UC Davis
Grand Challenges
Executive Summaries
Research Investments in the Sciences & Engineering (RISE)
Structural Biochemistry of Plant-Pathogen Interactions to Promote Healthy Crops and Enhance Global Food Security

Team lead: George Bruening
Co-leads: Gitta Coaker, S.P. Dinesh-Kumar, Andrew Fisher, Ioannis Stergiopoulos, David Wilson

Team vision:
In this banner year of agricultural production, it is easy to miss the longer term trend: world grain production increases have fallen behind world population increases since 1990. Rising middle and upper-classes worldwide are increasing the demand for animal and other high quality foods. Only a small fraction of microbes are plant pathogens, and only specific pairs of plant and plant pathogenic microbe result in an infection. Mechanistic understanding, at the atomic level, of how this interaction occurs is the core goal of this RISE theme. This understanding is expected to create the power to redirect effector-immune receptor interactions or to enhance or diminish their strength, with the practical goal of enhancing crop protection.

Goals:
Mechanistic understanding, at the atomic level, of how this interaction occurs between pathogen molecules and the plant molecules that recognize them is the core goal of this RISE theme. This understanding is expected to create the power to redirect effector-immune receptor interactions or to enhance or diminish their strength, with the practical goal of enhancing crop protection. The goals as stated in our original proposal are:
- Determine the crystal structures of several immune complex components singly and as biologically relevant complexes.
- Determine the biological activities of immune complex components and the intra- and inter-molecular changes induced during immune receptor activation.
- Validate immune complex structural models for biological relevance.

Highlights for year 2:
- The structure for a new fungal elicitor was determined.
- The full length RPM1 immune receptor and several fragments and associated proteins thereof were produced in soluble and biologically active form for crystallization studies.
- For the N immune receptor system, major fragments of N have been obtained in soluble form for crystallization studies. The ability of the TMV elicitor of N resistance, p50, to oligomerize has been measured and evaluated.
- The binding properties of three fungal elicitors were compared by numerous biological and chemical tests. Results show that the biological activities of the elicitors are not easily connected to their chemical properties; making structure determination a critical approach.
- The pattern recognition receptor ELF was obtained in soluble form for crystallization studies.
- New strategies for increasing the numbers of immune receptors, immune receptor fragments and elicitor/effector molecules entering the crystallization pipeline were developed and have increased throughput dramatically.

Future directions:
- Structure determination & refinement of individual components and complexes.
- Electron microscopy of immune complexes and modeling of complexes from individual components.
- Biological and biochemical validation of protein and immune complex structures.
Center for Translational Molecular Imaging

Team lead: Simon Cherry
Co-leads: Julie Sutcliffe, Ramsey Badawi, Lars Berglund, Karen Kelly, Jinyi Qi, Alice Tarantal, Terry Jones

Team vision:
To establish UC Davis as a national force and lead in translational molecular imaging by coordinating and leveraging existing expertise and infrastructure, and developing new capabilities, especially related to first in human molecular imaging studies.

Goals:
- Conduct feasibility and complete design for EXPLORER, the world's first total body positron emission tomography (PET) scanner
- Take a novel molecular imaging agent through preclinical evaluation, obtain IND approval and conduct first in human PET studies at UC Davis.
- Coordinate and integrate molecular imaging activities at UC Davis and create a Center to support future research and funding endeavors.

Highlights for year 2:
- Took [18F]FBA-PEG-A20FMDV2-PEG into non-human primates and conducted dynamic PET studies to confirm compound biodistribution and kinetics, and establish initial radiation dosimetry for future human studies
- Opened new radiochemistry facility in Sacramento, 2-year business plan approved, hiring underway and successfully completed first peptide labeling with 18F in preparation for preparing imaging agents for human use
- Complete in silico model of EXPLORER total body PET scanner, able to simulate complete datasets from scanner and produce reconstructed images
- Completed first EXPLORER detector module for testing and evaluation
- Took delivery of first set of electronics for EXPLORER scanner
- Two publications and one letter directly funded by RISE
- One provisional patent filed
- Eleven invited talks and international conference presentations
- Record of invention filed on a new molecular imaging agent
- NIH T32 training grant on Collaborative Cancer Imaging submitted

Future directions:
- Complete preclinical testing and FDA IND approval for novel molecular imaging agent
- Complete design studies for EXPLORER scanner
Team lead: Daniel Cox
Co-leads: Xi Chen, Josh Hihath, Gang-yu Liu, Ted Powers, Rajiv Singh, Michael Toney, Gergely Zimanyi

Team vision:
The vision of ANSWER is to initiate the development of amyloids formed from modified (from wild type) beta solenoid proteins as environmental benign templates for device manufacture, environmental remediation, enzyme/catalysis platforms, and potential nuclear fuel gatherers.

Goals:
- Demonstrate fibril formation with desired characteristics from genetically modified spruce budworm antifreeze protein (SBAFP) and modified ryegrass antifreeze protein (RGAFP)
- Demonstrate lateral self-assembly of SBAFP fibrils
- Complete simulation and design work on feasibility of creating a beta solenoid “alphabet” by altering matching conditions at the ends of the SBAFP & RGAFP mutants
- Synthesize modified SBAFP monomers capable of attaching synthetic peptides to for demonstrating templated growth of gold nanowires on fibrils
- Devise two reliable simulation approaches for estimating the bend/twist elastic constants of fibrils (umbrella sampling of deflected or twisted monomers, and time averaged inversion of strain autocorrelation functions) and find that the bend/twist persistence lengths are of the order 10 microns, long for a biopolymer, but dependent upon shape – a square cross section pentapeptide fibril and the SBAFP fibril have similar rigidities against bend and twist, while the RGAFP fibril is softer

Highlights for year 2:
- Successful fibril growth of modified SBAFP and RGAFP proteins
- Successful lateral assembly of SBAFP proteins
- Design, synthesis and attempted templating by gold of modified SBAFP- fibrilization not complete yet
- Design, synthesis and attempted fibrilization of alternating protein ABAB fibrils
- Design and synthesis of several modified beta solenoid proteins sequences have assembled into amyloid fibrils with optimal characteristics
- Three publications (in preparation) and four presentations

Future directions:
- Demonstrate the ability to template both gold nanowires and arrays of inorganic nanoparticles for device applications this coming year
- Generate large scale lateral assembly of SBAPF and RGAFP proteins during the coming year
- Synthesize fibrils and ordered fibril arrays based upon the square cross section pentapeptide repeat protein
- Submit an NSF STC pre-proposal in December 2014 for the group plus external members, and we are going to attempt to submit a proposal to DARPA with just local expertise led by Cox, Toney, Liu
Team lead: Satya Dandekar
Co-leads: Daniella Barile, Bruce German, Ralph deVere White, Carlito Lebrilla, David Mills, Richard Pollard, Thomas Prindiville, Mark Underwood

Team vision:
This collaborative RISE is highly multi-disciplinary in nature and engages researchers from several colleges at UC Davis. The immune system is essential for protection against pathogens yet uncontrolled activation of immune cells can cause chronic inflammatory diseases. The mission of this RISE project extends to the development of next generation junior researchers with inter-disciplinary training in biomedical research and knowledge of translational science.

Goals:
- Determine the effects of a combination of prebiotic milk oligosaccharides and Bifidobacterium species in establishing the microbiota in premature infant gut
- Develop novel approaches to investigate the effects of the chronic viral infections (HIV, CMV) on the gut microbiome and to examine implications for the gut repair and immune defenses
- Seek funding to test the safety of the pre and probiotic combination for future clinical trials
- Establish the Center of Health for Microbiome and Mucosal Protection (CHAMMP)
- Recruit new and junior investigators to the program and engage in training and mentoring activities

Highlights for year 2:
- Completion of the study on premature infants establishing improved colonization of select bifidobacteria when combined with milk glycans-the key symbiotic concept driving the RISE
- Studies in the non-human primate model identified early source of gut inflammation in HIV infection and impact of probiotics in preventing gut damage. This supports move to the next stage of planning experiments and grant and manuscript preparations
- The role of bile acid metabolism in altered microbiota and carcinogenesis was investigated. These findings led to funding of an NIH U01 grant.
- Recruited junior faculty researchers (Hartigan-O’Connor, Thompson, Zivkovic, Maverakis) to the program and have started collaborations with Dr. Marco from another RISE program.
- Established fully functional Microbiome Core facility for analysis of bacterial communities
- Improved bovine milk oligosaccharide production system in the Milk Processing Lab
- Three Records of Invention
- Symposium co-hosted at UC Davis with Science Translational Medicine on “Mucosal health: Tending the new terroir”
- Center of Health for Advancing Microbiome and Mucosal Protection (CHAMMP) under development

Future directions:
- Develop research collaborations with industry partners
- Initiate and support projects with new members
RNA-Based, Amplification Free, Pathogen Identification Using Nano-Enabled Electronic Detection (RAPID-NEED)

Team lead: Bryce Falk
Co-leads: Paul Feldstein, Josh Hihath, André Knoesen, Maria Marco, Erkin Seker

Team vision:
Our vision is to take advantage of the expertise within our multi-disciplinary team in the rapidly advancing technological areas of electrical engineering and nanotechnology as well as bioinformatics, genomics, microbiology and molecular biology to develop next generation sensors using electrochemical and molecular conductance measurements to detect and identify microbes that threaten food safety and security.

Goals:
- Show that DNA: RNA hybrids represent a superior substrate for molecular conductance measurements
- Make significant progress in controlling nanoporous gold surfaces as substrates for electrochemical detectors
- Examine the state of DNA and RNA detection targets in E. coli O157:H7 killed chemically or incubated on lettuce leaf surfaces
- Gather molecular conductance measurements of a biologically significant RNA fragment in a complex RNA population

Highlights for year 2:
- Successfully made molecular conductance measurements of DNA:RNA hybrids and demonstrated that they have greater conductance than their DNA:DNA counterparts
- Showed that the difference in conductance between DNA:RNA hybrids (A-form) and DNA:DNA duplexes (B-form) is largely due to the different geometry of these double stranded molecules by reversible interconversion of DNA:DNA duplexes between B-form and A-form by dehydration
- Developed novel methods of controlling pore size in nanoporous gold surfaces allowing different pore sizes in one surface as well as selecting a suitable detection molecule and determining an appropriate voltametric regimen to achieve a high signal-to-noise
- Successfully measured the conductance of an RNA fragment with a sequence made up of a mixture of GC and AU base pairs that was specific to an E. coli strain in a complex RNA population
- Examined the lifetime of DNA and RNA molecules from E. coli O157:H7 cells in situ on lettuce leaf surfaces, on petri plate surfaces, killed with isopropanol or heat as well as RNA degraded by RNaseA to determine the feasibility of using RNA’s greater instability to distinguish between live and dead cells
- Successfully measured the melting temperature of a biologically significant RNA molecule whose sequence was derived from the genome of tobacco mosaic virus in both solution and on a gold surface using surface plasmon resonance
- One Record of Invention
- International research partnerships under development with Chile

Future directions:
- Develop partnerships or potential industry collaborations
- Incorporate the np-Au sensor technology into a portable device for measuring probe-target hybridization
- Develop a protein-based detector molecule to improve the signal-to-noise ratio in electrochemical detectors.

http://research.ucdavis.edu/research/gc/rise/
Team lead: Katherine Ferrara  
Co-leads: Steven Currall, Ralph de Vere White, Fredric Gorin, Bruce Hammock, Alexander Revzin, Clifford Tepper. Anne Knowlton, Roy Curry

Team vision:  
During the next four years, 9 of the top 10 and 18 of the top 20 best-selling drugs in the world will go off patent. To address the critical need for screening tools, a team of cancer biologists, social scientists, bioinformatics experts and bioengineers has formed a single disciplinary group to develop and validate biomarker assays for the effect of new therapeutics. In the Center for Content Rich Evaluation of Therapeutic Efficacy (cCRETE, pronounced “secrete”) RISE program, we focus on assays of cell secreted factors in vitro and in vivo, including exosomes, peroxide, and matrix metalloproteinases (MMPs). Cell secreted factors are of interest in 1) gauging the response to therapy with new drugs and 2) the development of an understanding of cell-to-cell communication. The “rich” content to be assessed to understand the impact of cell secretions goes beyond the quantification of traditional markers such as proliferation and apoptosis to evaluate markers of invasive potential, inflammation, “stem-ness”, autophagy and metabolic pathways.

Goals:
- Several important classes of sensors have been created and a company formed to translate these
- Established the potential of diet and sEHi to treat cancer
- Substantial ongoing funding for miRNA and exosome work that can provide a springboard in these areas

Highlights for year 2:
- Ferrara-Revzin-de Vere White have established a working group for the bladder cancer PDX tumors.
- Ferrara-Gorin laboratories are investigating PET probes for uPAR- initial efforts with peptides were unsuccessful and therefore we are focusing on a small molecule approach
- Revzin continued to develop his startup company (ImmunoSense Technologies) related to cell secretion detection and is a tenant in the COE Engineering Translational Technology Center
- Gorin laboratory/startup company has submitted: STTR for pharmacokinetic studies of the lead compound in a rodent model of CNS high grade gliomas, SBIR for efficacy studies of lead compound in rodent model with CNS breast cancer metastases, and V foundation award for phase-0 like study of lead compound in dogs with highly advanced brain cancers containing these protease protein targets
- Fifty nine publications and many presentations in the past year

Future directions:
- Continue writing high profile papers and obtain extramural center funding.
- Studies of cCRETE technologies will be conducted in year 3
- Further, the Ferrara-Hammock collaboration has resulted in interesting data on the effect of diet on the immune system (and resulting cell secretions)
Initiative for Wireless Health and Wellness at UC Davis (iWhW)

Team lead: Jay Han
Co-leads: Prasant Mohapatra, Computer Science; Thomas Nesbitt, Family & Community Medicine; Heather Young, School of Nursing; Lars Berglund, Clinical & Translational Science Center

Team vision:
To develop novel methods for secure acquisition of sensor-derived, contextually-rich physical activity and other remotely monitorable data from smartphone and body sensors; and to transform these raw data streams into actionable health information for both health-care providers and consumers alike.

Goals:
- Obtained a Patient Centered Outcomes Research Institute (PCORI) grant in collaboration with the School of Nursing to test mobile platform integration and nurse health coaching against usual care for persons living with diabetes
- Coordinated with Health Informatics to submit Multi-campus Research Proposal (MRP) at UCOP with letters of support from industry vendors including Apple
- Implemented a multi-vendor and multi-device, web-enabled platform that can be used:
  - by multiple clinical trials for mobile health monitoring
  - as part of an innovative employee wellness program that includes health coaching
- Launched the campus’s first completely wireless clinical trial: Healthy-U Employee Wellness
  - The trial uses FitBit, Moves-App, and a customized UC Davis-branded version of the Fluxstream portal to investigate the efficacy of these wireless technologies alone and in combination with health coaching to improve the health of individuals
- Initiated design and development of α-version of DavisFit, a UC Davis physical activity monitoring app for mobile phones

Highlights for year 2:
- Obtained $2.1 million PCORI grant in collaboration with the School of Nursing to test mobile platform integration and nurse health coaching against usual care for persons living with diabetes
- Launched clinical trial to test use of mobile platform, activity sensors, and nurse health coaching within an employee wellness program
- Published new algorithms for calculation of energy expenditure
- Best Paper Award at 8th International Conference on Body Area Networks 2013, Boston USA
- International research partnerships under development with Ireland and South Korea

Future directions:
- Develop partnerships or potential industry collaborations
- Complete Healthy U clinical trial
- Increase interdisciplinary collaborations to:
  - Drive new methods of research including remote monitoring of food consumption, nutrition, stress
  - Integrate lifestyle information into the electronic medical record
  - Develop personalized health and lifestyle intervention strategies based on data collected from current studies
Cyber-security for Critical Infrastructures: Smart Grid, Financial and Human-centered Mobile Networks

Team lead: Karl Levitt
Co-leads: George Barnett, James Bushnell, Hao Chen, Mike Hogarth, Anna Scaglione, Nicole Woolsey Biggart

Team vision:
Increasingly, cyber technologies are embedded in all aspects of modern life. Traditional cyber-security focuses narrowly upon protection of computers and networks. What is needed, however, is a cross-disciplinary research agenda that focuses upon protecting the social and market systems that depend upon the embedded cyber technology. We pursue this vision by investigating methods for protecting power delivery systems, financial networks, mobile computing, transportation and medically inspired security approaches.

Goals:
- Secured external funding for new Smart Grid security work
- Developed a new research topic on securing automated vehicle systems and submitted a proposal
- Three conference papers for securing future Smart Grids
- Submit papers on wholesale price bidding technique for energy demand/response and security of automated vehicle systems
- Preliminary proposal on privacy in future computing infrastructures is in preparation
- Submit a proposal on protecting the privacy of ubiquitous health monitoring
- A proposal on security for future transportation management systems is in preparation
- Discussions with PG&E regarding Smart Grid security techniques

Highlights for year 2:
- Obtained major funding for Smart Grid security work
- Design and implement methods for protecting Smart Grids
- Designed and implemented smartphone privacy analysis systems and malicious mobile application detectors
- Organized the Cyberspace 2025 workshop on future security systems
- Developed a new research thrust in securing smart highway systems
- Developed a new research thrust in using medical diagnosis techniques for investigating cyber-attacks
- Grant awarded in collaboration with Pennsylvania State University

Future directions:
- Pursue partnerships with CalTrans and the automotive industry on securing next generation smart transportation systems
- Extend our smart grid security work to real grid systems in collaboration with SMUD and PG&E
- Develop cross-cutting research agenda covering privacy in emerging cyber infrastructures
- Explore setting up a commercial spin-off of our Internet of Things monitor
- Further develop research collaborations with industry partners including, but not limited to Delphi Automotive and Econolite

http://research.ucdavis.edu/research/gc/rise/
UC Davis Center for Visualization

Team lead: Kwan-Liu Ma
Co-leads: Ramsey Badawi, Robert Faris, Fu-Tong Liu, Tom Turrentine, Susan Verba

Team vision:
Visualization, which transforms raw data into vivid pictures, has proven to be an effective tool for understanding and explaining large, complex datasets. Although more visualization tools are becoming available, their usability in many research areas is rather limited.

Goals:
- Serve as a central point of access to advanced visualization technology
- Assemble large-scale cross/interdisciplinary research teams, possibly involving researchers at other institutions, to pursue the most challenging and pioneering research projects and bring institute/center-scale grants to UC Davis
- Educate graduate students in advanced data visualization and analysis techniques
- Develop custom visualization solutions for selected campus research units and convert promising prototype systems and toolkits into products targeting niche markets
- Seek industry partnerships and technology transfer opportunities

Highlights for year 2:
- Creating the second interactive exhibit with the Exploratorium featuring data from the Tagging of Pacific Predators (TOPP) project at Stanford University; anticipated display by summer of 2015
- A paper reporting our preliminary results has been accepted for publication by the 2014 IEEE International Conference on Bioinformatics and Biomedicine (BIBM)
- Visualization of one’s social contacts in two different years using a tree metaphor
- Visualization of one’s Facebook activities using a flower metaphor
- Completed a user study on wrist arthritis patient data and reported our findings in a paper
- Published two papers on our new advanced volume visualization technologies
- We have created a visual analytics tool for studying electric car driver behaviors
- Created a mobile phone application for driver data collection

Future directions:
- Develop two other interactive exhibits following the current one in development at the Exploratorium then write a paper reporting the design process and lessons learned
- Meet with physicians, clinical researchers, and medical informatics researchers at UC Davis to plan further studies using EMR data managed at UC Davis
- For the project with the Academia Sinica, we are developing a web-based contact diary data visualization system, which will be used to carry out a user study using sociologists
- Implementation of the remote visualization service
- Continue to develop new approaches to visualizing data for transportation studies and will conduct a usability study on the new visual-based tools
- Develop a visual monitoring design for real-time charging station data
New Tools for Understanding, Monitoring, and Overcoming Plant Stress

Team leads: Julin Maloof, Nelson Max
Co-leads: Jinyi Qi, Neelima Sinha, David Slaughter

Team vision:
Developing enhanced crop varieties and cultivation practices to cope with environmental stresses are key components for meeting the challenge of increased food production under unpredictable climate conditions. Our multi-disciplinary research program aims to develop new approaches for understanding plant development and environmental responses, to use these tools to characterize genetic resources that can be used for crop breeding, and to generate novel biosensors that can be used as early-warning signals of environmental stresses.

Goals:
Created protocols and constructs for rapid screening of fluorescent reporters. Successfully developed macroscopic instruments for monitoring plant growth and for assaying expression of fluorescent reporters. Demonstrated enhanced resistance to nitrogen deprivation stress in wild tomato. Developed protocols for micro-CT imaging of live plants.

Highlights for year 2:
- Used detailed plant physiological measurements to choose proper time points for stress-response transcriptome profiling experiments
- Found that the desert tomato species *S. pennellii* is notably more resistant to nitrogen deprivation than cultivated tomato, indicating potential breeding value
- Nitrogen trial RNAseq libraries made and sent for sequencing
- For stress-reporter plants, fluorescent protein vectors constructed, tested and best selected
- Research prototype equipment has been designed and fabricated for stereo reconstruction of whole plants and preliminary automated measurements of plant height, leaf height, leaf area from the virtual 3D reconstruction of these plants have been successful
- Successfully designed and fabricated a fluorescent macroscope for digital imaging of whole plants containing fluorescent proteins. We have successfully used this system to collect high quality images of whole plants containing the fluorescent proteins.
- Developed and presented at a conference a method to visualize micro-CT data of plant meristems, using a combination of CT density thresholds and Canny edge strength thresholds
- Completion of experimental techniques for transcriptional profiling

Future directions:
- Develop industry partnerships with Syngenta and Monsanto
- Future milestones:
  - Complete RNAseq for remaining 3 stresses
  - Test fluorescent reporter system with stress-inducible genes
  - Create 2nd generation reporter system with signal amplification
  - Field-deploy 3D imaging and fluorescent detection system
  - Develop motion-compensation algorithms for micro-CT scanning
Team lead: Kimberley McAllister  
Co-leads: David Amaral, Paul Ashwood, Melissa Bauman, Cameron Carter, Simon Cherry, Julie Sutcliffe, Judy Van de Water

Team vision:  
In this I-CAN-SZ initiative, we have created a collaborative, interdisciplinary group of scientists to definitively test the hypothesis that immune dysregulation contributes to the development of SZ by altering signaling of immune molecules in the brain. We are also developing novel tools to non-invasively image abnormal immune activation in the brain for diagnostic and drug discovery purposes. This high risk, high yield multidisciplinary effort to validate an immunological, developmental model of SZ is based on an unprecedented approach involving coordinated experiments by 5 accomplished research groups with appointments in the UC Davis School of Medicine, the College of Biological Sciences, the College of Letters and Sciences, and the School of Engineering. This will be the first study to characterize changes in peripheral immune activation, neural inflammation, cortical anatomy, and behaviors simultaneously in high-risk individuals during their first-break for SZ and mouse and non-human primate (NHP) immune-based model systems.

Highlights for year 2:  
- Discovered a hallmark of psychosis and schizophrenia—enhanced uptake of dopamine in the striatum—in the brains of non-human primate (NHP) maternal immune activation (MIA) offspring- validates our animal models as relevant for SZ  
- Discovered that cytokine receptor expression is altered in the brains of both mouse and NHP MIA offspring, relative to controls  
  - Five cytokines (out of 23 tested) were decreased in the NHP brain and all of these overlap (in kind or in function) with those identified in the mouse MIA brains. This discovery indicates that these cytokine receptors may be part of a central molecular pathway that underlies the SZ-like neuroanatomical and behavioral abnormalities in offspring. Because the same receptors are altered in the brains of such disparate species, it is likely that the receptors we have identified will also be altered in human disease. This discovery was the basis for our provisional patent, submitted in May 2014.  
- One Record of Invention submitted and provisional patent filed

Future directions:  
- Future partnerships or potential industry collaborations: We are working with the Office of Research to pursue these. All materials have been submitted and outreach has been initiated.
The UC Davis Eye-Pod: Functional Imaging of Single Cells in the Eyes of Living Animals under Normal, Pathogenic and Regenerative Conditions

Team lead: Edward N. Pugh, Jr.
Co-leads: Nadean Brown, Marie Burns, Hwai-Jong Cheng, Fitz Roy Curry, Paul Fitzgerald, Tom Glaser, Larry Hjelmeland, Kit Lam, Jan Nolta, Susanna Park, Scott Simon, Jon Werner, Robert Zawadzki

Team vision: We assembled a team of engineers, biologists and clinicians, from six departments of the Schools of Engineering, Medicine and Biological Science, to develop and apply technology for non-invasive observation of fluorescently-marked individual cells in the eyes of live animals over the lifespan of the animal. The technology we developed enable simultaneous, quantitative assessment of many basic cellular functions including the testing of therapeutic strategies in animal models of major diseases.

Goals:
- Simultaneous multimodal (OCT and SLO) imaging of the living mouse retina: mapping of neuronal and vascular morphology in 3D with cellular-level resolution over many months
- Adaptive Optics (AO) Imaging of the living eye at subcellular resolution
- Ontogenetic and AAV transfection of retinal cells with fluorescent protein reporters
- Stem cells: therapeutic intervention and tracking of functional integration of transplanted cells

Highlights for year 2:
- Completion of multimodal (OCT and SLO) retinal imaging system
- Completion of the Adaptive Optics Laser Scanning Ophthalmoscope
- First in vivo imaging and longitudinal studies of AAV Transfection of Retinal Cells with Fluorescent Protein Receptor
- First experiments on optical manipulation of retinal microvasculature
- First in vivo observations of integration of neuronal stem cells injected into mouse retina
- Construction and application of three high resolution ocular imaging systems completed
- One NIH R01, five additional R01’s in development based on RISE project preliminary data

Future directions:
- Observation of multicolored fluorescently-marked individual cell classes in the eyes of live animals
- Observation of integration of fluorescently-marked neuronal stem cells injected into mouse retina
- Development of cell specific nanoparticles to create contrast for Optical Coherence Tomography detection
- Development of the eye as the model to study cancer development and treatment using nano-medicine
- Development of compact wavefront sensor-less Adaptive Optics Optical Coherence Tomography system and an optical method for local rapid, reversible permeabilization of vasculature for delivery of therapeutic agents
- Implementation of optogenetic methods for measuring the activity of individual neurons longitudinally in the same mouse
- Application of the aforementioned techniques to several animal models of neuronal degeneration
- Development of Zemax optical model of mouse eye (collaboration with Phoenix Research Lab)
- Development of image processing and analysis tools for Adaptive Optics (AO) data sets

http://research.ucdavis.edu/research/gc/rise/
cEnergi: Transforming Consumer Energy Use in Vehicles, Buildings and Appliances

Team lead: Tom Turrentine
Co-leads: Nina Amenta, Glenda Drew, Ken Kurani, Kwan-Liu Ma, Alan Meier, Dan Sperling

Theme Vision:
For most immediate uses, energy is invisible, undifferentiated, and abundantly available (at the flick of a switch). Social ecological consequences of energy use are likewise far-removed, mediated by slightly more salient financial feedback received monthly in relation to abstract kilowatts and an entangled aggregate of usage across types and time, or weekly at the gas station in relation to seemingly fixed variables of miles that have to be traveled and gas mileage that is largely perceived to be entirely dependent on the vehicle. Even when effective, this type of control on energy use is aversive and does nothing to foster the kind of connection that is characterized by an affective sense and cognitive understanding of the interdependencies of individuals, communities, and energy processes, and promotes stewardship and sustainable relationships. cEnergi explores how community-level and tangible feedback interfaces can promote resilient, sustainable relationships between individuals, communities, and natural resources.

Goals:
- Grant proposals to NSF, CEC, and DOE
- Published papers on energy feedback and presented at conferences
- Student researchers designed and are building SESEME, a social, energy-sensing monument, as well as energy feedback mobile applications released to public app stores

Highlights for year 2:
- Student presentations to high profile ITS guests
- Created a living lab, undergrad internship opportunity, and product showcase space in space adjacent to PH&EV Center
- Forged important working relationships with other research entities and potential industry collaborators
- New post doctorate, Dr. Angela Sanguinetti, was hired for behavioral research in cEnergi

Future directions:
- Work with the Exploratorium
- Submit grant proposals to NSF, CEC, and DOE
- Work extensively with Western Cooling Efficiency Center on CEC grant
- cEnergi will continue to work with other on-campus organizations concerned with energy efficiency and community development
- Future milestones
  - SESEME will be installed on campus / potentially a residential community
  - Eco-driving feedback research will be published and presented
  - Host symposium to attract funding and showcase products
  - Further Research into design of community thermostats and water usage feedback interfaces