Plenary Keynote Lecture

"Uncommon Sense or Common Non-sense: Great ideas that would never work"

William R. Brody, Ph.D., M.D.

President of the Salk Institute

11:30 – 12:30
Wednesday, 29 August
Sapphire Ballroom

Abstract

Most often we look at historic events through the lens of past achievements. The phrase - "The history books are written by the victors of wars" - applies as well to technologic innovation. Rarely do we look at the process of innovation prospectively.

The purpose of this talk is to illustrate common fallacies in overreaching or under estimating the potential value of new inventions. Successful entrepreneurs attempt to credit their success to their intellect, creativity and drive to succeed, while those whose ideas or companies fail often attribute their lack of success due to external factors. In fact, in both cases, luck can play a major role in the success or failure of an idea, an invention, or a company.

Although there are not good statistics on the subject, our ability to predict winners or losers is not very good, and one author indicates that the probability of success for a start-up is around 30-35%, although the figure may be even lower as the total net returns for venture capital in the years between 2000 and 20010 were negative.

Some examples of errors of judgment that under or overestimated the chance of success for a new invention or innovation includes:

1. Luck – good or bad. Some innovations (e.g., coronary stents) succeed for entirely different applications that were intended by the inventor. Likewise, some truly great ideas fail because of market factors – e.g., failure to gain approval from Medicare for reimbursement – that are not under the control of the inventor or company developing the product.
2. An idea predicted to fail might actually succeed because although the analysis predicting failure was correct given a set of assumptions, one or more of the assumptions was actually not true. Magnetic resonance imaging illustrates this situation.
3. People may successfully innovate in their field but then become fixated on their solution and fail to recognize new opportunities when they become available. Cardiac surgeons developed the coronary artery bypass operation but failed to recognize the potential of balloon angioplasty and completely missed the opportunity.
4. An idea that would appear to have little application becomes highly successful when enabled by a second innovation. Coronary angiography was thought to have little clinical utility until the coronary bypass operation was developed.

Biographical Sketch

William R. Brody, President of the Salk Institute, is an acclaimed physician scientist. He was the 13th president of The Johns Hopkins University. Immediately prior to assuming that position, Dr. Brody was the provost of the Academic Health Center at the University of Minnesota. From 1987 to 1994, he was the Martin Donner Professor and director of the Department of Radiology, professor of electrical and computer engineering, and professor of biomedical engineering at Johns Hopkins, and radiologist-in-chief of The Johns Hopkins Hospital.

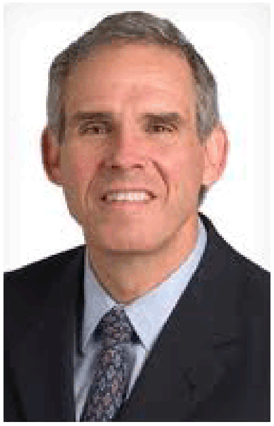
A native of Stockton, California, Dr. Brody received his B.S. and M.S. degrees in electrical engineering from the Massachusetts Institute of Technology, and his M.D. and Ph.D., also in electrical engineering, from Stanford University. Following post-graduate training in cardiovascular surgery and radiology at Stanford, the National Institutes of Health and the University of California, San Francisco, Dr. Brody was professor of radiology and electrical engineering at Stanford University (1977-1986). He has been a co-founder of three medical device companies, and served as the president and chief executive officer of Resonex Inc. from 1984 to 1987. He has over 100 publications and two U.S. patents in the field of medical imaging and has made contributions in medical acoustics, computed tomography, digital radiography and magnetic resonance imaging.

Dr. Brody serves as a trustee of The Commonwealth Fund and of the Baltimore Community Foundation. He serves on the board of directors of IBM. He is a member of the executive committee of the Council on Competitiveness, the International Academic Advisory Committee, Singapore, and the FBI's National Security Higher Education Advisory Board. He formerly served on the President's Foreign Intelligence Advisory Board, on the board of the Minnesota Orchestra Association, and on the Corporation of the Massachusetts Institute of Technology.

Dr. Brody is a member of the Institute of Medicine and the National Academy of Engineering, and a fellow of the Institute of Electrical and Electronic Engineers, the American College of Radiology, the American College of Cardiology, the American Heart Association, the International Society of Magnetic Resonance in Medicine, the American Institute of Biomedical Engineering, and the American Academy of Arts and Sciences.

Plenary Keynote Lecture

Digitizing Human Beings: A New Medicine



Eric J. Topol, M.D.
Director of the Scripps Translational Science Institute
Vice-Chairman of the West Wireless Health Institute

11:00 – 12:00
Thursday, 30 August
Sapphire Ballroom

Abstract

What if your cell phone could detect cancer cells circulating in your blood or warn you of an imminent heart attack? Mobile wireless digital devices, including smartphones and tablets with seemingly limitless functionality, have brought about radical changes in our lives, providing hyper-connectivity to social networks and cloud computing. But the digital world has hardly pierced the medical cocoon.

Until now. Beyond reading email and surfing the Web, we will soon be checking our vital signs on our phone. We can already continuously monitor our heart rhythm, blood glucose levels, and brain waves while we sleep. Miniature ultrasound imaging devices are replacing the icon of medicine—the stethoscope. DNA sequencing, Facebook, and the Watson supercomputer have already saved lives. For the first time we can capture all the relevant data from each individual to enable precision therapy, prevent major side effects of medications, and ultimately to prevent many diseases from ever occurring. And yet many of these digital medical innovations lie unused because of the medical community's profound resistance to change.

Biographical Sketch

One of the leading physicians in the United States, Topol is a pioneer of the genomic and wireless digital innovative technologies to reshape the future of medicine.

He is a practicing cardiologist at Scripps in La Jolla, California and well known for leading the Cleveland Clinic to become the #1 center for heart care. While there he also started a new medical school, led many worldwide clinical trials to advance care for patients with heart disease, and spearheaded the discovery of multiple genes that increase susceptibility for heart attacks.

Since 2007, in La Jolla, he is the Chief Academic Officer of Scripps Health, leads the flagship NIH supported Scripps Translational Science Institute and is a co-Founder and the Vice-Chairman of the West Wireless Health Institute. He also serves as Professor of Genomics at The Scripps Research Institute.

Topol pioneered the development of many medications that are routinely used in medical practice including t-PA, Plavix, Angiomax, and ReoPro and was the first physician to raise safety concerns on Vioxx. He has published over 1000 peer-reviewed articles and over 30 medical textbooks. In 2011, the University of Michigan initiated the Eric Topol Professor of Cardiovascular Medicine in his honor and the University of Rochester, his medical school alma mater, awarded him the Hutchison Medal.

He was elected to the Institute of Medicine of the National Academy of Sciences and has been recognized as one of the top 10 most cited researchers in medicine.

His book for consumers, The Creative Destruction of Medicine (Basic Books), was published in February 2012.

Plenary Keynote Lecture

Emerging Medical Device Technologies: Creating Better Healthcare Solutions for Chronic Disease Management

Rebecca Bergman

Vice President, Research & Technology, Cardiac Rhythm Disease Management, Medtronic, Inc.

11:05 – 12:00
Friday, 31 August
Sapphire Ballroom

Abstract

The overall burden of chronic, non-communicable diseases (NCDs), including cancer, heart and respiratory diseases, and diabetes, is rapidly rising and represents a major challenge to global health and development. Escalating health care costs, increasingly rigorous regulatory requirements, enhanced expectations for product quality and reliability, and the diverse needs in emerging markets also represent significant challenges for the industry. The desire for novel and effective solutions to these global healthcare challenges has never been greater. Advances in a variety of medical device technologies offer the opportunity to fundamentally transform the prevention, diagnosis, treatment, and management of NCDs over the next decade. Examples of leading-edge solutions will be discussed in areas such as miniaturization, minimally invasive procedures, sensors, health informatics, and remote care delivery. Capitalizing on the convergence of multiple scientific and technical disciplines, including engineering, materials science, information technology, communication technology, and biological sciences, will accelerate the pace of breakthrough system solutions and dramatically improve the affordability and accessibility of these solutions across the world.

Biographical Sketch

Ms. Bergman has more than 24 years of experience in the medical technology industry including over 17 years of experience in research and technology management and product development at Medtronic, Inc., a leading manufacturer of products and therapies used in the diagnosis, treatment and monitoring of chronic medical conditions. She currently serves as Vice President, Research & Technology for Medtronic's Cardiac Rhythm Disease Management (CRDM) business. She previously served as Vice President, CRDM New Therapies & Diagnostics as well as Vice President, Corporate Science and Technology, where she directed innovative technology, product development, and information management initiatives. She has received several of Medtronic's highest honors, including membership in the Bakken Society, an honorary society for Medtronic's most distinguished scientific and technical contributors, and recipient of the Wallin Leadership Award, which recognizes outstanding leadership at Medtronic. Ms. Bergman is a Fellow of the American Institute for Medical and Biological Engineering (AIMBE) and a member of the National Academy of Engineering (NAE). Since 2008, she has served as a member of the Board of Directors of Sigma-Aldrich. In addition, she currently is a member of the Board of Directors of The Bakken Museum, the Board of Trustees for Gustavus Adolphus College and a number of academic advisory boards. She previously served on the National Advisory Committee of the National Institute of Biomedical Imaging and Bioengineering (NIBIB) of the NIH and the St. Catherine University Board of Trustees. Ms. Bergman holds a B.S. degree in Chemical Engineering from Princeton University, completed graduate studies in Chemical Engineering and Materials Science at the University of Minnesota, and received an honorary Doctor of Engineering degree from Drexel University.

Special Keynote Lecture

Role of Fluid Mechanics and MicroRNA in Endothelial Regulation

Shu Chien, M.D., Ph.D
Y.C. Fung Professor of Bioengineering and Medicine
Director, Institute of Engineering in Medicine, University of California San Diego

09:45 – 10:45
Saturday, 1 September
Sapphire Ballroom

Abstract

Vascular endothelial cells (ECs) play significant roles in regulating circulatory homeostasis. The shear stress resulting from circulatory flow modulates EC functions by activating mechano-sensors, signaling pathways, and gene and protein expressions. Sustained shear stress with a clear direction (e.g., the pulsatile shear stress, PS, in the straight part of the arterial tree) down-regulates the molecular signaling of pro-inflammatory and proliferative pathways. In contrast, shear stress without a definitive direction (e.g., the disturbed or oscillatory flow, OS, at branch points and other regions of complex geometry) causes sustained molecular signaling of pro-inflammatory and proliferative pathways. The EC responses to directed mechanical stimuli involve the remodeling of EC structure to minimize alterations in intracellular stress/strain and elicit adaptive changes in EC signaling in the face of sustained stimuli; these cellular events constitute a feedback control mechanism to maintain vascular homeostasis and are athero-protective. Such a feedback mechanism does not operate effectively in regions of complex geometry, where the mechanical stimuli do not have clear directions, thus placing these areas at risk for atherogenesis. The differential modulation of EC functions by various flow patterns involves intricate interplays of signaling pathways and gene regulation, including the participation of microRNA (miR). We found that miR-23b mediates the PS-induced inhibition of EC proliferation and that miR-21 mediates the OS-induced monocyte adhesion to ECs. miR-92a exerts an inhibitory effect on the transcription factor KLF2, which is anti-inflammatory and anti-proliferative. The athero-protective effect of PS is mediated by the inhibition of miR-92a and the atherogenic effect of OS is mediated by the activation of miR-92a. The mechanotransduction-induced modulation of EC functions involves complex changes in molecular signaling, and a systems biology approach is required for its elucidation.

Biographical Sketch

He has made seminal scientific contributions to advancing our understanding of how mechanical forces modulate signal transduction and gene expression at the molecular level in blood vessels. He is a member of all three U.S. National Academies (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine), as well as the American Academy of Arts and Sciences. He was recently awarded the National Medal of Science by President Obama. He is also a Member of Academia Sinica in Taiwan and a Foreign Member of the Chinese Academy of Sciences in Beijing. Dr. Chien has been a tireless advocate of biomedical science and engineering at UCSD, having served at various times as president of the following national and international societies: American Physiological Society, Microcirculatory Society, International Society of Biorheology, Biomedical Engineering Society, Federation of Societies of Experimental Biology, and American Institute of Medical and Biological Engineering.

Theme Keynote Lectures

Advanced Drug Delivery for the 21st Century: Opportunities and Challenges

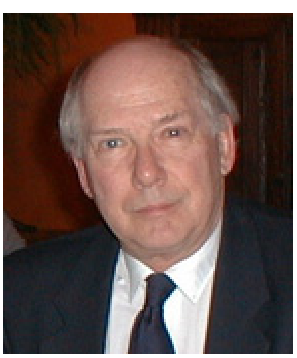
Hamid Ghandehari, Ph.D.
Professor of Bioengineering and Pharmaceutics
Director, Utah Center for Nanomedicine
Co-Director, Nano Institute of Utah, University of Utah, Salt Lake City, Utah

08:15 – 09:15
Wednesday, 29 August
Sapphire Ballroom

Abstract
Over the last few decades research at the interface of materials science, drug discovery, biology and clinical translation has enabled the design and development of delivery systems for more effective and less toxic treatment of a variety of conditions such as cancer and infectious diseases. Most of these systems such as liposomes and polymeric matrices are designed for passive delivery of bioactive agents. Recent advances in nanotechnology, materials science and engineering, as well as improved understanding of the diseased conditions have provided opportunities for the development of better defined delivery strategies in response to changes in local stimuli. This talk will focus on a few examples of such strategies. The use of gold nanorod-mediated hyperthermia for enhancing localized delivery of polymer therapeutics to solid tumors will be presented. Example of design and development of recombinant polymers with motifs sensitive to matrix metaloproteases for delivery of gene carriers to treat head and neck tumors will be discussed. Strategies for enhanced delivery of dendritic structures across the epithelial barrier of the gut will be reviewed and finally the influence of geometry, porosity and surface properties of silica nanoparticles on cellular uptake, toxicity and biodistribution will be presented.

Biographical Sketch
Dr. Hamid Ghandehari is a Professor at the Departments of Bioengineering and Pharmaceutics and Pharmaceutical Chemistry, Director of Utah Center for Nanomedicine and Co-Founder and Co-Director of the Nano Institute of Utah at the University of Utah. His research focuses on the design of new polymers for gene therapy of head and neck cancer, targeted delivery of antiangiogenic inhibitors, oral delivery of chemotherapeutics, assessing the biocompatibility of silica and dendritic nanoconstructs, and design and development of stimuli-sensitive hybrid nanoparticles for controlled chemical delivery. Dr. Ghandehari is Editor in Chief of Advanced Drug Delivery Reviews, Fellow of the American Institute for Medical and Biological Engineering and the American Association of Pharmaceutical Scientists, Member of Center for Scientific Review College of Reviewers at the NIH, and serves on boards of several drug delivery journals and organizations. He has published over 110 articles, 250 abstracts and proceedings, and given over 130 invited talks. He received his BS in Pharmacy and PhD in Pharmaceutics and Pharmaceutical Chemistry from the University of Utah.

Reproducibility in Modeling: Technology for the Stepping Stones of Science



James B. Bassingthwaighte, M.D., Ph.D.
Professor of Bioengineering and Radiology, University of Washington

15:30 – 16:30
Wednesday, 29 August
Sapphire Ballroom

Abstract
In the modeling of biological structures and processes in order to construct the Physiome (the quantitative and mechanistic modeling of the organism), one simplifies both to understand and to reduce models for practical computation. Fractals help to reconstruct the anatomy of organs, and the local correlation they describe reduces the need for high spatial resolution in mechanical and biochemical processes. At another level, the multiple conformational states that proteins undergo often give rise to fractal kinetics (logarithmic slowing) and conflict with the use of simple first order kinetics in chemical equations. The challenge of the Physiome is to reconcile the scientific and computational conflicts and to bring engineering efficiency into the understanding of biology. Modeling technologies are now advanced enough so the Reproducible Research Packages

can be used to provide intact and complete coverage of a research model and the data analysis validating its use as a stepping stone. These will serve the end goal of bringing the power of modeling into the design of therapies and the selection of pharmaceutic agents.

Biographical Sketch

James B. Bassingthwaighte is a Professor of Bioengineering and Radiology at the University of Washington. He is an active teacher and researcher focused on bioengineering and quantitative and integrative approaches to cardiovascular physiology. He trained in Physiology and Biochemistry (University of Toronto, B.A. 1951), Medicine (University of Toronto, M.D. 1955), and studied at the PostGraduate Medical School of London (Hammersmith Hospital) and at the Mayo Graduate School of Medicine and Mayo Clinic in Rochester, Minnesota, where he completed a residency in Medicine and Cardiology and a Ph.D. in Physiology (1964). In 1973 at the Mayo Graduate School of Medicine from 1964 to 1975 he became Professor of Medicine and Physiology. From 1975 to 1979, he chaired the Department of Bioengineering at the University of Washington. In 1979 he established the National Simulation Resource Facility for Circulatory Mass Transport and Exchange at the University of Washington, a center for research and development of methods of modeling analysis of the circulation, kinetics of solute blood-tissue exchange and metabolic systems. Particular contributions are in the interpretation of PET and NMR images and in multiple indicator dilution studies. His scientific goals have emphasized integrative approaches. In 1997 he formally initiated the Physiome Project, a large-scale, international effort to organize and integrate physiological knowledge from genome to integrated function. This effort required the development of web-based and networked biological databases (www.phsyiome.org). He has authored over 300 peer-reviewed publications and two books, served as President of the Biomedical Engineering Society and the Microcirculatory Society, chaired the Cardiovascular Section of the American Physiological Society, and was the Editor-in-chief of the Annals of Biomedical Engineering. He is a Fellow of AIMBE (American Institute of Medical and Biological Engineering) and of the IFMBE (International Federation for Medical and Biological Engineering) and has been the recipient of honors from BMES, American Physiological Society, Maastricht University (The Netherlands), The Netherlands Biophysical Society, Cardiovascular Systems Dynamics Society, Microcirculatory Society, and McGill University. He is a member of the National Academy of Engineering.

Bioengineering: The Bridge between Biology and Orthopaedic Sports Medicine

Savio L-Y. Woo, Ph.D., D.Sc.(Hon), D.Eng.(Hon)
Distinguished University Professor and Director Musculoskeletal Research Center,
Department of Bioengineering, Swanson School of Engineering, University of Pittsburgh

16:45 – 17:45
Wednesday, 29 August
Sapphire Ballroom

Abstract

Bioengineering has made many significant contributions to clinical medicine, notably diagnostics, drug delivery and tissue repairs and replacement. Coupled with the explosive growth in biological sciences, new doors have been opened for bioengineers to introduce a new paradigm, termed Functional Tissue Engineering (FTE) for medical and surgical practices. As a result, it has become an even more attractive discipline.

In this lecture, we will discuss how bioengineering has served as the bridge between biology and clinical management of ligament and tendon injuries in orthopaedic sports medicine. Examples of how laboratory studies have contributed to both non-operative and operative management of complete tears of ligaments and tendons will be given. In recent years, FTE, especially extracellular matrix (ECM) bioscaffolds have been used to further improve the quality of healing tendons and ligaments. Through robotics technology, new knowledge on the multiple degree-of-freedom (DOF) knee kinematics was used to improve ligament reconstruction procedures. Further, in-vivo studies of joint kinematics using novel biplanar fluoroscopy in combination with computational modeling have produced valuable data on in vivo ligament and tendon function. This combined approach will permit us to learn more about mechanisms of ligament injury and to help develop improved treatment procedures, design customized rehabilitation as well as injury prevention protocols for individual patients.

The biological complexity will continue to introduce larger gaps between diagnostics and treatment. This will present challenges as well as opportunities for bioengineers to use these new biological and bioengineering technologies to develop new analytical and experimental techniques at the molecular, cellular, tissue and organ levels. Working in concert with biologists, clinicians, and others, it is possible to come up with more creative and scientifically based procedures to provide better patient care.

Materials, Mechanics and Manufacturing for Bio-Integrated Electronics

John A. Rogers, Ph.D.
Lee J. Flory-Founder Chair in Engineering, University of Illinois at Urbana-Champaign

08:15-09:15
Thursday, 30 August
Sapphire Ballroom

Abstract
Biology is curved, soft and elastic; silicon wafers are not. Semiconductor technologies that can bridge this gap in form and mechanics will create new opportunities in devices that require intimate integration with the human body. This talk describes the development of ideas in semiconductor nanomaterials for electronics, sensors and actuators that offer the performance of state-of-the-art, wafer-based systems but with the mechanical properties of a rubber band. We explain the underlying materials science and mechanics of these approaches, and illustrate their use in bio-integrated, 'tissue-like' devices with unique diagnostic and therapeutic capabilities, when conformally laminated onto the heart, brain or skin. Demonstrations in live animal models and in humans illustrate the functionality offered by these technologies, and suggest several clinically relevant applications.

Biographical Sketch
Professor John A. Rogers obtained BA and BS degrees in chemistry and in physics from the University of Texas, Austin, in 1989. From MIT, he received SM degrees in physics and in chemistry in 1992 and the PhD degree in physical chemistry in 1995. From 1995 to 1997, Rogers was a Junior Fellow in the Harvard University Society of Fellows. During this time he also served as a founder and Director of Active Impulse Systems, a company that commercialized technologies developed during his PhD work. He joined Bell Laboratories as a Member of Technical Staff in the Condensed Matter Physics Research Department in 1997, and served as Director of this department from the end of 2000 to 2002. He is the Lee J. Flory-Founder Chair in Engineering at University of Illinois at Urbana/Champaign with a primary appointment in the Department of Materials Science and Engineering. He also holds joint appointments in the Departments of Chemistry, Bioengineering, Mechanical Science and Engineering, and Electrical and Computer Engineering. He currently serves as the Director of a Nanoscale Science and Engineering Center on nanomanufacturing, funded by the National Science Foundation.

Rogers' research includes fundamental and applied aspects of nano and molecular scale fabrication as well as materials and patterning techniques for unusual electronic and photonic devices, with an emphasis on bio-integrated and bio-inspired systems. He has published more than 300 papers, and is an inventor on over 80 patents and patent applications, more than 50 of which are licensed or in active use by large companies and startups that he has co-founded. His research has been recognized with many awards including, most recently, the Lemelson-MIT Prize (2011), a MacArthur Fellowship from the John D. and Catherine T. MacArthur Foundation (2009), the George Smith Award from the IEEE (2009), the National Security Science and Engineering Faculty Fellowship from the Department of Defense (2008), the Daniel Drucker Eminent Faculty Award from the University of Illinois (2007) and the Leo Hendrick Baekeland Award from the American Chemical Society (2007). Rogers is a member of the National Academy of Engineering (NAE; 2011) and a Fellow of the Institute for Electrical and Electronics Engineers (IEEE; 2009), the American Physical Society (APS; 2006), the Materials Research Society (MRS; 2007) and the American Association for the Advancement of Science (AAAS; 2008).

Cellular and Molecular Image Analysis

Erik Meijering, Ph.D.

Associate Professor of Bioimage Analysis, Erasmus University Medical Center, Rotterdam, Netherlands

15:30-16:30
Thursday, 30 August
Sapphire Ballroom

Abstract

A main challenge of biomedical research in the postgenomic era is the unraveling of the cellular and molecular mechanisms of life. Thorough understanding of the biological processes occurring at these scales is of fundamental importance for the discovery of biomarkers for early diagnosis and for the development of effective drugs and therapies. In the past two decades, revolutionary advances in molecular probing and microscopic imaging technologies have had an enormous impact on the field, and progress in biology has come to rely heavily on these technologies. It has become clear that in order to get the full picture of any living thing, it is necessary to study not only its spatial (morphological or anatomical) properties, but also its temporal (dynamic or functional) behavior. This requires time-lapse imaging, and indeed it is nowadays commonplace to image biological phenomena in three dimensions over time, at multiple wavelengths. The rapidly increasing size (currently in the gigabyte range), dimensionality (3D, 4D, 5D), and complexity (high-content) of the resulting image data poses new challenges for automated data management and analysis. One of the topics for which interest has increased exponentially over the years is object tracking. In order to detect, segment, track, and quantify hundreds to thousands of cells or particles in many hundreds to thousands of image frames, sophisticated computerized methods are very much needed. The goal of this presentation is to survey and discuss the latest trends in the development and application of such methods.

Biographical Sketch

Erik Meijering received a MSc degree (cum laude) in Electrical Engineering from Delft University of Technology (in 1996), and a PhD degree in Medical Image Analysis from Utrecht University (in 2000), both in the Netherlands. From 2000-2002, he worked as a postdoctoral fellow at the Biomedical Imaging Group of the Swiss Federal Institute of Technology in Lausanne (EPFL), Switzerland. In 2002, he returned to the Netherlands to join the new Biomedical Imaging Group Rotterdam of the Erasmus University Medical Center Rotterdam, where he is currently an Associate Professor of Bioimage Analysis. His research interests are in the areas of computer vision, image processing, and image analysis, with applications in cellular and molecular imaging. He published more than 60 scientific articles in this area. He is a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE), its Engineering in Medicine and Biology Society (EMBS), and Signal Processing Society (SPS). He was Technical Program Chair for the IEEE International Symposium on Biomedical Imaging (ISBI) in 2006 and 2010. He was/is an Associate Editor for the IEEE Transactions on Medical Imaging (since 2004), the International Journal on Biomedical Imaging (term 2006-2009), and the IEEE Transactions on Image Processing (term 2008-2011), and was a Guest Editor for the September 2005 Special Issue of the latter journal, which focused on Molecular and Cellular Bioimaging. He also served/serves in a great variety of scientific conference, advisory, and review boards.

Transforming Health Care with Biomedical Engineering: Model-Based Approaches

Misha Pavel, Ph.D.

Program Director, National Science Foundation

16:45-17:45
Thursday, 30 August
Sapphire Ballroom

Abstract

As healthcare is rapidly becoming one of the far-reaching national and global challenges, technology-based solutions are increasingly viewed as a key component of a potential remedy addressing these demands. However, transforming healthcare to be evidence-based, patient-centered and proactive will require significant fundamental and technical advances. Recognizing these challenges, NSF has developed a program in Smart Health and Wellbeing that is focused on stimulating relevant research in key areas including computer science, engineering, and

behavioral and social sciences, reflecting the multidisciplinary nature of problems. In this respect, I will suggest a possible major role of biomedical engineering in addressing many of the key technical barriers to advancing health care quality while lowering costs. Biomedical engineering is a discipline that comprises a broad range of technical approaches. However, in order to play a key role in the transformation of healthcare, biomedical engineering will need to further broaden its focus to incorporate transdisciplinary approaches including ranging from computer science, cognitive science and social-behavioral sciences. Transforming healthcare will require application of computational predictive modeling at multiple scales to mobile health, behavioral (big) data, social networks, etc. Moreover, one of the key issues requiring new research efforts is the development of patient-specific computational, multi-scale models that will enable the utilization of heterogeneous, big data in conjunction with individual-specific observations and measurements. I will illustrate the model-based approaches on a small sample of specific problems.

Biographical Sketch
Misha Pavel is currently a Program Director at the National Science Foundation in charge of a program called Smart Health and Wellbeing. Concurrently, he has an appointment as a professor in the Department of Biomedical Engineering, with a joint appointment in the Department of Medical Informatics and Clinical Epidemiology, at Oregon Health and Science University. Previously, he was a chair of the Department of Biomedical Engineering and the Director of the Point of Care Laboratory, which focuses on unobtrusive monitoring, neurobehavioral assessment and computational modeling. His current research is focused on technology that would enable transformation of healthcare to be proactive, evidence-based, distributed and patient-centered. Prior to his academic career, he was a member of the technical staff at Bell Laboratories, where his research included network analysis and modeling. His current research is at the intersection of computational modeling of complex behaviors of biological systems, engineering, and cognitive science with a focus on information fusion, pattern recognition, augmented cognition, and the development of multimodal and perceptual human-computer interfaces. He developed a number of quantitative and computational models of perceptual and cognitive processes, eye movement control, and a theoretical framework for knowledge representation; the resulting models have been applied in a variety of areas, ranging from computer-assisted instruction systems, to enhanced vision systems for aviation, to augmented cognition systems. He has a Ph.D. in experimental psychology from New York University, an M.S. in electrical engineering from Stanford University, and a B.S. in electrical engineering from the Polytechnic Institute of Brooklyn. Misha Pavel is a Senior Member of IEEE.

Technical Innovation in Mechanical Ventilation

Michael B. Duich
Senior Director, Research & Development, Philips Healthcare / Hospital Respiratory Care

08:15-09:15
Friday, 31 August
Sapphire Ballroom

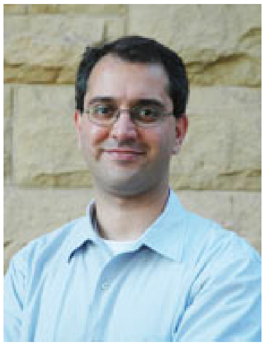
Biographical Sketch
Mike Duich is the Senior Director of Research and Development for Philips Healthcare's Hospital Respiratory Care business unit. In this position, he oversees all research, product development, program management, and sustaining engineering activities for hospital ventilation, patient interface, and respiratory gas monitoring product lines. Mr. Duich was appointed to this position in March 2006, when the business was a division of Respironics, Inc prior to the acquisition by Philips Healthcare. Mr. Duich has more than twenty years of experience in medical device and life science technology. Prior to joining Respironics, he served as Vice President, Product Development and Program Management for the Molecular Biology division of Applied Biosystems, Inc.

Mr. Duich began his career with Pall Corporation as an Electronics Engineer, and then assumed positions of increasing responsibility in Research and Development for the Pall Safety Atmospheres military technology business unit. In 1989, Mr. Duich transitioned to the medical device industry when he joined the Critikon, Inc patient monitoring business as a Project Electrical Engineer. He was appointed to roles of increasing responsibility as an individual contributor, project and functional manager. Mr. Duich was Engineering Manager at the time of Johnson and Johnson's divestiture of Critikon in 1998. From there, he joined the Nellcor division of Mallinckrodt, Inc. as Manager and then subsequently as Director of OEM and Licensing Technology for the pulse oximetry and patient monitoring businesses.

In 2002, Mr. Duich was appointed Vice President of Research and Development for Puritan Bennett. He joined shortly after the acquisition by Tyco Healthcare, and successfully led the effort to rebuild the Research and Development organization. In this role was he was accountable for the development of hospital ventilation as well as homecare ventilation, oxygen, and sleep therapy products.

Mr. Duich holds five US Patents. He earned a Bachelor of Science in Computer Engineering from the University of Florida.

Toward High-Performance Clinically Viable Brain-Machine Interfaces



Krishna V. Shenoy, Ph.D.
Professor of Electrical Engineering, Bioengineering and Neurobiology, Stanford University

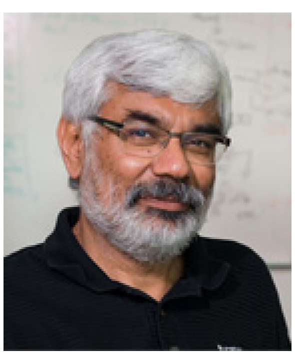
15:30-16:30
Friday, 31 August
Sapphire Ballroom

Abstract
Neural prosthetic systems, also termed Brain-Machine Interfaces, aim to help disabled patients by translating neural signals from the brain into control signals for guiding computer cursors, prosthetic arms, and other assistive devices. Intracortical electrode arrays measure action potentials and local field potentials from individual neurons, or small populations of neurons, in the motor cortices and can provide considerable information for controlling prostheses. Despite several compelling proof-of-concept laboratory animal experiments and an ongoing FDA Phase I clinical trial, at least three key challenges remain which, if left unaddressed, may hamper the translation of these systems into widespread clinical use. We will review these challenges: achieving able-bodied levels of performance across tasks and across environments, achieving robustness across multiple years, and restoring able-bodied quality proprioception and somatosensation. We will also describe some emerging opportunities for meeting these challenges, as well as recent results from our laboratory. If these challenges can be met, intracortically-based neural prostheses may achieve full clinical viability and help increasing numbers of disabled patients.

Biographical Sketch
Krishna V. Shenoy (IEEE S'87–M'01–SM'06) received the B.S. degree in EE from UC Irvine in 1990, and the M.S. and Ph.D. degrees in EE from MIT, Cambridge, in 1992 and 1995. He was a Neurobiology Postdoctoral Fellow at Caltech, Pasadena, from 1995 to 2001 and then joined the Stanford University, Stanford, faculty where he is currently an Associate Professor in the Departments of EE, BioE, and Neurobiology. His research interests include computational motor neurophysiology and neural prosthetic system design.

Dr. Shenoy was a recipient of NSF and Hertz Foundation Graduate Fellowships, the 1996 Hertz Foundation Doctoral Thesis Prize, a 1999 Burroughs Wellcome Fund Career Award in the Biomedical Sciences, a 2002 Alfred P. Sloan Research Fellowship, a 2007 McKnight Endowment Fund in Neuroscience Technological Innovations in Neurosciences Award, a 2009 National Institutes of Health Directors Pioneer Award, and the 2010 Stanford University Postdoctoral Mentor Award. Dr. Shenoy also heads the Stanford-Brown-UCSF-UCL, ten-investigator DARPA-DSO research program termed REPAIR.

Engineering: The Sine qua Non for Systems Biology and Medicine



Shankar Subramaniam, Ph.D.
Professor of Bioengineering, Chemistry and Biochemistry, Cellular and Molecular Medicine and Nano Engineering, and Bioengineering Department Chair, University of California at San Diego.

16:45-17:45
Friday, 31 August
Sapphire Ballroom

Abstract
The advent of high throughput technologies in biology has a significant challenge and a unique set of opportunities. The challenge lies in the integrative processing of the deluge of data in the context of functional biology. The opportunities are the ability to bring strong systems engineering approaches to bear on deciphering biological mechanisms and function and most importantly the ability to develop quantitative models of biological processes. Engineering has essentially become the harbinger for next generation biology in every aspect ranging from development of innovative technologies and devices to building systems-level quantitative models.

In this talk, I will highlight,

- Aspects of new technology, especially one that is associated with next generation sequencing to obtain transcriptional parts lists and mass spectrometric methods for identifying metabolites in physiology.
- Novel statistical learning approaches that transform data from measurements in knowledge in biology.
- Insights into mechanisms in physiology that lead to normal and pathophysiology from applying engineering methods.
- Building quantitative models of biological mechanisms and phenotypes and the implications for experimental biology.

I will also outline some engineering challenges in biology for the next coming decade involving the essential paradigms of analysis, design and modeling to biological systems.

Biographical Sketch

Professor Shankar Subramaniam received his Ph.D. degree in Chemistry from the Indian Institute of Technology at Kanpur. Prior to moving to UCSD, Subramaniam was a professor of biophysics, biochemistry, molecular and integrative physiology, chemical engineering and electrical and computer engineering at the University of Illinois at Urbana-Champaign (UIUC). He also was the director of the Bioinformatics and Computational Biology Program at the National Center for Supercomputing Applications (NCSA), and co-director of the W.M. Keck Center for Comparative and Functional Genomics at UIUC. He is currently the Chair of the Bioengineering Department at UCSD and holds the inaugural Joan and Irwin Jacobs Endowed Chair in Bioengineering and Systems Biology. He was the Founding Director of the UCSD Bioinformatics Graduate Program and holds the title of Distinguished Scientist at the San Diego Supercomputer Center.

As a strong advocate of systems engineering principles applied to biomedical sciences, Dr. Subramaniam's research covers several areas of systems biology and medicine, and he is widely recognized as a leader in new areas of biomedical engineering. He is well-known as the developer of the Biology WorkBench, a Web-based analysis environment that allows biologists to search a variety of popular protein and nucleic acid sequence databases. His recent work on insulin resistance, which has revealed mechanisms associated with insulin resistance, response and non-response to thiazolidinedione drugs and identifying markers of response, have garnered significant interest in the biomedical research community. His work on macrophages and inflammation has led to novel mechanistic insights, and provided the first complete picture of mammalian lipid metabolism in response to inflammation. His work on deciphering the cellular modules involved in skeletal muscle physiology and pathophysiology is likely to have significant impact in understanding diseases such as Duchesne muscular dystrophy.

Dr. Subramaniam is a fellow of the American Institute for Medical and Biological Engineering (AIMBE) and a recipient of Smithsonian Foundation and Association of Laboratory Automation Award. In 2002 he received the Genome Technology All Star Award, and in 2008, he was awarded the Faculty Excellence in Research Award at UCSD.