering in 2015 and as an honorary academician of the Academia Sinica, Taiwan in 2016.

As president of the NAE Dr. Mote is committed to ensuring highly competitive talent in the US engineering workforce, facilitating public understanding of engineering, demonstrating how engineering creates a better quality of life, and engaging the academy in global engineering issues in support of national interests. A highlight of global engineering engagement is the promotion of the NAE's 14 Grand Challenges for Engineering, whose solutions are needed to achieve the global vision "Continuation of life on the planet, making our world more sustainable, safe, healthy, and joyful."

Induction Ceremony for the NAE Class of 2017



Dr. Alton D. Romig, Jr.
Executive Officer, National Academy of Engineering

As executive officer of the National Academy of Engineering, **Alton D. Romig, Jr.** is the chief operating officer responsible for the program, financial, and membership operations of the academy, reporting to the NAE president.

He was previously vice president and general manager of Lockheed Martin Aeronautics Company Advanced Development Programs, better known as the Skunk Works®. He spent the majority of his career at Sandia National Laboratories, operated by the Lockheed Martin Corporation, having joined Sandia as a member of the technical staff in 1979 and moved through a succession of R&D management positions leading to his appointment as executive vice president in 2005. He served as deputy laboratories director and chief operating officer until 2010, when he transferred to the Skunk Works.

He is active on a number of advisory committees including those at the University of Washington, MIT, Ohio State, Purdue, the Colorado School of Mines, and Sandia. He is also visiting associate of applied physics and materials science at Caltech.

Dr. Romig is a fellow of ASM International, TMS, IEEE, AIAA, and AAAS. He was elected to the NAE in 2003 and the Council on Foreign Relations in 2008, and was awarded the ASM Silver Medal for Materials Research in 1988. He received his BS (1975), MS (1977), and PhD (1979) in materials science and engineering from Lehigh University.

2:00–2:30 pm

Break (NAE Class of 2017 and Anniversary Members group photo)

Class of 2017 and 25th Anniversary Members (Class of 1992) proceed with NAE staff guidance to the Constitution Avenue Lobby

2:30–4:00 pm

Awards Program

2:30–2:50 pm

2017 Simon Ramo Founders Award Recipient



Dr. John E. Hopcroft
Professor, Computer Science Department
Cornell University

The Simon Ramo Founders Award, the oldest award presented by the National Academy of Engineering, was established in 1965 to honor an outstanding NAE member or foreign member who has upheld the ideals and principles of the NAE through professional, educational, and personal achievement and accomplishment.

John E. Hopcroft, recipient of the 2017 Simon Ramo Founders Award, is being honored “for contributions to the advancement of computer science through pioneering publications, educational leadership, public service, and outstanding research.”

Dr. Hopcroft is the IBM Professor of Engineering and Applied Mathematics in Computer Science at Cornell University. His research centers on theoretical aspects of computer science. He was dean of Cornell’s College of Engineering from 1994 to 2001.

In 1992 he was appointed by President George H.W. Bush to the National Science Board, which oversees the National Science Foundation, and served through May 1998. He serves on Microsoft’s Technical Advisory Board for Research Asia, and the advisory boards of IIT Delhi and Seattle University’s College of Engineering.

He is a member of the National Academy of Engineering (1989) and National Academy of Sciences (2009), and a fellow of the American Academy of Arts and Sciences, American Association for the Advancement of Science, Institute of Electrical and Electronics Engineers (IEEE), Association of Computing Machinery (ACM), and Society of Industrial and Applied Mathematics.

He has received the A.M. Turing Award (1986), IEEE Harry Goode Memorial Award (2005), Computing Research Association’s Distinguished Service Award (2007), ACM Karl V. Karlstrom Outstanding Educator Award (2009), IEEE John von Neumann Medal (2010), and China’s Friendship Medal (2016), China’s highest recognition for a foreigner. In addition, the Chinese Academy of Sciences has designated him an Einstein professor.

He has honorary degrees from Seattle University, the National College of Ireland, the University of Sydney, St. Petersburg State University in Russia, Beijing University of Technology, and Hong Kong University of Science and Technology, and is an honorary professor of the Beijing Institute of Technology, Shanghai Jiao Tong University, Chongqing University, Yunnan University, and Peking University.

He received his BS (1961) from Seattle University and his MS (1962) and PhD (1964) in electrical engineering from Stanford University.

2:50–3:10 pm

2017 Arthur M. Bueche Award Recipient



Dr. Louis J. Lanzerotti
(Retired Distinguished Member Technical Staff
Bell Laboratories, Alcatel Lucent)
Distinguished Research Professor, Department of Physics
New Jersey Institute of Technology

The Arthur M. Bueche Award of the National Academy of Engineering recognizes an engineer who has been actively involved in determining US science and technology policy, promoting technological developments, and contributing to the enhancement of relations between industries, government, and universities.

Louis J. Lanzerotti, recipient of the 2017 Arthur M. Bueche Award, is being honored “for leadership in understanding the Earth’s radiation environment and its effects on communications and space hardware, and for contributions to public policy on space-based research.”

Louis J. Lanzerotti was born and grew up in Carlinville, Illinois. After a postdoctoral fellowship at Harvard University, he joined the technical staff of AT&T Bell Laboratories in 1965. He retired in 2002 and remained a consultant to Alcatel-Lucent through 2008. In 2002 he was appointed a Distinguished Research Professor of Physics in the Center for Solar-Terrestrial Research at the New Jersey Institute of Technology. He has also been an adjunct professor of electrical engineering at the University of Florida and a Regents’ Lecturer at UCLA.

His primary research interests have included space plasmas, geophysics, and engineering problems related to the impacts of atmospheric and space processes and the space environment on space and terrestrial technologies. Much of his research has involved close collaborations with telecommunication service providers on commercial satellite and long-haul (principally transoceanic) cables. His research has also involved geomagnetism, solid earth geophysics, and some oceanography. This research has been applied to the design and operation of systems associated with spacecraft and cable operations.

He has been principal investigator (PI) or coinvestigator on a number of NASA Earth, planetary, and interplanetary missions (ATS-1&3, IMP-4&5, Voyager 1&2, Ulysses, Galileo Orbiter and Entry Probe, and Cassini), and is currently a PI with instruments on the two spacecraft in the NASA Van Allen Probes mission launched in August 2012. He has also conducted geophysical research in the Antarctic and Arctic (beginning in the 1970s), directed largely toward understanding Earth’s upper atmosphere and space environments.

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He has coauthored one book, coedited four books, is an author of more than 500 refereed engineering and science papers, and was founding editor of *Space Weather: The International Journal of Research and Applications*, published by the American Geophysical Union (AGU). He has eight patents.

He was appointed in 2004 by President George W. Bush to a six-year term on the National Science Board and chaired its Committee on Science and Engineering Indicators (2006–10). He also served on the NASA Advisory Council (1988–94) and Vice President's Space Council Advisory Committee (1990–92), was vice president of COSPAR (1994–2002), and chaired the Assessment Committee for the National Space Weather Program (2006), Fachbeirat of the Max-Planck-Institut für Aeronomie (1994–2006), governing board of the American Institute of Physics (AIP; 2007–15), and AIP Publishing board of managers.

He has been active on numerous committees of the National Academies. Among others, he chaired the Committee on Solar and Space Physics, Space Studies Board, Army Research Laboratory Technical Assessment Board, Antarctic Committee on Science and Policy, Decadal Survey of Solar and Space Physics, Spent Nuclear Fuel, Committee on Assessment of Options for Extending the Life of the Hubble Space Telescope, and Committee on Electronic Vehicle Controls and Unattended Acceleration.

In addition to the NAE (1988), he is a member of the International Academy of Astronautics (IAA; 1987) and a fellow of the Institute of Electrical and Electronics Engineers (IEEE), American Institute of Aeronautics and Astronautics (AIAA), AGU, American Physical Society (APS), and American Association for the Advancement of Science (AAAS). He is the recipient of two NASA Distinguished Public Service Medals, the NASA Distinguished Scientific Achievement Medal, AGU William Bowie Medal (2011; the highest award of the AGU), COSPAR William Nordberg Medal (2004), IAA Basic Science Award (2012), Innovators Award from the New Jersey Inventors Hall of Fame (2012), Space Weather Award from the American Meteorological Society (2014), AGU William Kaula Award (2016), and Antarctic Service Medal (1978). Minor Planet 5504 Lanzerotti recognizes his space and planetary research, and Mount Lanzerotti (74.50° S, 70.33° W) recognizes his research in the Antarctic.

He was elected to three consecutive 3-year terms (1982–90) on his local (Harding Township, NJ) school board, and served as chair of the Curriculum Committee (8 years) and vice president (5 years). He was elected to seven terms (1993–2014) on the township's governing body and was mayor in 2007–09 and 2013.

He received his BS in engineering physics from the University of Illinois at Urbana-Champaign (1960) and his AM (1963) and PhD (1965), both in physics, from Harvard University.

3:10–4:00 pm

Bernard M. Gordon Prize for Innovation in Engineering and Technology Education Lecture

The Bernard M. Gordon Prize for Innovation in Engineering and Technology Education recognizes new modalities and experiments in education that develop effective engineering leaders. It focuses on innovations such as curricular design, teaching methods, and technology-related learning that strengthen students' capabilities and desire to grow into leadership roles.



This year's Bernard M. Gordon Prize for Innovation in Engineering and Technology Education recognizes Northwestern University's educator **Julio M. Ottino** "for an educational paradigm that merges analytical, rational left-brain skills with creative, expansive right-brain skills to develop engineering leaders."

Julio Mario Ottino is dean of the Robert R. McCormick School of Engineering and Applied Sciences at Northwestern University, where he is also Distinguished Robert R. McCormick Institute Professor, Walter P. Murphy Professor of Chemical and Biological Engineering, and professor (by courtesy) of mechanical engineering. He previously held positions at the University of Massachusetts Amherst as well as chair and senior appointments at the California Institute of Technology and Stanford University, and has supervised more than 50 PhD theses. He is the founder and former director of the Northwestern Institute on Complex Systems (NICO).

His research in fluid dynamics, chaos and nonlinear dynamics, and complex systems has been featured in articles and on the covers of *Nature*, *Science*, *Scientific American*, the *Proceedings of the National Academy of Sciences of the USA*, and other publications and has impacted fields as diverse as complex systems, microfluidics, geophysical sciences, and nonlinear dynamics and chaos. He has written more than 220 papers; one of his monographs has been cited over 2,600 times.

In addition to his election to the National Academy of Engineering (1997) and American Academy of Arts and Sciences (2003), Dr. Ottino has been selected as a Guggenheim fellow (2001) and American Physical Society (APS) fellow (1993). He has received numerous national awards, including the Alpha Chi Sigma Award for Chemical Engineering Research (1994) and William H. Walker Award for Excellence in Contributions to Chemical Engineering Literature (2001) from the American Institute of Chemical Engineers (AIChE) and the APS Fluid Dynamics Prize (2008). Also in 2008 he was identified by the AIChE as one of the "100 Engineers of the Modern Era," and in 2010 he was selected to deliver the AIChE Institute Lecture.

He has chaired committees for the National Science Foundation, National Research Council, and NAE; was a member of the International Review of Engineering in the United Kingdom; and has served on multiple visiting boards for nonprofit organizations and educational institutions in the United States. He was a senior advisor to Unilever, and a member of the technical advisory board of Dow Chemical and the science board of AkzoNobel. He has consulted for 3M, DSM, Rohm & Haas, B.F. Goodrich, Merck, Baxter, and others.

Dr. Ottino grew up in Argentina with twin interests in the physical sciences and visual arts. He received his PhD in chemical engineering at the University of Minnesota.

4:00–4:30 pm

Break

4:30–5:30 pm

Plenary Speakers: *Autonomous Systems*

Introduction

Dr. C. D. Mote, Jr.

President, National Academy of Engineering



Extended Intelligence – A System of Humans and Machines

Mr. Joichi Ito

Professor of the Practice in Media Arts and Sciences, MIT Media Lab

Joichi Ito is director of the MIT Media Lab, professor of the practice of media arts and sciences at MIT, and a visiting professor of law from practice at Harvard Law School. He is chair of the board of PureTech Health; a board member of the New York Times Company, MacArthur Foundation, and John S. and James L. Knight Foundation; cofounder and board member of Digital Garage; and strategy advisor of Sony Corporation. He is an independent senior advisor to the minister for financial services of Japan and a member of the Japanese Ministry of Education, Culture, Sports, Science and Technology Center of Innovation (COI) STREAM governance committee. He is a visiting executive researcher of the Keio Research Institute and the Internet & Society Lab at Shonan Fujisawa Campus in Japan, and a faculty associate of the Berkman Center for Internet & Society at Harvard University. He has helped created numerous Internet companies, including PSINet Japan, Digital Garage, and Infoseek Japan, and was an early-stage investor in Twitter, Wikia, Flickr, Kickstarter, littleBits, Formlabs, and other companies. He maintains a weblog (<http://joi.ito.com/>) and is the author, with Jeff Howe, of *Whiplash: How to Survive Our Faster Future* (Grand Central Publishing, 2016). He is also a PADI IDC staff instructor, an emergency first responder instructor, and a Divers Alert Network (DAN) instructor trainer.

Mr. Ito was named by *Time* magazine as a member of the Cyber Elite in 1997, and in 2000 was listed as one of the 50 Stars of Asia by *Businessweek* and commended by the Japanese Ministry of Posts and Telecommunications. He was selected by the World Economic Forum in 2001 as one of the Global Leaders for Tomorrow, chosen by *Newsweek* as a member of the Leaders of the Pack in 2005, and listed by *Vanity Fair* as a member of the Next Establishment in 2007. *Businessweek* named him one of the 25 Most Influential People on the Web in 2008. In 2011 he was selected by *Foreign Policy* magazine as one of the Top 100 Global Thinkers, and he received the Lifetime Achievement Award from the Oxford Internet Institute in recognition of his role as one of the world's leading advocates of Internet freedom. In 2011 and 2012 he was chosen by Nikkei Business as one of the 100 most influential people for the future of Japan.

He received a doctor of literature honoris causa from the New School in 2013, and the following year he was inducted into the SXSW Interactive Festival Hall of Fame and awarded the Golden Plate Award by the Academy of Achievement. In 2015 he received an honorary doctorate from Tufts University and ranked #68 on the WorldPost/GDI–Global Thought Leaders Index. In 2016 he was selected as one of the GK100: Boston's 100 Most Influential People of Color and ranked #44 in the 2016 Wired 100 (UK). In 2017 he received the IRI Medal. He is a member of the American Academy of Arts and Sciences.

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Autonomous Systems and Ethics

Dr. Patrick Lin

Director, Ethics + Emerging Sciences Group

California Polytechnic State University

Patrick Lin is director of the Ethics + Emerging Sciences Group, based at California Polytechnic State University, San Luis Obispo, where he's a philosophy professor. His research focus is technology ethics, broadly construed to include law and policy. He holds concurrent appointments at Stanford Law School's Center for Internet and Society; University of Notre Dame's Emerging Technologies of National Security and Intelligence (ETNSI) initiative at the Reilly Center; World Economic Forum's Global Future Council on AI and Robotics; Foundation for Responsible Robotics; and the 100-Year Study on AI. Previous affiliations include Stanford's School of Engineering (Center for Automotive Research, CARS), the US Naval Academy's VADM Stockdale Center for Ethical Leadership, Dartmouth College's Philosophy Department, Australia's Centre for Applied Philosophy and Public Ethics (CAPPE), and the New America Foundation.

The technology areas on which he focuses include robotics (especially military systems and autonomous cars), artificial intelligence, cyberwarfare, human enhancements, nanotechnology, space exploration ethics, virtual/mixed reality, and military technologies (including nonlethal weapons).

He has published extensively on technology ethics, from scholarly articles to popular media essays in *The Atlantic*, *Wired*, *Slate*, *Forbes*, *the Washington Post*, *Wall Street Journal*, and other respected publications. His books include *Robot Ethics* (MIT Press, 2012), *Robot Ethics 2.0* (Oxford University Press, 2017), and *What Is Nanotechnology and Why Does It Matter?* (Wiley-Blackwell, 2010). His funded reports include *Ethics of Hacking Back* (National Science Foundation, 2016), *Enhanced Warfighters: Ethics, Risk, and Policy* (Greenwall Foundation, 2013), *Ethics of Human Enhancement: 25 Questions and Answers* (NSF, 2009), and *Autonomous Military Robotics: Risk, Ethics, and Design* (Office of Naval Research, 2008). He has published in leading academic journals such as *Artificial Intelligence* and *Journal of Military Ethics*.

Dr. Lin has delivered briefings and invited talks to government, military, industry, and academic organizations, including the United Nations, US DOD, CIA, DARPA, US National Institutes of Health, US National Academies, Cal-EPA, Google, Apple, Tesla, Nissan, Bosch, Daimler Benz, Stanford, Harvard, US Naval Academy, US Air Force Academy, and UCLA.

Dr. Lin earned his BA in philosophy from UC Berkeley and PhD from UC Santa Barbara, with a background in the biosciences.

5:30–7:00 pm

6:00–9:00 pm

Reception

Golden Bridge Society Reception and Dinner
(by invitation)

West Lawn

Offsite

MONDAY, OCTOBER 9

7:00–8:30 am

Continental Breakfast

Great Hall

Foreign Secretary's Breakfast

(by invitation only to the foreign members)

Members' Room

Home Secretary's Breakfast

(by invitation)

Lecture Room

8:30–9:30 am

NAE Business Session (members and foreign members only)

Kavli Auditorium

9:30 am–12:30 pm

Forum:

AUTONOMY ON LAND AND SEA AND IN THE AIR AND SPACE

Kavli Auditorium

Welcome

Dr. C. D. Mote, Jr.

President, National Academy of Engineering

AUTONOMY ON LAND

Dr. Raj Rajkumar

George Westinghouse Professor, Carnegie Mellon University

AUTONOMY AT SEA

Dr. James Bellingham

Director, Center for Marine Robotics

Woods Hole Oceanographic Institution

AUTONOMY IN THE AIR

Dr. Claire Tomlin

Charles A. Desoer Chair, College of Engineering

University of California, Berkeley

AUTONOMY IN SPACE

Ms. MiMi Aung

Deputy Division Manager, Autonomous Systems

NASA Jet Propulsion Laboratory

Moderator

Mr. Ali Velshi

Chief Business Correspondent and Anchor

NBC News and MSNBC Live

There will be a 20-minute break during the program.



Raj Rajkumar is the George Westinghouse Professor of Electrical & Computer Engineering at Carnegie Mellon University, where he also directs the USDOT National University Transportation Center on Mobility and Metro21, CMU's Smart Cities Initiative, as well as the Real-Time and Multimedia Systems Laboratory. In addition, he is an affiliated professor in CMU's Robotics Institute and codirects the General Motors–Carnegie Mellon Connected and Autonomous Driving Collaborative Research Laboratory (CAD-CRL). He was also the founder of Ottomatika Inc. (acquired by Delphi in 2015), a company that delivered the software intelligence for self-driving vehicles. He holds three US patents.

His research interests include all aspects of cyberphysical systems, with an emphasis on self-driving vehicles, and his work has influenced many commercial operating systems. He has served as program and general chair of six international ACM/IEEE conferences on real-time systems, wireless sensor networks, cyberphysical systems, and multimedia computing/networking.

Dr. Rajkumar has authored one book, edited another, and has more than 160 publications in peer-reviewed forums. Eight of these publications have received best paper awards. He has given keynotes and distinguished lectures at international conferences and universities.

He is a fellow of the National Academy of Inventors and IEEE, a co-recipient of the IEEE Simon Ramo Medal, and an ACM Distinguished Engineer. He has received an Outstanding Technical Achievement and Leadership Award from the IEEE Technical Committee on Real-Time Systems.



James Bellingham is a pioneer in the development of autonomous marine robots. He has led and participated in research expeditions around the world from the Arctic to the Antarctic. He is the founding director of the Center of Marine Robotics at the Woods Hole Oceanographic Institution, founded the Autonomous Underwater Vehicles Laboratory at MIT, and cofounded Bluefin Robotics. He serves on numerous advisory committees and boards, including the Secretary of the Navy Advisory Panel and several National Academies studies, and he chairs the Naval Research Advisory Committee.

Dr. Bellingham's honors include the Lockheed Martin Award for Ocean Science and Engineering, and selection as the MIT Fourteenth Robert Bruce Wallace lecturer. He received his SB, SM, and PhD in physics from the Massachusetts Institute of Technology.



Claire Tomlin is a professor of electrical engineering and computer sciences at the University of California at Berkeley, where she holds the Charles A. Desoer Chair in Engineering. She was assistant, associate, and full professor at Stanford (1998–2007) and joined Berkeley in 2005. She has been an affiliate at Lawrence Berkeley National Laboratory in the Life Sciences Division since January 2012. She works in hybrid systems and control, with applications to air traffic and unmanned air vehicle systems, robotics, energy, and biology.

Dr. Tomlin pioneered methods for computing the reachable set to encompass all behaviors of a hybrid system, which makes it possible to verify that the system stays within a desired safe range of operation and to design controllers to satisfy constraints. She has applied these methods to collision avoidance control for multiple aircraft, and to the analysis of switched control protocols in avionics and embedded controllers in aircraft.

Her work has been tested in simulation and UAV test flights, and applied to and flown on two large commercial platforms: (1) *Boeing aircraft*: Her method was used to compute collision

zones for two aircraft paired approaches, and was flown on a Boeing T-33 test aircraft, flying close to a piloted F-15. The F-15 pilot flew “blunders” into the path of the T-33, which used Tomlin’s algorithm to avoid collision. (2) *Scania trucks*: Dr. Tomlin’s method was used to derive a minimum safe distance between transport trucks driving in high-speed platoons for fuel savings, and revealed that the relative distance used today can be reduced significantly with this automation. Her work is also being considered for application in the Next Generation Air Transportation System (NextGen) and in Unmanned Aerial Vehicle Traffic Management (UTM).

Dr. Tomlin is a MacArthur Foundation, IEEE, and AIMBE fellow. She has received the Donald P. Eckman Award of the American Automatic Control Council in 2003, the Tage Erlander Guest Professorship of the Swedish Research Council in 2009, an honorary doctorate from KTH in 2016, and in 2017 the IEEE Transportation Technologies Award. She received her BA from the University of Waterloo and MS from Imperial College London, both in electrical engineering, and her PhD in electrical engineering and computer science from UC Berkeley.



MiMi Aung is a project manager at NASA’s Jet Propulsion Laboratory (JPL) in Pasadena, where she is leading the project to develop a Mars helicopter technology demonstration. Since joining JPL in 1990 she has performed various roles in multiple disciplines on space flight and Deep Space Network (DSN) projects, technology development, and line management. She is passionate about space exploration, especially to advance the autonomous capability of spacecraft exploring deep space.

She started in the DSN development of its first operational digital receiver system, the Block V Receiver. She developed, analyzed, and tested receiver algorithms, and continued work through implementation to operationalization at all three DSN complexes across the globe. She then led a multidisciplinary team to evaluate the applicability of the monopulse technique for precise pointing of the 34-meter-diameter antennas, leading to operational use in the DSN. She next worked on the Earth Orbiting System Microwave Limb Sounder instrument as a cognizant engineer for the 240 GHz radiometer.

In 2000 she became project element manager for the autonomous formation flying sensor on the StarLight two-spacecraft interferometer mission, where she applied her knowledge of transmit/receive systems to the determination of interspacecraft range and bearing measurement for precise formation flying of multiple spacecraft. She went on to become the project element manager for formation flying on the Terrestrial Planet Finder project.

In 2003 she took on the additional duty of technical group supervisor, a line management position, for the Guidance, Navigation & Control (GN&C) Sensors Group, where she was involved in next-generation sensor technologies required for future spaceflight missions. Her technical interest expanded to next-generation GN&C capabilities for increasingly autonomous space exploration. In 2010 she became manager of the Guidance and Control Section, where she emphasized the development of advanced GN&C technologies and their infusion in future missions for precision entry, descent, and landing on planetary surfaces; proximity operations about small bodies; multispacecraft precision formation flying; and precision pointing of spacecraft. In 2013 she became deputy manager of the Autonomous Systems Division responsible for spacecraft GN&C, power, avionics, flight software, and robotics. Since 2015 she has been the lead for Mars helicopter technology demonstration development.

Ms. Aung earned her BS (1988) and MS (1990) in electrical engineering from the University of Illinois at Urbana-Champaign. Her MS thesis was in the area of signal processing and communications.



Ali Velshi is an MSNBC anchor and business correspondent with NBC News and cohost of the daily *MSNBC Live with Velshi & Ruhle*, MSNBC's weekly business show *Velshi & Ruhle*, and *MSNBC Live with Ali Velshi*. Most recently he hosted *Ali Velshi on Target*, a nightly prime-time show on Al Jazeera America that spoke truth to power through debate, interviews, and on-the-ground reporting. He joined Al Jazeera America from CNN, where he was the channel's chief business correspondent, anchor of CNN International's *World Business Today*, and host of CNN's weekly business roundtable *Your Money*. He also cohosted CNN's *American Morning*.

Mr. Velshi has reported from the US presidential campaign trail and covered ISIS, the Syrian refugee crisis, the days leading up to the nuclear deal from Tehran, the tensions between Russia and NATO from Eastern Europe and the High Arctic, the debt crisis in Greece, and the funeral of Nelson Mandela in South Africa.

He was nominated for two 2016 Emmy Awards for work on disabled workers and Chicago's red-light camera scandal. In 2010 he was honored with a National Headliner Award for Business & Consumer Reporting for "How the Wheels Came Off," a special on the near collapse of the American auto industry. Also that year CNN was nominated for an Emmy for his breaking news coverage of the attempted terror attack by Umar Farouq Abdulmuttalab on Northwest flight 253 to Detroit.

Mr. Velshi has reported extensively on the global financial crisis. Known for his exposition and explanation, he appeared as a guest economic analyst on *Oprah*, *The View*, and *the Daily Show with Jon Stewart*, explaining the causes of the meltdown in plain terms. He is the author of *Gimme My Money Back* (Sterling and Ross, 2008) and coauthor with CNN's Christine Romans of *How to Speak Money* (Wiley, 2010).

He splits his time between New York City and Philadelphia. Active in the community, he serves on the board of the Chicago History Museum and is a member of the Council on Foreign Relations. He volunteers with the homeless outreach program of New York's Center for Urban Community Services.

Born in Kenya and raised in Canada, Mr. Velshi graduated from Queen's University in Ontario with a degree in religion, and was awarded an honorary doctorate from his alma mater in 2016.

MONDAY, OCTOBER 10

12:30–1:30 pm

Lunch

West Lawn

12:45–1:30 pm

Testifying Before Congress: A Tutorial

Lecture Room

Lunch buffet served in the East Court

It is essential that congressional policymakers hear a clear and objective interpretation of what science and technology bring to the policy agenda. This communication is a special type of oral presentation, and several elements are key to its success.



Christopher King is executive director of the academies' Office of Congressional and Government Affairs. He was previously acting assistant secretary for the Office of Congressional and Intergovernmental Affairs at the US Department of Energy, where he also served as a senior advisor in the Office of Energy Policy and Systems Analysis (EPSA) and director of policy analysis for the Office of Energy Efficiency and Renewable Energy (EERE). Before joining DOE, Mr. King spent over a decade on Capitol Hill, including as the Energy and Environment Subcommittee staff director for the US House Science, Space, and Technology Committee. During his tenure with the committee he was the chief advisor on DOE matters and involved in a number of successful legislative initiatives, including passage of the America COMPETES Act and establishment of the Advanced Research Projects Agency–Energy (ARPA-E). Mr. King is a graduate of the University of Texas at Austin.

2:00–5:00 pm

Section Meetings

NAS Building, 2101 Constitution Avenue NW

- 02 Bioengineering
- 03 Chemical
- 05 Computer Science
- 06 Electric Power/Energy Systems
- 11 Earth Resources

NAS 125
NAS Lecture Room
NAS Board Room
NAS 280
NAS 250

Keck Center, 500 Fifth Street NW

- 01 Aerospace
- 04 Civil
- 07 Electronics, Communications & Information Systems
- 08 Industrial, Manufacturing & Operational Systems
- 09 Materials
- 10 Mechanical
- 12 Special Fields & Interdisciplinary

Keck 206
Keck 101
Keck 103
Keck 207
Keck 106
Keck 105
Keck 208

6:30–7:30 pm

Reception

**Grand Ballroom,
JW Marriott Hotel**

7:30–midnight

**Dinner and Dancing
(black tie optional)**

**Grand Ballroom,
JW Marriott Hotel**

The JW Marriott Hotel is at 1331 Pennsylvania Avenue NW in downtown Washington. As ever, dance music will be provided by the popular Odyssey Band.

GENERAL INFORMATION

Registration Check-In

On Sunday, October 8, and Monday, October 9, meeting registration will be located in room 120 at the NAS Building. Please be sure to check in to receive your registration materials.

Registration and Help Desk Hours

Sunday, October 8, 10:30 am–4:00 pm

Monday, October 9, 7:00 am–2:00 pm

Shuttle Bus Service

Sunday, October 8

Morning

Departs at 10:15 am, every 15 minutes, last bus departs at noon

From

JW Marriott

To

NAS Building

Afternoon

Departs at 2:00 pm, every 15 minutes, last bus departs at 2:45 pm

NAS Building

JW Marriott

Evening

Departs at 5:30 pm, every 15 minutes, last bus departs at 7:30 pm

NAS Building

JW Marriott

Monday, October 9

Morning

Departs at 6:45 am, every 15 minutes, last bus departs at 8:15 am

JW Marriott

NAS Building

Afternoon

Departs at 1:35 pm and 1:45 pm

NAS Building

Keck Center

Evening

Departs at 4:30 pm, every 15 minutes, last bus departs at 5:15 pm

NAS Building

JW Marriott

Departs at 4:30 pm, every 15 minutes, last bus departs at 5:15 pm

Keck Center

JW Marriott

Guest Tour Bus Service

Monday, October 9

Buses Depart

9:30 am (Loads at 9:15 am)

9:30 am (Loads at 9:15 am)

From

NAS Building

NAS Building

To

Torpedo Factory Art Center

Apothecary & Gadsby's

Tavern and Museum

Noon

Torpedo Factory

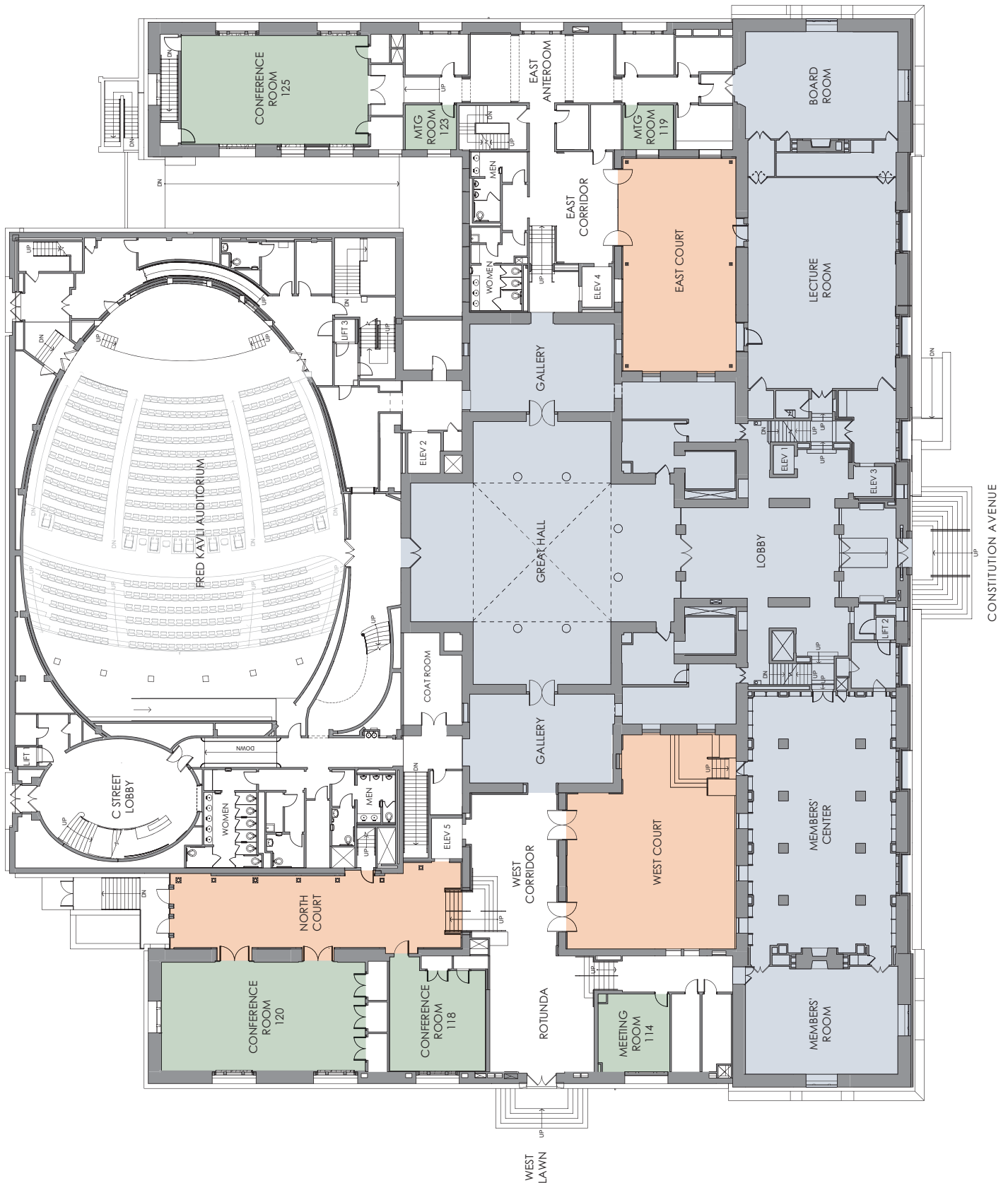
Gadsby's

2:00 pm

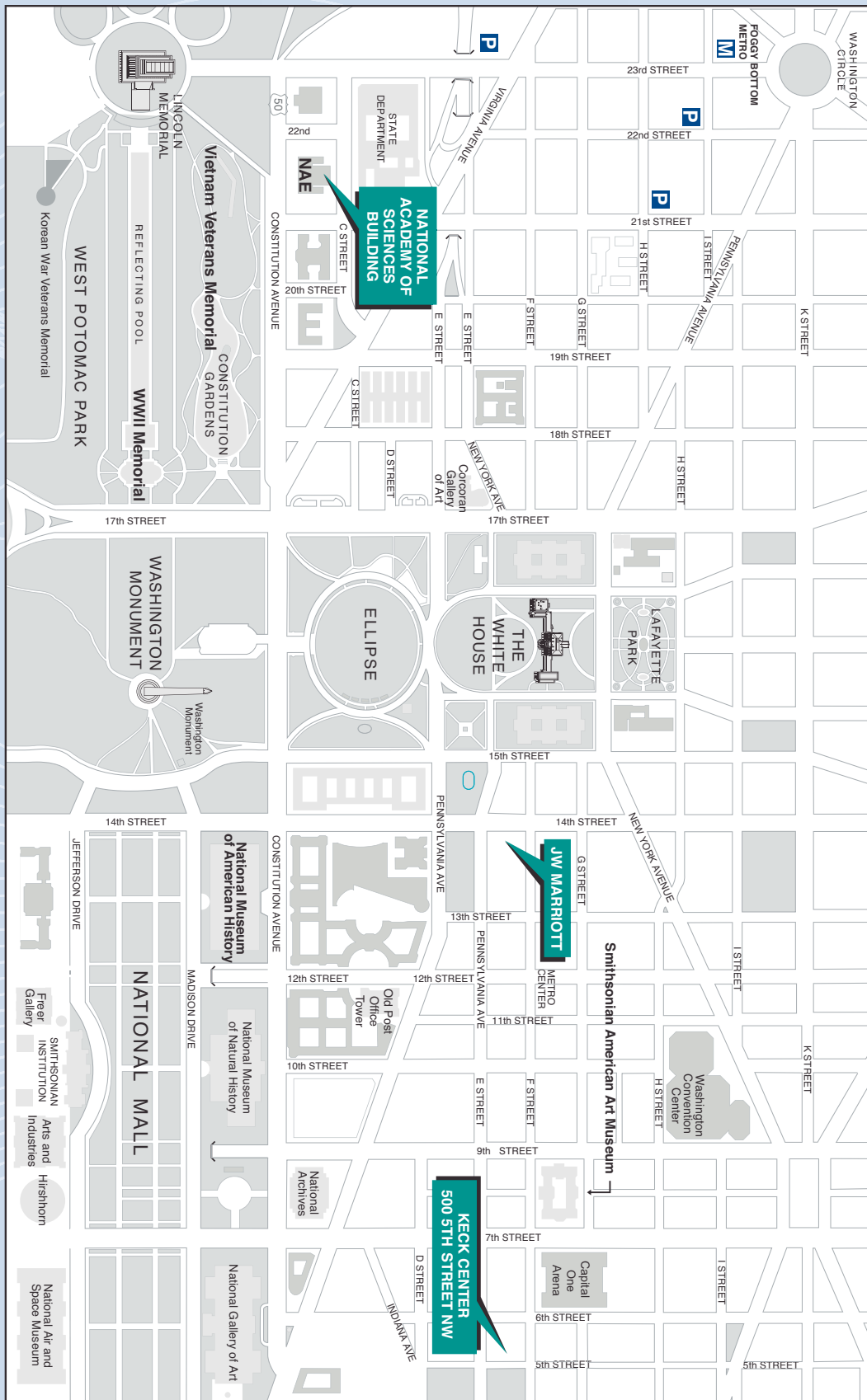
Gadsby's

JW Marriott

NAS BUILDING MAP



AREA MAP



GUEST PROGRAM

On **Sunday, October 8**, guests are welcome to join NAE members for brunch, followed by the public program—the induction of new members, the awards program, and other presentations—after which they are invited to the reception on the West Lawn at the NAS Building.

On the morning of **Monday, October 9**, guests are invited to the public forum on Autonomy on Land and Sea and in the Air and Space, or they may choose either to participate in an art or history tour in Old Town Alexandria—at the Torpedo Factory Art Center or two historical museums: the Apothecary and Gadsby's Tavern—or to tour and learn more about the historic NAS Building.

The **Torpedo Factory Art Center** (www.torpedofactory.org) was established in 1974 in an old munitions plant and is now home to the nation's largest community of working artists' open studios under one roof. This Alexandria landmark is the highlight of the Potomac Riverfront, featuring artwork in a wide variety of media—painting, ceramics, photography, jewelry, stained glass, fiber, printmaking, and sculpture—in 82 artists' studios. Visitors are welcome to observe the creative process, ask questions, and purchase original work. This program will last approximately 2 hours: an overview of the center followed by time to meet the artisans and view their work. There are 3 levels of the building, with stairs and elevators.

The **Apothecary Museum** (www.AlexandriaVA.gov/Apothecary) boasts a vast collection of herbal botanicals, handblown glass, and historical medical equipment. It also has a spectacular collection of archival materials—journals, letters and diaries, prescription and formula books, ledgers, orders, and invoices. The names of famous customers appear in these documents, including Martha Washington, Nelly Custis, and Robert E. Lee. **Gadsby's Tavern and Museum** (www.AlexandriaVA.gov/GadsbysTavern) consists of two buildings, the tavern (ca. 1785) and the 1792 City Hotel. The buildings, named for Englishman John Gadsby who operated them from 1796 to 1808, were a center of political, business, and social life in early Alexandria—dancing assemblies, theatrical and musical performances, and meetings of local organizations. George Washington enjoyed the tavern's hospitality and twice attended the annual Birthnight Ball held in his honor. Other prominent patrons were John Adams, Thomas Jefferson, James Madison, James Monroe, and the Marquis de Lafayette. This program will be 45 minutes at each museum with a 500-foot walk between them. The two historical buildings have 3–4 levels and no elevators.

For both tours comfortable shoes are recommended for moderate walking and standing. The tours will conclude with a luncheon at Gadsby's Tavern, about a 7-minute walk from the Torpedo Factory. (Bus transportation provided.)

Advance registration is required for the offsite Monday guest tours.

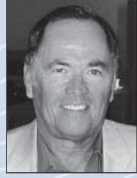
Also offered is a tour of the **NAS Building** led by Janice Goldblum, archivist of the National Academy of Sciences. Starting in the foyer, she will talk about the bronze and glass doors and then visit the Members' Center, Members' Room, and Lecture Room. Find out about the painting of President Lincoln signing the charter for the National Academy of Sciences in the Board Room. Using our new Great Hall Dome Explorer iPad App, the tour will end with an in-depth look at the Great Hall and its beautifully restored ornate decorations by Hildreth Meiere.

This program will last approximately 45 minutes. The tour will begin in the West Court at 9:30 am. Lunch will be provided at 12:30 pm in the tent on the West Lawn. Please register for this tour in room 120.

SECTION CHAIRS

Section Chairs (July 1, 2017)

Note: Numbers following section chairs' names denote primary and secondary NAE section affiliations. Terms end June 30 of year shown.



Section 1: Aerospace Engineering
Robert L. Crippen (1)
(Retired President
Thiokol Propulsion)
(2019)



Section 7: Electronics, Communication & Information Systems Engineering
Joe C. Campbell (7)
Professor
Electrical/Computer Engineering Department
University of Virginia
(2019)



Section 2: Bioengineering
James W. Burns (2, 3)
Head of North America R&D Hub
Sanofi
(2019)



Section 8: Industrial, Manufacturing & Operational Systems Engineering
John R. Birge (8,12)
Jerry W. and Carol Lee Levin Professor of
Operations Management
The University of Chicago
(2018)



Section 3: Chemical Engineering
Montgomery M. Alger (3)
Director
Institute for Natural Gas Research
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Pennsylvania State University
(2018)



Section 9: Materials Engineering
Alfred Grill (9, 7)
IBM Fellow
IBM Thomas J. Watson Research Center
(2018)



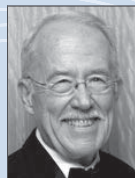
Section 4: Civil Engineering
Lisa Alvarez-Cohen (4, 2)
Fred and Claire Sauer Professor of
Civil and Environmental Engineering
Civil and Environmental Engineering Department
University of California, Berkeley
(2019)



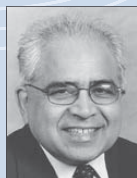
Section 10: Mechanical Engineering
Andrew Jackson (10, 8)
Professor of Practice
University of Pennsylvania
(2018)



Section 5: Computer Science & Engineering
Robert P. Colwell (5)
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Intel Corporation)
President
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(2018)



Section 11: Earth Resources Engineering
George F. Pinder (11, 4)
Distinguished College Professor
University of Vermont
(2018)



Section 6: Electric Power/Energy Systems Engineering
Anjan Bose (6, 7)
Regents Professor and Distinguished Professor
of Electric Power Engineering
School of Electrical Engineering and
Computer Science
Washington State University
(2019)



Section 12: Special Fields and Interdisciplinary Engineering
James O. Ellis, Jr. (12, 1)
(Retired President and CEO
Institute of Nuclear Power Operations)
Annenberg Distinguished Visiting Fellow
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(2018)

MEETING SERVICES

Food Service

Efforts are made to provide healthy, nutritionally balanced meals at all meetings. If you have any questions about food service or if you have special dietary restrictions, please contact Ervin Pinckney in the registration room (NAS 120).

Information Desk

The NAE Information Desk is located in the Great Hall of the NAS Building. Staff will be available to provide assistance and answer questions about the annual meeting and the NAE membership.

Logo Items and Rosettes

NAE logo items will be available for purchase in the registration room (NAS 120).

Lost and Found

Lost and found is located in the registration room (NAS 120).

Medical Assistance

For medical assistance go to the Information Desk in the Great Hall of the NAS Building. A registered nurse will be onsite.

Smoking Policy

Smoking is not permitted in any building of the National Academies. It is permitted only in designated outdoor areas.

2016 HONOR ROLL OF DONORS

ANNUAL GIVING SOCIETIES

The National Academy of Engineering gratefully acknowledges the following members and friends who made charitable contributions to the NAE and those NAE members who supported the Committee on Human Rights, a joint committee of the three academies, during 2016. The collective, private philanthropy of these individuals has a great impact on the NAE and its ability to be a national voice for engineering. We acknowledge contributions made as personal gifts or as gifts facilitated by the donor through a donor-advised fund, matching gift program, or family foundation.

During the 2016 annual meeting, Chairman Gordon England announced the creation of a \$100,000 Chairman's Challenge for Section 1 that he is personally funding and asked others to join him in creating giving challenges for each section by the 2017 annual meeting. Donors who participated in the Chairman's Challenge are noted with the # symbol.

In response to the Chairman's Challenge, Paul Boulos gave \$25,000 to fund a challenge for Section 4; Gordon Bell, Tom Leighton, and Bob Sproull gave \$100,000 to create a challenge for Section 5; and James Truchard gave \$100,000 to challenge Section 7. Section 4 challenge donors are noted with the & symbol, Section 5 with the \$, and Section 7 with %.

Fran Ligler, a member of the NAE Council, and her husband George pledged \$100,000 in 2015 to encourage new and increased giving by Section 2 members for five years, or until the \$100,000 goal is reached. Donors who participated in the Ligler Challenge are noted with the # symbol.

The Sanjit K. Mitra Family Challenge encouraged members in the classes of 2013–2016 to support the NAE and our programs. Donors who participated in the Mitra Challenge are noted with the ◇ symbol.

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Sunday, October 8

All events take place at the NAS Building, 2101 Constitution Avenue NW, unless otherwise noted.

10:30 am–4:00 pm	Registration	NAS 120
11:00 am–12:15 pm	Brunch	West Lawn
11:00 am–12:15 pm	Financial, Gift and Estate Planning Seminar (with brunch)	Members' Room
	PUBLIC PROGRAM	
12:30–2:00 pm	Induction Ceremony for NAE Class of 2017	Kavli Auditorium
2:30–4:00 pm	Awards Program	Kavli Auditorium
4:30–5:30 pm	Plenary Speakers: <i>Autonomous Systems</i>	Kavli Auditorium
5:30–7:00 pm	Reception	West Lawn
6:00–9:00 pm	Golden Bridge Society Reception and Dinner (by invitation)	Offsite

Monday, October 9

7:00 am–2:00 pm	Registration	NAS 120
7:00–8:30 am	Continental Breakfast	West Lawn
7:00–8:30 am	Foreign Secretary's Breakfast (by invitation to the foreign members)	Members' Room
7:00–8:30 am	Home Secretary's Breakfast (by invitation)	Lecture Room
8:30–9:30 am	NAE Business Session	Kavli Auditorium
9:30–12:30 pm	Forum: AUTONOMY ON LAND AND SEA AND IN THE AIR AND SPACE	Kavli Auditorium
12:30–1:30 pm	Lunch	West Lawn
12:45–1:30 pm	Testifying before Congress: A Tutorial (with lunch)	Lecture Room
2:00–5:00 pm	Section Meetings	NAS Building and Keck Center
6:30 pm	Reception	JW Marriott, Grand Ballroom
7:30 pm–midnight	Dinner and Dancing	JW Marriott, Grand Ballroom

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