Opening Keynote Luncheon
“The Impact of Information Technology on Health Care Delivery”

John Glaser, Ph.D.

Health Services – Siemens Healthcare

12:15 – 13:45
Tuesday, 31 August
Marriott 4th Floor, Salon E

Ticket required

Abstract
Health care providers are facing unprecedented pressures to reduce the cost of care and improve the quality and safety of care. These pressures are expected to lead to significant changes in the structure of the industry and the means used to reimburse care providers.

Information technology (IT) is seen as a critical contributor to efforts to transform health care delivery. Leveraging a foundation of broadly adopted electronic health records, IT will have four core impacts:

- Enabling and improving health care processes
- Delivering knowledge to care providers
- Engaging patients
- Enabling sophisticated analyses of treatment effectiveness and efficiency

For IT to achieve its potential research and innovation will be required in several areas.

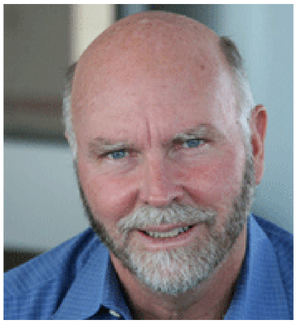
Biographical Sketch
John Glaser, PhD, is Chief Executive Officer, Health Services Business. Previously he was Vice-President and Chief Information Officer, Partners HealthCare. Dr. Glaser was the founding Chairman of College of Healthcare Information Management Executives (CHIME) and is past President of the Healthcare Information and Management Systems Society (HIMSS). He was a Senior Advisor to the Federal Office of the National Coordinator for Health Information Technology.

He is a fellow of HIMSS, CHIME and the American College of Medical Informatics. CHIME has established a scholarship in Dr. Glaser’s name. He was elected to CIO Magazine’s CIO Hall of Fame.

He holds a Ph.D. in Healthcare Information Systems from the University of Minnesota

Keynote Lecture

From Reading to Writing the Genetic Code



J. Craig Venter, Ph.D.

Founder, Chairman and President, J. Craig Venter Institute
Founder and CEO, Synthetics Genomics, Inc.

14:00 – 15:15
Tuesday, 30 August
Marriott 4th Floor, Salon F

Abstract
Dr. Venter will be discussing the science that led from the first genome to the first synthetic life.

Biographical Sketch
J. Craig Venter, Ph.D., is regarded as one of the leading scientists of the 21st century for his numerous invaluable contributions to genomic research. He is Founder, Chairman, and President of the J. Craig Venter Institute (JCVI), a not-for-profit, research organization with approximately 400 scientists and staff dedicated to human, microbial, plant, synthetic and environmental genomic research, and the exploration of social and ethical issues in genomics.

Dr. Venter is also Founder and CEO of Synthetic Genomics Inc., a privately held company dedicated to commercializing genomic-driven solutions to address global needs such as new sources of energy and next generation vaccines.

Dr. Venter began his formal education after a tour of duty as a Navy Corpsman in Vietnam from 1967 to 1968. After earning both a Bachelor's degree in Biochemistry and a Ph.D. in Physiology and Pharmacology from the University of California at San Diego, he was appointed professor at the State University of New York at Buffalo and the Roswell Park Cancer Institute. In 1984, he moved to the National Institutes of Health campus where he developed Expressed Sequence Tags or ESTs, a revolutionary new strategy for rapid gene discovery. In 1992 Dr. Venter founded The Institute for Genomic Research (TIGR, now part of JCVI), a not-for-profit research institute, where in 1995 he and his team decoded the genome of the first free-living organism, the bacterium Haemophilus influenzae, using his new whole genome shotgun technique.

In 1998, Dr. Venter founded Celera Genomics to sequence the human genome using new tools and techniques he and his team developed. This research culminated with the February 2001 publication of the human genome in the journal, Science. He and his team at Celera also sequenced the fruit fly, mouse and rat genomes.

Dr. Venter and his team at the Venter Institute continue to blaze new trails in genomics. He and his team have sequenced and analyzed hundreds of genomes, and have published numerous important papers covering such areas as environmental genomics, the first complete diploid human genome, and the groundbreaking advance in creating the first self replicating bacterial cell constructed entirely with synthetic DNA.

Dr. Venter, one of the most frequently cited scientists, is the author of more than 250 research articles. He is also the recipient of numerous honorary degrees, public honors, and scientific awards, including the 2008 United States National Medal of Science, the 2002 Gairdner Foundation International Award and the 2001 Paul Ehrlich and Ludwig Darmstaedter Prize. Dr. Venter is a member of numerous prestigious scientific organizations including the National Academy of Sciences, the American Academy of Arts and Sciences, and the American Society for Microbiology.

Keynote Lecture

From Nature and Back Again… Giving New L:ife to Materials for Energy, Electronics, Medicine and the Environment

Angela Belcher, Ph.D.

Massachusetts Institute of Technology

14:45 – 15:30
Wednesday, 31 August
Westin 3rd Floor, Essex Ballroom

Abstract

Organisms have been making exquisite inorganic materials for over 500 million years. Although these materials have many desired physical properties such as strength, regularity, and environmental benign processing, the types of materials that organisms have evolved to work with are limited. However, there are many properties of living systems that could be potentially harnessed by researchers to make advanced technologies that are smarter, more adaptable, and that are synthesized to be compatible with the environment. One approach to designing future technologies which have some of the properties that living organisms use so well, is to evolve organisms to work with a more diverse set of building blocks. These materials could be designed to address many scientific and technological problems in electronics, military, medicine, and energy applications. Examples include a virus enabled lithium ion rechargeable battery we recently built that has many improved properties over conventional batteries, as well as materials for solar and display technologies. This talk will address conditions under which organisms first evolved to make materials and scientific approaches to move beyond naturally evolved materials to genetically imprint advanced technologies.

Biographical Sketch

Angela Belcher is a Materials Chemist with expertise in the fields of biomaterials, biomolecular materials, organic-inorganic interfaces and solid state chemistry. Her primary research focus is evolving new materials for energy, electronics and the environment. She received her B.S. in Creative Studies with an emphasis in biology from The University of California, Santa Barbara. She continued her education at UCSB and earned a Ph.D. in Inorganic Chemistry (1997). Following a year of postdoctoral research in electrical engineering at UCSB, Dr. Belcher joined the faculty at The University of Texas at Austin in the Department of Chemistry in 1999. She joined the faculty at MIT in 2002. In 2006, she was appointed Germeshausen Professor of Materials Science and Engineering and Biological Engineering. In 2002, she founded the company Cambrios Technologies, Inc., and in 2007 she founded Siluria Technologies, Inc. At MIT she services as the MIT campus director of the Army UARC -The Institute for Collaborative Biotechnologies.

In 2010, Dr. Belcher received the Eni Prize for Renewable and Non-conventional Energy. In 2005, she was named as one of 10 to watch by Fortune magazine for "How The World Will Work In The Next 75 Years." The next year she was named Research Leader of the Year by Scientific American and was awarded a Popular Mechanics Breakthrough Award. In 2007, Time Magazine named her a "Hero" for her research related to Climate Change. In 2009, Rolling Stone Magazine named her one of the "100 People Who are Changing The World." Other awards include the MacArthur Foundation Fellowship; a Four Star General Recognition Award (US Army), Presidential Early Career Award for Science and Engineering (PECASE), Top 10 Innovators Under 40 (Fortune Magazine), 2002 World Technology Award (Materials), 2002 Popular Science Brilliant Ten, 2002 Technology Review Top 100 Inventors (TR100). She is a 2001 Packard Fellow, won the 2001 Wilson Prize in Chemistry at Harvard University, 2001 Alfred P. Sloan Research Fellow, received the 2000 Beckman Young Investigator Award, received the 1999 DuPont and IBM Young Investigator Awards, and the 1999 Army Research Office Young Investigators Award.

Her work has been published in many prestigious scientific journals including Science and Nature, and has been reported in the popular press including Time, Fortune, Forbes, Discover, Scientific American, Rolling Stone, The New York Times, Washington Post and The Wall Street Journal.

Keynote Lecture

Engineering Drug Dosing in Dynamic Biological Systems

David J. Balaban, Ph.D.

Amgen Inc.

14:45 – 15:30
Wednesday, 31 August
Marriott 4th Floor, Salon F

Abstract

Many human biophysical systems have complex physiological responses when regulated by pharmaceutical agents. Predicting such responses is difficult if there are long delay times between receiving a dose of a drug and seeing an effect, if the system exhibits nonlinear responses, or if subsystems respond at very different time scales. We show how computer-based, nonlinear model predictive control can be used to specify an adaptive dosing protocol to produce a desired response. The controller uses repeated measurements of the patient's physiological state, together with statistical parameter estimation methods, to adapt to changes in the patient's condition. In addition to helping predict appropriate doses, these estimated parameters may be of interest to physicians, as they reflect important aspects of the patient's condition that are normally difficult to measure directly.

We use human erythropoiesis as an example biophysical system. It is a dynamic, complex, multi-step process where hemoglobin levels (Hb) are regulated with erythropoiesis stimulating agents (ESAs). Fourier analysis reveals that for some patients, the time series of their Hb levels is wildly variable and even oscillatory. Much of this variability can be explained by changes in patient condition and physicians' best-effort actions to counteract these changes with next-dose recommendations based on an observational history shorter than one red blood cell (RBC) lifetime. Via computer simulation, using a partial differential equation-based model describing time-dependent RBC aging as well as feedback effects for ESAs, we explore the possibility of using computer-generated dosing protocols to create a smoother response that more effectively maintains Hb levels.

Medical, engineering, commercial, and psychological challenges must be overcome before such controllers can be widely used, but we believe that such techniques promise better regulation of many human biophysical systems. The creation of an adequate, but still mathematically and computationally tractable, model of the biological system can be difficult and time consuming, but often yields its own biological insights. Physicians are naturally and justifiably apprehensive about trusting computers to recommend pharmaceutical doses. However, when the biological system is sufficiently complex, computer-based control systems may offer significant improvements in control as compared to the unaided practitioner.

Biographical Sketch

As Amgen's Vice President of Research & Development Informatics, Dave works closely with the head of R&D and the CIO to provide operational and strategic leadership in support of Amgen's worldwide initiatives in drug discovery and development. Dave leads teams of scientific and technical professionals in Translational Sciences, Discovery Sciences, Systems Informatics, Strategy & Operations, Knowledge Management, and Development. The Research & Development Informatics staff numbers over 250 and serves Amgen and its patients from four global sites. Dave's responsibilities include managing a large client-funded budget, collaborating with clients to identify and improve processes, developing and implementing enterprise architecture standards, making recommendations on new systems, and managing the implementation of business plans.

Prior to joining Amgen Inc., Dave was CIO and Vice President of Informatics and Information Technology at Signature Bioscience in San Francisco, CA. He developed and led teams to enhance corporate and scientific computing facilities, built a drug discovery infrastructure, developed corporate strategy, and began software development for cellular instruments. Dave holds a Ph.D. in Applied Mathematics from the University of California Berkeley. Throughout his more than twenty-five year career, Dave has been awarded over 15 patents in the field of database design and data visualizing techniques and has a similar number of patent applications pending. His technical interests include functional programming and the application of mathematical systems theory to biology and drug discovery. Dave is a member of the Board of Trustees of the Institute for Pure and Applied Mathematics at the University of California Los Angeles, a member of the Computer Aids for Chemical Engineering Task Force of the Foundations of Systems Biology in Engineering group, a founding member of the Industrial Haskell Group, and a graduate of the CIO Institute.

Keynote

Re-engineering the War on Cancer:
A Call to Action for Personalized Medicine

Mara G. Aspinall M.B.A.
On-Q-ity, Inc.

13:00 – 14:30
Thursday, 1 September
Marriott 4th Floor, Salon F

Abstract
Cancer research, treatment and care has come a long way in the last 50 years, dominating the science in industry and academia. Yet, current cancer treatments are effective only 22 percent of the time and almost half of all patients do not survive five years. Personalized medicine through the use of diagnostic tools can make the difference, but needs to be implemented in the forefront of medicine. There have been many discussions, meetings and plans to make this happen, but the questions remain: Is the science ready? Are the diagnostic tools reliable and reproducible? Do the regulatory agencies have the necessary framework to move personalized medicine products forward? And, will physicians incorporate these new advances into their clinical practice?

Personalized medicine can save lives. Through the human genome project and advances in diagnostic and imaging technology, we now know more about disease than ever before. Every disease area can now be divided into more and more precise sub-types. The challenge now is making those sub-types clinically meaningful. First – we need to instill confidence in physicians and payors to support the diagnostic tools available today. Second – we need to embrace new technology to understand not just what disease sub-type a patient has but how it progresses and recedes. Third – we need to create new tools that will not only improve diagnosis for an individual patient but monitor that patient throughout the course of their disease to ensure that their treatment is at maximal efficacy. Through advanced diagnostics, we can move the treatment paradigm from one that is organ-based (how to treat breast cancer) to one that is mechanism-based (how to treat Her-2 based cancers).

The Call to Action is clear – we must embrace diagnostics to move the needle in personalized medicine from "concept" to reality in disease management, most notably in cancer. We must replace the "trial and error" and "watch and wait" with "target and succeed". In this talk, I will discuss the successes and failures of personalized medicine to date and how we must make some structural changes in our health care system to ensure its success.

Biographical Sketch
Mara Aspinall is the Chief Executive Officer of On-Q-ity, an innovative personalized medicine company focused on transforming cancer lifecycle management through diagnostics. On-Q-ity is developing diagnostics that will identify the unique characteristics of an individual's cancer, predict the response to therapy and monitor the efficacy of treatment in multiple cancer types. On-Q-ity leverages two core technologies: Microfluidic chip technology to capture, enumerate, and characterize circulating tumor cells (CTC) from a patient's blood and protein biomarkers to predict treatment response.

Before being recruited to On-Q-ity, Mara was previously president of Genzyme Genetics, a leading provider of testing in the oncology and reproductive markets. Under Mara's leadership, Genzyme Genetics set the standard for quality genetics testing in the industry, while profitably growing at an unprecedented pace. She transformed the business, expanding its scope and reach to become one of the nation's largest diagnostic laboratories. Before that, Mara served as president of Genzyme Pharmaceuticals.

An active participant in the healthcare policy community, Mara is a Director of the Personalized Medicine Coalition (PMC), a founding Director of the European Personalized Medicine organization (EPEMED), as well as an active member of the Federal Secretary of Health and Human Services' Advisory Committee on Genetics, Health and Society. Mara currently holds an appointment as lecturer in health care policy at Harvard Medical School and is a Director of Blue Cross Blue Shield of Massachusetts. Mara co-authored, "Realizing the Promise of Personalized Medicine" in the Harvard Business Review and, most recently, was named one of the 2010 "100 Most Inspiring People in Life Sciences" by PharmaVOICE Magazine.

Mara started her business career at Bain & Company, an international strategic consulting firm. She earned her MBA from Harvard Business School and her Bachelors in International Relations from Tufts University.

Keynote Lecture

Frontiers in Neuroimaging: from Cortical Columns to Whole Brain Function, Connectivity and Morphology

Kamil Ugurbil, Ph.D.

University of Minnesota

14:45 – 15:30
Thursday, 1 September
Westin 3rd Floor, Essex Ballroom

Abstract
In the last decade and a half, imaging of cellular processes in vivo has been identified as an indispensible capability for biomedical research. Today, numerous different technologies are employed in pursuit of imaging processes such as organ function, intracellular chemistry, tissue perfusion, oxygen utilization, gene expression, and enzyme activity in intact animals and humans. In this effort, magnetic resonance imaging (MRI) has proven to be rich in information content but inherently poor detection sensitivity, which impose a fundamental limitation on this methodology. In the last two decades, we have pursued ever increasing magnetic fields for use in MRI to alleviate this limitation and also for extracting unique physiological information in humans, going first to 4 Tesla, and subsequently to 7 and 9.4T. A plethora of early experiments, particularly at 7T, demonstrated superior sensitivity and accuracy of functional brain imaging (fMRI) signals, and improvements in several contrast mechanisms for anatomical imaging. In fMRI, these gains have ultimately resulted in unique applications such as robust functional mapping of elementary computational units in the human brain, functional connectivity through resting state fMRI, and neuronal tractography. These applications had to deal with complexities arising from damped traveling wave behavior of 300 MHz RF, the 7T proton frequency, in the human body. These were managed through multichannel transmit capability on the transmit side while, on the receive side, they lead to significant gains in spatial encoding using parallel imaging.

Biographical Sketch
Professor Kamil Ugurbil holds a Ph.D. in physics and chemical physics from Columbia University. After receiving his Ph.D., he joined AT&T Bell Laboratories, subsequently returning to Columbia University in 1979 as a faculty member. In 1982, he moved to the University of Minnesota where his research effort in magnetic resonance (MR) led to the evolution of his laboratory into an interdepartmental and interdisciplinary research center, the Center for Magnetic Resonance Research (CMRR). Dr. Ugurbil currently holds the McKnight Presidential Endowed Chair Professorship in Radiology, Neurosciences, and Medicine and is the Director of CMRR at the University of Minnesota. His research focus has been the development of biological magnetic resonance imaging and spectroscopy using very high magnetic fields, with particular emphasis on brain function, anatomy, and chemistry. One of the two studies that introduced functional imaging in the brain using magnetic resonance techniques (fMRI) were conducted in CMRR at the University of Minnesota under his leadership. Since then, his work has primarily revolved around understanding the origins of the MR detected functional signals and developing strategies to improve the spatial accuracy, and spatial resolution of the functional maps obtained by magnetic resonance. The use of ultrahigh magnetic fields (7 Tesla and above) for human studies was pioneered by CMRR as part of this neuroimaging effort.

Professor Ugurbil's contributions to biomedical magnetic resonance was recognized with the Gold Medal from the International Society of Magnetic Resonance in Medicine (ISMRM) in 1996, the highest award given by this society. He was subsequently elected as a Fellow of ISMRM in 1997 and of the International Society of Magnetic Resonance (ISMAR) in 2009. Dr. Ugurbil was inducted into the American Academy of Arts and Sciences and the National Academy of Sciences (USA) – Institute of Medicine in 2005 and 2007, respectively. In 2005 he received an Honorary Doctorate (Doctorate Honoris Causa) from the University of Utrecht, Netherlands.

Keynote Lecture

Health, Innovation and Seduction

Roni Zeiger M.D.
Google Inc.

14:45 – 15:30
Thursday, 1 September
Marriott 4th Floor, Salon E

Abstract

Innovation in health typically focuses on scientific and technological breakthroughs. While these are and will continue to be critical, we are leaving a tremendous amount of health on the table. This is a result of "the last mile problem in health" — we often know the right therapeutic or preventive intervention, but we don't know how to make it compelling enough for most of us to take it or do it.

Part of the answer lies in making health more engaging: we need to make health seductive much in the same way the market does so for nearly every other product. The next generation of health innovation, from robotics to digital medicines, will be engineered to seduce you.

Biographical Sketch

Dr. Roni Zeiger is Chief Health Strategist at Google where he helps lead efforts in health search, Google Health, and health projects at google.org including Google Flu Trends and Google Crisis Response. He has worked as a primary care physician and has served as a Clinical Instructor of Medicine at Stanford University School of Medicine. He continues to practice urgent care medicine on occasional weekends. Dr. Zeiger received his MD from Stanford and completed an internal medicine residency at the University of California, San Francisco. He was a fellow in medical informatics at Veterans Affairs in Palo Alto, California, and received a masters degree in biomedical informatics from Stanford University. He currently serves on the board of directors of the Society for Participatory Medicine.

Keynote

Applications and Opportunities for Wearable Technology in Physiological Monitoring

Dale Wiggins

Philips Healthcare Patient Care and Clinical Informatics

13:00 – 14:30
Friday, 2 September
Marriott 4th Floor, Salon F

Abstract

It is estimated that patients on general care floors of the hospital are increasingly sicker than ever before, yet the clinician-to-patient ratio has remained low. Serious consequences can arise when patients develop 'hidden' complications in between clinician visits.

Patient physiologic monitoring can help to identify subtle degradations in patient condition and alert clinicians when attention is needed. Conventional physiological monitoring systems have several limitations when applied to patients on the general care floors. The patients have to be 'wired' to the bed, resulting in immobilization and slower physical and emotional healing. In addition, with traditional monitoring systems, clinician workflow may be complicated by cumbersome equipment management and overwhelming information overload.

Wearable monitoring devices have attracted increasing interest in recent years, both in research and Industry. New technologies and evolving solutions are being developed that can address the constraints of conventional monitoring systems and significantly improve patient outcomes. These solutions must enhance the patient healing process by adapting to the patient condition. They must be robust enough to deal with the environmental constraints of the hospital environment. They must eliminate redundant steps in the clinical workflow. And lastly, they must provide accurate, actionable information to the appropriate caregivers.

In this talk, early experiences with these technologies and solutions will be shared and insights into future development opportunities and accompanying benefits will be offered.

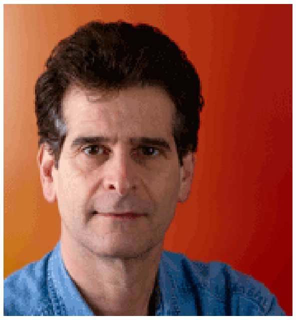
Biographical Sketch

Dale Wiggins is Vice President of Technology for Philips Healthcare Patient Care and Clinical Informatics. In this role, he leads the team that is focused on driving strategic technology plans across the businesses and oversees activities related to several principal healthcare industry themes including systems integration within the hospital enterprise architecture, clinical decision support, interoperability standards, and outcomes improvement studies and other clinical research.

Previously, Dale was Chief Architect for the global Patient Monitoring business. He joined Philips from Hewlett-Packard/Agilent Technologies where he held various management, architecture, and engineering positions in research and development. Dale holds BS and MS degrees in Computer and Systems Engineering.

Keynote Lecture

The Process of Innovation



Dean Kamen

DEKA Research and Development Corporation

14:45 – 15:30
Friday, 2 September
Marriott 4th Level, Salon E

Abstract

Dean Kamen is an inventor, an entrepreneur, and a tireless advocate for science and technology. His roles as inventor and advocate are intertwined—his own passion for technology and its practical uses has driven his personal determination to spread the word about technology's virtues and by so doing to change the culture of the United States. As an inventor, he holds more than 440 U.S. and foreign patents, many of them for innovative medical devices that have expanded the frontiers of health care worldwide.

Recently, Dean and DEKA have been working with DARPA and the Department of Defense on a robotic arm for our veterans. The story of the arm, dubbed "Luke," illustrates the motivation for and the process of innovation. Behind every invention there is a story as complex and interesting as the device itself.

Dean will also discuss FIRST (For Inspiration and Recognition of Science and Technology), a nonprofit that encourages students to seek careers in science and engineering through robotics competitions. It is up to the current group of technology leaders to inspire the next generation of inventors and innovators; that is what FIRST is all about.

Biographical Sketch

As an inventor and physicist, Dean Kamen has dedicated his life to developing technologies that help people lead better lives. As an inventor, he holds more than 440 U.S. and foreign patents, many of them for innovative medical devices that have expanded the frontiers of health care worldwide. While still a college undergraduate, he invented the automatic, self-contained ambulatory pump designed to deliver precise doses of medication to patients with a variety of medical conditions. In 1976 he founded Auto-Syringe, Inc., to manufacture and market the pumps. At age 30, he sold that company to Baxter International Corporation. By then, he had developed a number of other infusion devices, including the first wearable insulin pump for diabetics. Following the sale of AutoSyringe, Inc., he founded DEKA Research & Development Corporation to develop internally generated inventions, as well as to provide R&D for major corporate clients.

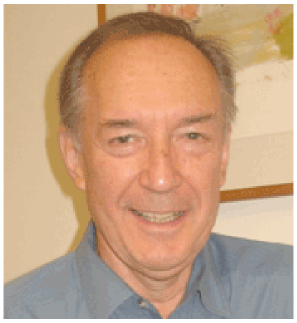
The array of products and technologies invented and developed by Dean and the engineering team at DEKA is extremely broad. Some examples of notable breakthrough medical devices invented and developed by DEKA are the HomeChoice™ portable dialysis machine, marketed by Baxter Healthcare and the iBOT™ Mobility System, a sophisticated mobility aid developed for Johnson & Johnson. DEKA's other projects include: a DARPA-funded robotic arm project intended to restore functionality for individuals with upper extremity amputations; a new and improved Stirling engine intended to convert almost any fuel into electrical power and clean heat as part of a system that is clean, quiet, easy to use and easy to maintain with a long operating life; new water purification technology intended to convert almost any source water into safe drinking water; and many others. Dean is also widely recognized as the inventor of the Segway™ Human Transporter, which was designed to provide a clean alternative for short distance travel and enhance people's productivity.

Among Dean's proudest accomplishments is founding FIRST (For Inspiration and Recognition of Science and Technology), an organization dedicated to motivating the next generation to understand, use and enjoy science and technology. In 2010, its flagship program, the FIRST Robotics Competition, will reach more than 45,000 high-school students onmore than 1,800 teams in 43 regional competitions, seven district competitions, and one national championship. The FIRST Robotics Competition teams professionals and young people to solve an engineering design problem in an intense and competitive way. In 1998, the FIRST LEGO League was created for children ages 9-14. Similar to the FIRST Robotics Competition, these young participants build a robot and compete in an event designed for their age group. In the 2009/10 season, over 147,000 children participated in56 countries. FIRST also offers the Junior FIRST LEGO League for 6 to 9 year-olds and the FIRST Tech Challenge, whichprovides high-school-aged students with a hands-on learning experience to develop and hone their skills and abilities in science and technology.

Dean has received numerous awards and accolades including the Heinz Award in Technology, the Economy and Employment in 1998, the National Medal of Technology from President Clinton in 2000, the Lemelson-MIT Prize in 2002 for Invention and Innovation, the United Nations Association of the USA Global Humanitarian Action Award in 2006, the American Society of Manufacturing Engineers Medal in 2007, the 2008 LEGO Prize, the 2009 Committee for Economic Development Public Policy Award and honorary degrees from more than 25 colleges and universities. Dean was inducted into The National Inventors Hall of Fame in May 2005.

Keynote Luncheon

Modularity for Motor Coordination



Emilio Bizzi M.D., Ph.D.
Massachusetts Institute of Technology

14:45 – 15:30
Friday, 2 September
Westin 3rd Floor, Essex Ballroom

Abstract
Selecting the appropriate muscle pattern to achieve a given goal is an extremely complex task because of the dimensionality of the search space and because of the non-linear and dynamical nature of the transformation between muscle activity and movement. The complex task of mapping a goal into a muscle pattern might be simplified by organizing a modular and hierarchical control architecture. In a modular system the control task is decomposed in a series of simple control processes that can be carried out in parallel. Furthermore, a hierarchical organization allows for an efficient use of the same modules for different tasks and facilitates learning new tasks. To investigate whether the central nervous system uses a modular and hierarchical architecture to control movement we took a reverse engineering approach.

We recorded electro-myographical activity from of the hind limb muscles of intact and freely moving frogs during jumping, swimming, and walking in naturalistic conditions with the aim of identifying the invariant characteristics of the motor output as clues of the functional organization of the controller. We used multidimensional factorization techniques to extract specific relationships among the amplitude and timing of the muscle activations observed during a variety of different movements, We found that a small number of synergies could explain a large fraction of the variation in the muscle patterns and that sets of synergies with different number of elements captured different levels of detail, providing a hierarchical characterization of the structure in the patterns. Most synergies appeared to be preserved across different behaviors and animals, supporting the inference that the structure captured by the synergies reflects a modular and hierarchical organization of the controller.

We have also examined muscle activity in stroke patients as they performed different reaching movements. The patients had stroke damage in one cortical hemisphere only, so one arm was impaired while the other was unaffected. By comparing the activity patterns in the two arms, we showed that the same modules were present in both arms, but their activation and combination was disrupted specifically on the affected side; a finding indicating that the supra-spinal motor control areas generate movements specifying the combination of synergies and by setting up the right coefficient of activation for each spinal synergy.

Biographical Sketch
Born in Rome, Italy, Emilio Bizzi received his M.D. from the University of Rome in 1958, and his Docenza in 1968. He is currently an Institute Professor at Massachusetts Institute of Technology. He served as Chairman of the Department of Brain and Cognitive Sciences at MIT from 1986 to 1997 and Director of Whitaker College of Health Sciences, Technology, and Management at MIT from 1983 to 1989.

Dr. Bizzi's primary research interest is the understanding of how the brain controls voluntary movements. To this end he has focused on two related questions: how does the brain handle the enormous complexity involved in making even the simplest movement and how does the brain learn a new motor task and then generalize that learning to each new variation of the task. During the last two years, he began investigations of of applying his work on muscle modules to methods that could lead to enhanced rehabilitation. In addition, his lab also continues collaborations with neurosurgeons from Massachusetts General Hospital to develop the next generation of neural prosthetics.

He is a member of the National Academy of Sciences (1986), and the American Academy of Arts and Sciences, (1980), where he recently completed service as President. In 1998 he was elected to the Accademia dei Lincei, Rome. In 2004 he was awarded a degree "honoris causa" in Biomedical Engineering, University of Genova , Italy. (2004), and in 2005 he was elected to the Institute of Medicine of the National Academies.

He has won awards for his research and academic work including the W. Alden Spencer Award and the Hermann von Helmoltz Award for Excellence in Neuroscience, and in 2005 received the President of Italy Gold Medal for achievements in science and the Empedocles Prize.

He has authored numerous publications over the years, including text books, journal articles, reviews, and abstracts.

Keynote Lectures and Panel Discussion

The Importance of Neuromechanical Limb Models in the Design of Leg Prostheses and Orthoses

Keynote Lectures and Panel Discussion
Saturday, 3 September
13:00 - 14:30
Marriott 4th floor, Salon G
Open to all registered conference attendees

Speakers:

Dirk Beernaert, PhD - European Commission
John Parrish, MD - Center for Integration of Medicine & Innovative Technology
Subra Suresh, PhD - National Science Foundation
Xian-En Zhang, PhD - Chinese Ministry of Science & Technology

This session will be organized in short talks followed by a panel discussion. The first three talks by Dr.Subra Suresh, Dr.Dirk Beernaert, and Dr.Xian-En Zhang will be focused on their vision on the impact of research and technology on the way medicine will be practice in the future. These talks will be followed by a short presentation given by Dr.John Parrish who will elaborate on how research and technology could be translated into the practice of medicine from a physician's point of view. Dr.Parrish will moderate a discussion among the keynote speakers that will follow their talks.

Subra Suresh, PhD - Study of Human Diseases Across Disciplinary Boundaries

Major advances in various branches of engineering and natural sciences, coupled with transformational developments in information technology, computational modeling and simulation, genetics, genomics, and nanotechnology, have provided unprecedented opportunities to explore human health and diseases at the cellular, subcellular, and molecular levels. Such developments have also facilitated completely new opportunities to study fundamental mechanistic processes with the goal of developing basic scientific understanding, new diagnostic tools, and novel therapeutics across a wide variety of human diseases. This presentation will provide an overview of some recent accomplishments and opportunities for future exploration. Specific examples are drawn from the study of infectious diseases, hereditary blood disorders, and cancer.

Dr. Subra Suresh, distinguished engineer and professor, was sworn in as the 13th director of the National Science Foundation (NSF) on October 18, 2010. Suresh leads the only federal agency charged with advancing all fields of fundamental science and engineering research and education. He oversees the NSF's $7-billion budget, directing programs and initiatives that keep the United States at the forefront of science and engineering, empower future generations of scientists and engineers, foster economic growth and innovation, and improve the quality of life for all Americans. Prior to his confirmation as NSF director, Suresh served as Dean of the Engineering School and Vannevar Bush Professor of Engineering at the Massachusetts Institute of Technology (MIT). He joined MIT's faculty ranks in 1993 as the R.P. Simmons Professor of Materials Science and Engineering. During his more than 30 years as a practicing engineer, he held joint faculty positions in four departments at MIT as well as appointments at the University of California at Berkeley, Lawrence Berkeley National Laboratory and Brown University. A mechanical engineer interested in materials science and biology, Suresh pioneered research to understand the mechanical properties of materials. His most recent research tackled the biomechanics of red blood cells under the influence of diseases such as malaria. In 2006, Technology Review magazine selected Suresh's work on nanobiomechanics as one of the top 10 emerging technologies that "will have a significant impact on business, medicine or culture." Holding true to his personal ideals, Suresh successfully leveraged his renowned research and leadership positions in academia to increase the number of women and minority engineers. He personally mentored more than 100 engineers and scientists in his research group. As department head and dean of engineering, he also led a successful campaign to increase the number of women among MIT's engineering faculty ranks. The Padma Shri Award (2011) from the President of India, Indian Science Congress General President's Award (2011), Society of Engineering Science Eringen Medal (2008), European Materials Medal (2007) and Acta Materialia Gold Medal (2006) are among the many prestigious awards Suresh has received for his innovative research and commitment to improving engineering education around the world. He holds honorary doctorate degrees from Sweden's Royal Institute of Technology and Spain's Polytechnic University of Madrid. He has been elected a fellow or honorary fellow of all the major materials societies in the United States and India, including the American Society of Materials International, Materials Research Society, American Society of Mechanical Engineers, American Ceramic Society, the Indian Institute of Metals and the Materials Research Society of India. Suresh has authored more than 230 research articles in international journals and is a co-inventor in more than 18 U.S. and international patent applications. He is author or co-author of several books that are widely used in materials science and engineering, including Fatigue of Materials and Thin Film Materials. He has consulted with more than 20 international corporations and research laboratories and served as a member of several international advisory panels and non-profit groups. Suresh has been elected to the U.S. National Academy of Engineering, American Academy of Arts and Sciences, Spanish Royal Academy of Sciences, German National Academy of Sciences, Academy of Sciences of the Developing World, Indian National Academy of Engineering and Indian Academy of Sciences.

He earned his bachelor's degree from the Indian Institute of Technology in Madras in 1977; his master's from Iowa State University in 1979; and his doctorate from MIT in 1981. Suresh married his wife, Mary, in 1986, and they have two children, Nina and Meera.

Dirk Beernaert, PhD - A European Strategy for Smart, Sustainable and Inclusive Growth: How Research and Innovation in ICT, Miniaturisation and Micro-Nano-Bio Systems Meet the Future Challenges for Health and Well Being

The European Framework Program for Research, Development and Innovation has to elaborate world-class advanced research results and to contribute to the larger policy objectives of the Union. Europe has still to overcome the fragmentation of its' research landscape and to create a true integrated single European research area. It needs to invest more in innovation and manufacturing to bring research results faster to the market and has to invest in smart, sustainable and inclusive growth. We should make best use of these competence Regions in Europe where knowledge in specific fields is concentrated for the benefit of the EU competitiveness at large and for the well being of the European citizens. The first part of the presentation will address these policy objectives and the recent flagships and activities launched. The second part will go more into detail on the research activities being executed and planned in the near future in order to meet the European challenges for health, well being and assistance of aging population. In particular, we will look at how smart miniaturisation, smart integration and smart systems can contribute to a more healthy future for our aging citizens. How can miniaturisation help elderly to stay longer independent? Comfort, predictability, reliability and cost are the issues. What can we expect from the convergence of micro-nano-bio-ICT technologies and smart systems for the future personalized healthcare? What opportunities may offer the mix of different scientific disciplines, the integration of different technologies and how will this multi-diciplinarity affect the research and engineering landscape? A holistic view on this emerging field covering research on technologies and products, manufacturing and market and business opportunities need to be considered. Examples of ongoing European projects and planned activities will be given and some opportunities for international collaboration elaborated.

Dr. Dirk Beernaert is an engineer in physics, in nuclear science and in material science (University of Ghent – Belgium -1976). Before joining the European Commission he was involved in statistics and as engineering and technology manager in setting up a laboratory to sustain the design of microelectronic components and subsequently in setting up a manufacturing site in micro-electronics to produce digital, analogue and high voltage components. He was responsible for a team dealing with technology development and technology transfer between different organisations. He has joined the European Commission in 1990 where he has been responsible for research initiatives in micro-electronics under different European Frameworks (FP) for Research and for cooperation with Eureka in that field. He also was responsible for setting up the workplan for research in e-work, e-business, e-commerce (FP5). He has started a Unit and a Program dealing with 'Integrated Micro and Nanosystems' (FP 5 and 6) including Microsystems, sensors, interfaces, displays and large area integration and for setting up the workplan for Photonics at the start of the 7th Framework. He is now responsible for running within Directorate General Information Society the Unit of 'nano-electronics' dealing with the implementation of Framework 6 and 7 activities, with planning the future activities and with all related research, innovation stimulation and regulatory activities in these fields. He is recently nominated Executive Director – at interim – of the first public private partnership between industry, European Member States and the European Commission in the field of Nanoelectronics (The Joint Undertaking ENIAC). Owner of 2 patents and author of more than 100 articles on diverse research topics, on commercialisation, on innovation and research strategies mainly in the field of micro-nano-technologies and miniaturisation.

Xian-En Zhang, PhD - Development of Medical Devices: China's Perspectives.

Medical Technology may have broad sense, including medical devices, therapy technology and medication. This report provides an overview on the development of medical devices in China. Medical device industry is a typical innovation-driven, interdisciplinary and global competitive emerging strategic industry. Currently, United States, West Europe and Japan account for over 84% of global medical device market share, while China accounts for only 3% with low-end products. China's 1.37 billion people as well as more than 300 thousand medical and health institutions make China the world's third largest medical device market after US and Europe. The annual growth rate has been more than 20% in recent years. The goal of building a moderately prosperous society and the reform of the medical and health system further secure this fast growth. By the end of 2015, total demand of medical devices in China is expected to reach 50 Billion RMB (about 1% of GDP). "Early health" philosophy is changing the patterns of medical development. This will give a strong push in developing a series of sophisticated-techniques medical devices, such as new imaging technology, non-invasive diagnosis, neural and brain signal detection analysis, interventional therapy, new medical sensors/biosensors/biochips, personal genomics/proteomics and other core technologies. Strengthening the primary medical care system is one of the priorities of the medical system reform. Rural and community health care as well as family care require a huge amount of medical equipment, which should have features of high performance, low cost, intelligence, portability and easiness of operation. Multi-functional and mobile medical platforms are also important especially for rural and field work people. Such demands are giving the researchers opportunities and challenges. Standardization of diagnosis and treatment of traditional Chinese medicine (TCM) create opportunities for the development of modern TCM apparatus, comprising high-precision pulse meter, tongue imaging, new acupuncture treatment instrument, and so on. Real success of these devices will depend on a wide range of clinical investigation. Data banks of pathological/physical signs are also to be built. To achieve the goal mentioned above will largely rely on the development of multi-/inter- disciplinary, particularly nano technology, photonics and microelectronics, new and biocompatible materials, high precision imaging technology, network technology, remote medicine technology, genome sequencing and bioinformatics, etc.

Dr. Xian-En Zhang received his first degree in Hubei University in 1982, MPhil. (microbiology) and Ph.D. (biochemistry) later in the Chinese Academy of Science (CAS). He became a full professor in Wuhan Institute of Virology, CAS in 1993. He is specializing in analytical biotechnology (particularly recombinant biosensors) with 160 peer-reviewed papers and three books on biosensors and biochips. He serves as a vise chair of the Chinese Society for Microbiology, a vice chair of Biophysical Society of China, editorial member of a few international scientific journals (such as *Biosensors & Bioelectronics, Biocatalysis & Biotransformation*), and guest professor in a number of universities. Since 2002, Dr. Zhang has been serving as director general of Basic Research Department, China Ministry of Science and Technology, where he mainly involves in policy study and national planning for science development, and implantation of national major basic research program and the State Key Laboratories. He is the author or coauthor of many science and technology development reports, including the book "The role of science and technology in building the powers".

Keynote Lecture

The Importance of Neuromechanical Limb Models in the Design of Leg Prostheses and Orthoses

Hugh Herr Ph.D.

MIT's Program of Media Arts and Sciences, and The Harvard-MIT Division of Health Sciences and Technology

14:45 – 15:30
Saturday, 3 September
Westin 3rd Floor, Essex Balroom

Abstract

A long-standing goal in rehabilitation science is to apply neuromechanical principles of human movement to the development of highly functional prostheses and orthoses. Critical to this effort is the development of actuator technologies that behave like muscle, device architectures that resemble the body's own musculoskeletal design, and control methodologies that exploit principles of biological movement. In this lecture, I discuss how agonist-antagonist actuation, polyarticular limb architecture, and reflex behaviors can result in quiet, stable, and economical legged mechanisms for walking and running. Neuromechanical models are presented to examine the importance of limb morphology and neural control on locomotory performance. These models are then used to motivate design strategies for prosthetic and orthotic mechanisms.

Biographical Sketch

Hugh Herr is an associate Professor within MIT's Program of Media Arts and Sciences, and The Harvard-MIT Division of Health Sciences and Technology. His primary research objective is to apply principles of biomechanics and neural control to guide the designs of wearable robotic systems for human rehabilitation and physical augmentation. In the area of human augmentation, Professor Herr has employed cross bridge models of skeletal muscle to the design and optimization of a new class of human-powered mechanisms that amplify endurance for cyclic anaerobic activities. He has also built elastic shoes that increase metabolic economy for running, and leg exoskeletons for walking load-carrying augmentation. In the area of assistive technology, Professor Herr's group has developed powered orthotic and prosthetic mechanisms for use as assistive interventions in the treatment of leg disabilities caused by amputation, stroke, cerebral palsy, and multiple sclerosis. Professor Herr has authored or coauthored over 60 technical publications in biomechanics and wearable robotics, and was the recipient of the 2007 Heinz Award for Technology, Economy, and Employment.