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OFFICE OF RESEARCH

RISE

# Research Investments in the Sciences and Engineering (RISE) Program Report

Office of Research

University of California, Davis

November 29, 2012

## Executive Summary

The **Research Investments in the Sciences and Engineering (RISE)** program is designed to launch new, globally competitive large-scale interdisciplinary research activity at UC Davis. A desired outcome is that funded projects will lead to transformative knowledge and technologies that will aid in solving major problems facing our state, nation and the world. The goals of the RISE program are synchronized to major goals of Chancellor's Vision of Excellence: Foster a Vibrant Community of Learning and Scholarship; Drive Innovation at the Frontiers of Knowledge, and Nurture a Sustainable Future and Propel Economic Vitality.

In February 2012, the RISE request for applications (RFA) was announced. Submissions were solicited in the form of white papers (or "Themes"). Briefings and networking events were organized by the Office of Research to raise awareness of the program and facilitate introductions among faculty and staff. A total of 119 applications were received; 521 senate and federation faculty and researchers participated in proposals, with representation from a broad range of schools and colleges. Over $111 million in support was requested with $9 million pledged in matching cash funds and in-kind contributions from external sources. Following a rigorous, external peer-review process, 13 RISE Themes were chosen for support based on their potential for future high impact discoveries and innovation, as judged by their scientific merit, potential societal importance, and sustainability. The 13 RISE Themes include 81 faculty from 7 colleges and schools, representing 38 academic departments and campus units. They provide support for 48 undergraduate trainees, 59 graduate students, and 23 post-doctoral researchers. Awards totaled $10.9 million to be distributed over a three year period. A rigorous system of metrics will be put into place to monitor the success of the Themes, coupled with an extensive program to support the Themes in their bid for large-scale funding from government, foundations and the private sector.

## RISE Program Overview

The **Research Investments in the Sciences and Engineering (RISE)** program is an initiative designed to promote the establishment of new, globally competitive large-scale interdisciplinary research activity at UC Davis. The program will facilitate the formation and enhancement of interdisciplinary teams to carry out joint research activities in areas of strategic importance. RISE funding is intended to propel UC Davis faculty and researchers to a position of strength in competing for major federal, corporate, and philanthropic research grants and partnerships. Successful Themes were chosen based on their potential for future high impact discoveries and innovation, judged on their scientific merit, potential societal importance, and sustainability.

On February 7, 2012, the RISE request for applications (RFA) was announced to the campus. The deadline for submissions was April 2, 2012. Submission format was a 12-page white paper through which groups of faculty and staff would present a new, cutting-edge interdisciplinary approach to solve critical scientific, medical or social problems.

During the submission window, five briefings were organized across campus to apprise faculty of the funding opportunity and to provide answers to queries on goals, intent and process. The Office of Research also facilitated two "Research Collaborator Meet-and-Greets" to raise awareness and facilitate introductions. Feedback from participants indicated that these networking meetings provided a catalyst for faculty who might not have interacted to collaborate around research themes.

The campus research community responded to the RFA with an astounding variety of innovative white papers. 119 submissions were received and 521 faculty and researchers participated with representation from all schools and colleges. More than $111 million in support was requested with $9 million in matching cash funds and in-kind contributions pledged from external sources. Ample evidence of commitment to student and postdoctoral training was clear, with support requests for 179 postdoctoral researchers, 395 graduate students and 313 undergraduate trainees.

Following a rigorous, external peer-review process, 13 RISE Themes were chosen for support. Successful Themes were comprised of 81 faculty and researchers from seven schools and colleges, encompassing 38 academic departments and campus units (Table 1, Appendix 3). They provide support for 48 undergraduate trainees, 59 graduate students, and 23 post-doctoral researchers.

**Table 1: Distribution of Theme Members by Schools and Colleges**

| School or College | (Proposals) No. Theme Leaders | (Proposals) No. Theme Members | No. funded Theme Members (No. Theme Leaders) | Submissions not meeting essential eligibility criteria |
|---|---|---|---|---|
| School of Medicine | 41 | 151 | 29 (4) | 11 |
| College of Engineering | 26 | 93 | 21 (6) | 3 |
| College of Agricultural and Environmental Sciences | 17 | 95 | 10 (2) | 4 |
| School of Veterinary Medicine | 12 | 44 | 0 | 3 |
| College of Letters and Sciences: Mathematical and Physical Sciences | 11 | 44 | 6 (1) | 3 |
| College of Letters and Sciences: Social Sciences | 2 | 25 | 1 | 2 |
| College of Letters and Sciences: Humanities, Arts and Cultural Studies | 1 | 14 | 3 | 1 |
| College of Biological Sciences | 8 | 40 | 8 | 1 |
| Graduate School of Management | 0 | 7 | 2 | 0 |
| School of Education | 1 | 4 | 0 | 0 |
| School of Nursing | 0 | 2 | 1 | 0 |
| School of Law | 0 | 1 | 0 | 0 |
| Other | 0 | 1 | 0 | 0 |
| **Total** | **119** | **521** | **81** | **28** |

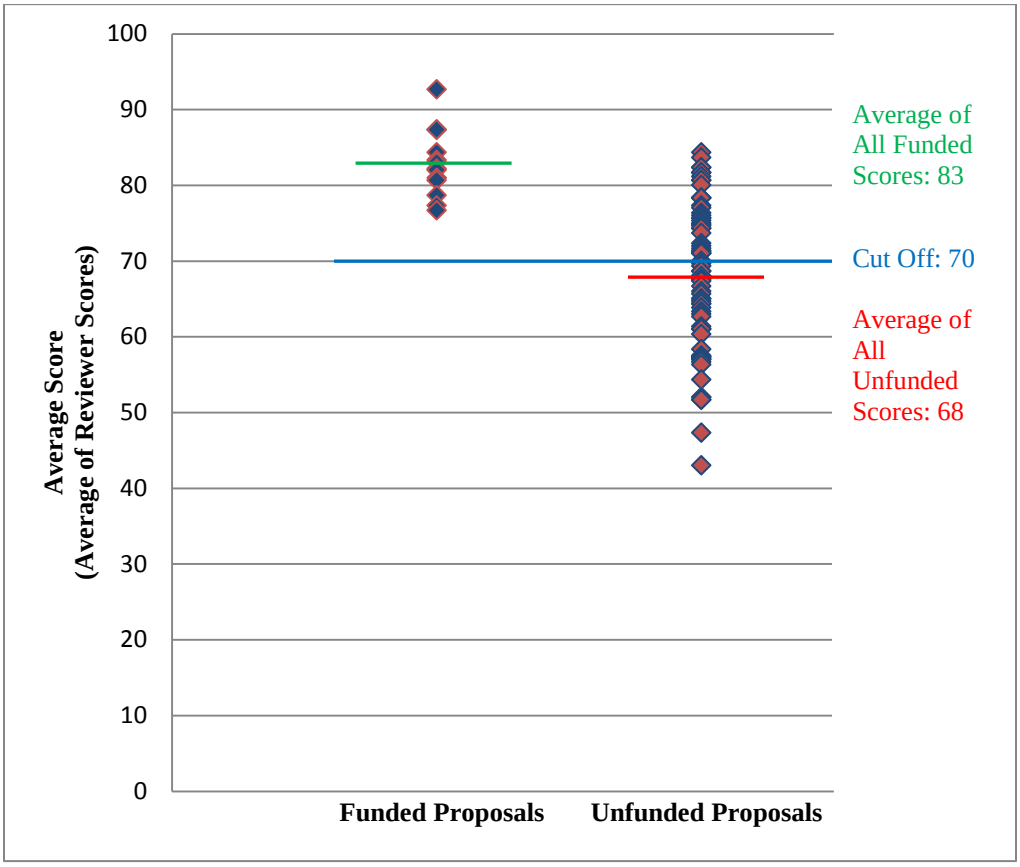


**Figure 1; Distribution of proposal review scores of funded/unfunded submissions.** Proposals scoring below 70 were not considered further. Fifty-two proposals were discussed in detail by the External Scientific Advisory Committee (ESAC). Thirteen proposals were selected for funding.

## RISE Review Process Description - Overview

In order to provide a thorough assessment of submitted white papers and choose those that best matched goals of the RISE program, the review process was divided into three phases.

1. A preliminary review phase determined the eligibility of white papers. Eligibility was based on white papers meeting essential criteria of RISE goals as outlined in the RFA.
2. The secondary phase was an external written review process that was conducted by the External Scientific Advisory Committee (ESAC) in conjunction with *ad hoc* reviewers with domain expertise. Assessment was based on criteria described in the RFA.
3. The tertiary phase was an onsite review conducted by the ESAC panel in Davis where white papers were presented and discussed in detail and recommendations were made for funding.

Following the review process, Vice Chancellor for Research Harris Lewin discussed the review results and ESAC recommendations with Provost and Executive Vice Chancellor Ralph Hexter and Chair of the Academic Senate Linda Bisson before final funding decisions were made.

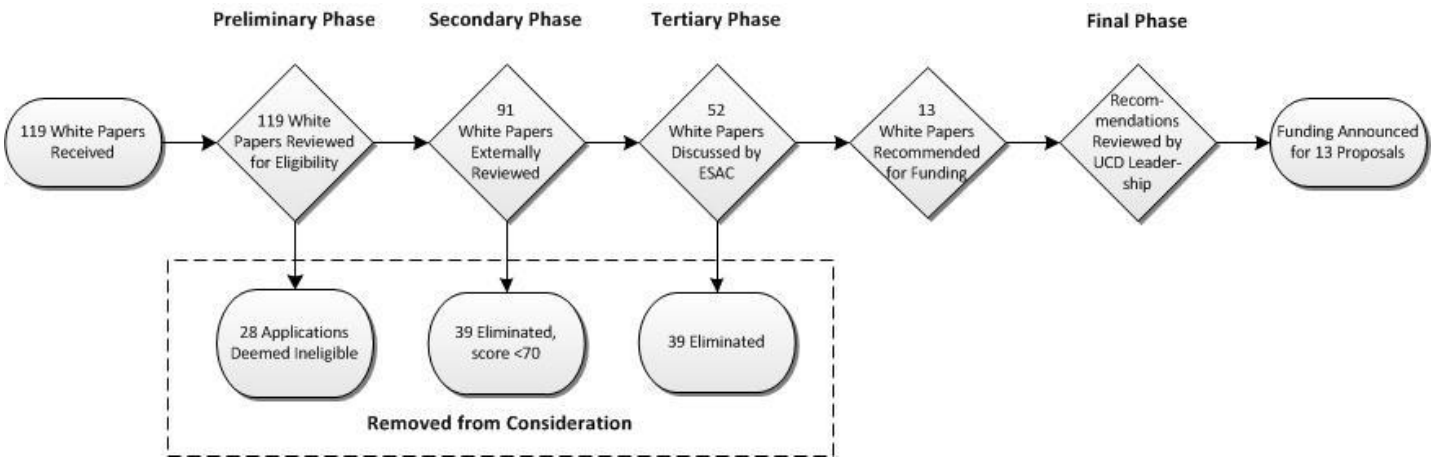


**Figure 2: RISE review process overview**

## Detailed Description

### Preliminary Phase: Eligibility Review

Following the overwhelmingly positive response to the call, a larger than anticipated number of applications was received and, in line with funding agency practice, a preliminary review phase was implemented based on essential eligibility criteria. In this initial assessment round, white papers were reviewed for eligibility by a panel of three distinguished UC Davis faculty emeriti with assistance from members of the Office of Research. This initial review phase was not based on an assessment of scientific quality; rather, white papers were assessed for their eligibility in meeting essential RISE criteria articulated in the RFA. The criteria assessed were as follows:

1. The RISE Theme must clearly address a scientific or engineering problem or challenge that has potential to produce substantial societal and/or economic impact.
2. The problem to be solved must be clearly articulated.
3. The problem proposed must necessitate an interdisciplinary team approach.
4. A clear and detailed sustainability plan must be presented.
5. Measurements of success and achievable milestones must be clearly delineated.

Based on this assessment, 28 white papers were deemed not to meet the essential eligibility criteria and were not advanced to subsequent review stages.

**Secondary Phase: External Review**

The ESAC, comprised of members of national academies, or individuals of similar stature, was recruited to assess the white papers (Appendix 1). Nominations for the ESAC were sought from deans and the Academic Senate Committee on Research. Individual committee members were chosen for their particularly broad range of research interests and expertise, and their availability. The ESAC members were confirmed to be free of conflicts of interest before appointment. The ESAC was chaired by Professor Lawrence Coleman, a distinguished UC Davis emeritus faculty member (Department of Physics).

In addition to reviews by the ESAC, secondary and tertiary reviews were provided from off-site subject matter experts with domain expertise complementing the ESAC panel. Each reviewer is a recognized leader in his/her field, and was chosen to match topical research areas represented by multiple white papers. In keeping with common funding agency practice, identities of the external expert reviewers remained anonymous and were not made known to the ESAC or to applicants.

White papers were assigned to reviewers based on area of expertise. Each reviewer was allocated multiple white papers and given four weeks to return completed reviews. Responses from all reviewers were compiled and secondary and tertiary reviews were provided to the primary ESAC reviewers for their consideration and presentation at the on-site panel discussion.

In total, 26 reviewers (9 ESAC and 17 external experts) conducted the external review phase. Each white paper received three individual reviews with at least one by a member of the ESAC. Reviewers utilized a weighted scoring sheet that was based on criteria identified on page 6 of the RFA and summarized below. Reviewers also provided relative rankings, nominally categorizing each submission as top, middle or bottom relative to white papers they had reviewed. Reviewers also had an option to provide written comments.

The principal criteria considered were as follows. Each proposal was assessed to determine if it:

1. Addressed a major problem or challenge requiring a multidisciplinary approach.
2. Proposed original and meritorious science.
3. Demonstrated genuine interdisciplinarity, with a strong and appropriate team with all requisite expertise.
4. Described an appropriate training component.
5. Demonstrated potential for economic impact.
6. Identified a strong plan/potential for sustainability beyond RISE support, especially a plan for alignment with opportunities from federal, industrial or philanthropic sources.
7. Described adequate metrics of success and achievable milestones.
8. Proposed a budget (and match if indicated) that was considered adequate and appropriate.
9. Provided appropriate facilities to undertake the proposed research.

**Tertiary Phase: External Scientific Advisory Committee Meeting at UC Davis**

The ESAC convened at UC Davis for a three day meeting June 12-14, 2012. The committee was provided extensive briefing on the review process the evening before the meeting commenced.

Scores and rankings from all reviewers were tabulated and proposals were ranked by highest mean score. Proposals with the mean score below 70 (see Figure 2) were removed from further consideration. Proposals with highly variable scores were flagged for specific consideration during this process. Additionally, committee members were given an opportunity to make a case for reconsidering any white paper that they judged to be particularly worthy of further discussion; two were reconsidered based on this process. In total, 52 white papers were selected for discussion.

Each white paper was considered in turn by the committee. The discussion was led by the primary reviewer from the ESAC, who presented external reviews in addition to their own review. White papers were discussed and binned into four categories: Exceptional, High, Medium and Low Priority. Discussion focused on placing white papers in the appropriate ranking category and was coupled with an ongoing re-ranking relative to each other throughout the ranking process. Seventeen white papers were categorized as having exceptional or high merit.

The top 17 white papers were then further discussed and assigned to four quartiles in order of priority for funding. Proposals were first ranked within and between quartiles and finally ranked 1 through 17. The discussion of strengths and weaknesses was recorded by Office of Research staff, and provided to the ESAC for feedback and editing. These summaries were shared with proposal Theme Leaders at the conclusion of the review process.

ESAC members participated in a written "blind" vote to indicate their recommendations for a funding cut-off point. The majority indicated their preference to limit funding to the top 12 white papers.

Subsequent to the onsite review it was determined that four white papers had been overlooked during the submission process. The Theme Leaders were informed immediately upon discovery of this administrative error and their white papers were subsequently subjected to the exact same process as the original set of reviews. Every review step was replicated. All four white papers were confirmed to satisfy the essential RISE criteria and were thus dispatched for external review. Each white paper was distributed to three reviewers including at least one ESAC member. Individual review scores were collated as before. Two white papers scored below the cut-off mark of 70 (and were subsequently eliminated from competition) and two scored above 70. The ESAC convened via conference call and discussed in detail the two white papers that scored above an average of 70 from the written reviews. The committee recommended that one of the two white papers should be advanced for funding.

**Final Phase: Funding Recommendations**

Vice Chancellor Lewin discussed the ESAC recommendations with Provost and Executive Vice Chancellor Ralph Hexter and Academic Senate Chair Linda Bisson. Following this consultation it was decided to make awards to the 13 Themes recommended for funding by the ESAC. White papers selected for funding are listed in Appendices 2 & 3.

**Post Review Process and Feedback**

Reviews were compiled and forwarded to all RISE Theme Leaders. The score for each category was averaged. In some instances reviewers only provided overall scores and did not score individual categories; in those instances the overall score may not directly match cumulative scores from individual categories. Overall score was used in each instance to provide the initial ranking of white papers.

All awardees received notification that their awards were conditional upon receipt of an amended budget and scope of work. While awards are for a period of three years, each year's allocation will be conditional on receipt of a satisfactory progress report and a review of advancement of the Theme's goals by Office of Research staff.

In addition, each Theme Leader will be required to present a progress report of their Theme's activities at an annual RISE symposium every Fall quarter. The inaugural meeting will take place on 30th November 2012.

**Postscript**

It is expected that these awards will lead to transformative new knowledge and technologies that will attract large-scale funding from federal, state, foundation, corporate and other private sources. In addition, the RISE program will create a large number of new opportunities for interdisciplinary research training at the undergraduate, graduate and postdoctoral levels. During the next three years, the Office of Research will work closely with RISE faculty to ensure that the RISE Themes are successful. Together with our partners in the public and private sectors we will build on our combined strengths to meet the societally relevant research challenges being addressed by the RISE Themes.

Harris A. Lewin
Vice Chancellor for Research

## Appendices

1. External Scientific Advisory Committee (ESAC)
2. RISE Theme Awardees
3. RISE Awardee Abstracts

## Appendix 1: External Scientific Advisory Committee (ESAC)

| | |
|---|---|
| **Paul M. Allen, Ph.D.** | Robert L. Kroc Professor, Pathology and Immunology<br>Washington University School of Medicine |
| **Roger N. Beachy, Ph.D.** | Founding President<br>Donald Danforth Plant Science Center |
| **Richard O. Buckius, Ph.D.** | Vice President for Research<br>Professor, Mechanical Engineering<br>Purdue University |
| **Lawrence B. Coleman, Ph.D. (Chair)** | Professor Emeritus of Physics<br>UC Davis<br>Former Vice Provost for Research<br>University of California |
| **John Erdman, Ph.D.** | Professor, Department of Food Science and Human Nutrition<br>University of Illinois, Urbana-Champaign |
| **Art Kramer, Ph.D.** | Director of the Beckman Institute for Advanced Science and Technology – Human Perception and Performance<br>Professor, Department of Psychology & Neuroscience<br>University of Illinois, Urbana-Champaign |
| **Herbert Levine, Ph.D.** | Co-Director, Center for Theoretical Biological Physics<br>Professor of Physics<br>University of California, San Diego |
| **Mark S. Lundstrom, Ph.D.** | Don and Carol Scifres Distinguished Professor of Electrical and Computer Engineering<br>Purdue University |
| **Guy Palmer, DVM, Ph.D.** | Director, Paul G. Allen School for Global Animal Health<br>Jan and Jack Creighton Endowed Chair in Global Health<br>Regents Professor of Pathology and Infectious Diseases<br>Washington State University |
| **Rob A. Rutenbar, Ph.D.** | Abel Bliss Professor and Department Head<br>Department of Computer Science<br>University of Illinois, Urbana-Champaign |

## Appendix 2: RISE Theme Awardees

| Theme Leader | Theme Title | Theme Faculty |
|---|---|---|
| **George Bruening**<br>Plant Pathology | Structural Biochemistry of Plant-Pathogen Interactions to Promote Healthy Crops and Enhance Global Food Security | Gitta Coaker, Plant Pathology; SP Dinesh-Kumar, Plant Biology; Andrew Fisher, Molecular & Cellular Biology; Ioannis Stergiopoulos, Plant Pathology; David Wilson, Molecular & Cellular Biology |
| **Simon Cherry**<br>Biomedical Engineering | UC Davis Center of Excellence in Translational Molecular Imaging | Julie Sutcliffe, Biomedical Engineering/Oncology; Ramsey Badawi, Radiology; Jinyi Qi, Biomedical Engineering; Alice Tarantal, Cell Biology and Human Anatomy; Lars Berglund, Internal Medicine, Clinical and Translational Science Center; Karen Kelly, Hematology & Oncology, Comprehensive Cancer Center |
| **Daniel Cox**<br>Physics | ANSWER: Amyloids for Nanoparticle Synthesis, Wiring, Energy, and Remediation | Rrajiv Singh, Physics; Xi Chen, Chemistry; Josh Hihath, Electrical and Computer Engineering; Gang-yu Liu, Chemistry; Michael Toney, Chemistry; Ted Powers, Molecular and Cellular Biology; Gergely Zimanyi, Physics |
| **Satya Dandekar**<br>Medical Microbiology and Immunology | Protecting the Fragile Intestine: Integrating Microbiota and Mucosal Health | Bruce German, Food Science & Technology; Mark Underwood, Pediatric Neonatology; David Mills, Viticulture & Enology; Ralph deVere White, Urology, Comprehensive Cancer Center; Richard Pollard, Infectious Diseases; Thomas Prindiville, Gastroenterology & Hepatology |
| **Bryce Falk**<br>Plant Pathology | RNA-Based, Amplification Free, Pathogen Identification Using Nano-Enabled Electronic Detection (RAPID-NEED) | Paul Feldstein, Plant Pathology; Erkin Seker, Electrical and Computer Engineering; Maria Marco, Food Science & Technology; Josh Hihath, Electrical and Computer Engineering; Andre Knoesen, Electrical and Computer Engineering |
| **Katherine Ferrara**<br>Biomedical Engineering | Center for Content Rich Evaluation of Therapeutic Efficacy (cCRETE) | Steven Currall, Graduate School of Management; Ralph deVere White, Urology, Comprehensive Cancer Center; Bruce Hammock, Entomology; Dawei Lin, Genome Center; Alexander Revzin, Biomedical Engineering; Clifford Tepper, Biochemistry and Molecular Medicine; Frederic Gorin, Neurology |
| **Jay Han**<br>Physical Medicine and Rehabilitation | iWHW: initiative for Wireless Health and Wellness At UC Davis | Prasant Mohapatra, Computer Science; Thomas Nesbitt, Family and Community Medicine; Heather Young, School of Nursing; Lars Berglund, Internal Medicine, Clinical and Translational Science Center |

| RISE Theme Awardees (continued) | | |
|---|---|---|
| **Theme Leader** | **Theme Title** | **Theme Faculty** |
| **Karl Levitt**<br>Computer Science | Cyber-Security for Critical Infrastructures: Smart Grid, Financial and Human-centered Mobile Networks | James Bushnell, Economics; Anna Scaglione, Electrical and Computer Engineering; George Barnett, Communication; Nicole Woolsey Biggart, Graduate School of Management; Hao Chen, Computer Science |
| **Kwan-Liu Ma**<br>Computer Science | UC Davis Center of Excellence for Visualization | Fu-Tong Liu, Dermatology; Ramsey Badawi, Radiology; Robert Faris, Sociology; Susan Verba, Design; Tom Turrentine, Institute of Transportation Studies |
| **Nelson Max**<br>Computer Science | New Tools for Understanding, Monitoring, and Overcoming Plant Stress | Julin Maloof, Plant Biology; David Slaughter, Biological and Agricultural Engineering; Neelima Sinha, Plant Biology; Jinyi Qi, Biomedical Engineering |
| **Kimberley McAllister**<br>Neurology; Neurobiology Physiology and Behavior; Center for Neuroscience | I-CAN SZ (Interdisciplinary, Collaborative, Analysis of Neuroimmune-Based Schizophrenia) | Cameron Carter, Psychiatry; David Amaral, Psychiatry; Julie Sutcliffe, Biomedical Engineering; Simon Cherry, Biomedical Engineering; Judy Van de Water, Internal Medicine: Rheumatology; Paul Ashwood, Medical Microbiology and Immunology; Melissa Bauman, Psychiatry and Behavioral Sciences |
| **Edward Pugh**<br>Physiology and Membrane Biology; Cell Biology and Human Anatomy | The UC Davis Eye-Pod: Functional Imaging of Single Cells in the Eyes of Living Animals under Normal, Pathogenic and Regenerative Conditions | Paul Fitzgerald, Cell Biology and Human Anatomy; John S. Werner, Neurobiology Physiology and Behavior; Jan Nolta, Hematology & Oncology, Institute for Regenerative Cures; Susanna Park, Ophthalmology; Scott Simon, Biomedical Engineering; Fitz-Roy Curry, Physiology and Membrane Biology; Nadean Brown, Cell Biology and Human Anatomy; Hwai-Jong Cheng, Neurobiology, Physiology and Behavior; Marie Burns, Opthamology; Larry Hjelmeland, Opthamology; Tom Glaser, Cell Biology and Human Anatomy |
| **Thomas Turrentine**<br>Institute of Transportation Studies | Transforming Consumer Energy Use in Vehicles, Buildings and Appliances | Alan Meier, Institute of Transportation Studies; Ken Kurani, Institute of Transportation Studies; Kwan-Liu Ma, Computer Science; Nina Amenta, Computer Science ; Glenda Drew, Design; Dan Sperling, Civil Engineering, Environmental Science and Policy, Institute of Transportation Studies |

# Appendix 3: RISE Awardee Abstracts

## Structural Biochemistry of Plant-Pathogen Interactions to Promote Healthy Crops and Enhance Global Food Security

| | | |
|---|---|---|
| *Theme Leader*: | George Bruening | Plant Pathology |
| *Theme Faculty:* | Gitta Coaker | Plant Pathology |
| | Andrew Fisher | Chemistry |
| | S.P. Dinesh-Kumar | Plant Biology |
| | Ioannis Stergiopoulos | Plant Pathology |
| | David Wilson | Molecular and Cellular Biology |

Even for that small subset of microorganisms that is pathogenic in some settings, the great bulk of potential pathogen and potential host pairs do not result in disease. The contrasting outcomes of successful innate defense or disease development are dependent on specific communication between pathogen and host, regardless of whether the host is plant or human or other animal of any type. Thus, results obtained in this project will have broad implications for pathology generally. Specific communication is mediated by interactions between pathogen and host proteins, or proteins and small molecules: "immune receptors" of the host and pathogen "effectors."

Plant innate defense against fungal, bacterial, and viral pathogens is a topic of central agricultural importance because, after the physical barriers, innate defense provides the first line of protection and is responsible for activating other defense mechanisms. Additionally, reaction of the host to an invading pathogen is itself an important aspect of disease development separate from direct pathogen effects. Very little is known about the molecular details of the interactions involving the effectors and their cognate immune receptors. Our Theme faculty of plant molecular biologists and protein-structure researchers will obtain 3-dimensional structures of effectors and immune receptors and, most importantly, their complexes, as well as the biological and biochemical information needed to interpret the complexes in functional terms. Knowledge of the intimate interaction of immune receptor and effector and the resulting signaling and its biological consequences are expected to guide new approaches to altering pathogen-plant interactions in favor of the plant.

## UC Davis Center of Excellence in Translational Molecular Imaging

| | | |
|---|---|---|
| *Theme Leader:* | Simon R. Cherry | Biomedical Engineering |
| *Theme Faculty:* | Julie Sutcliffe | Biomedical Engineering/Oncology |
| | Ramsey Badawi | Radiology |
| | Jinyi Qi | Biomedical Engineering |
| | Alice Tarantal | Cell Biology and Human Anatomy |
| | Lars Berglund | Internal Medicine, Clinical and Translational Science Center |
| | Karen Kelly | Hematology & Oncology, Comprehensive Cancer Center |

The field of *in vivo* molecular imaging makes use of non-destructive and highly sensitive imaging technologies combined with the injection of molecularly-targeted agents or "probes" to visualize, in three dimensions, the distribution and activity of specific molecular targets in a living subject. It is a broad platform technology applicable across virtually all major disease states that is used to develop and optimize a wide array of new diagnostic and therapeutic strategies and ultimately will be critical in implementing the concept of personalized medicine.

The goal of the Center for Translational Molecular Imaging is to build the infrastructure and expertise necessary to translate novel molecular imaging agents and devices for clinical research studies and perform "first-in-human" molecular imaging studies at UC Davis. It represents a collaborative and interdisciplinary effort between the Department of Biomedical Engineering, the Department of Radiology, the California National Primate Research Center, the Comprehensive Cancer Center and the Clinical and Translational Science Center. The grant has two main themes. First to take a novel molecular imaging agent that has been validated pre-clinically and perform "first-in-human" studies to establish the translational pathway for these agents at our institution, and second to fund initial development work for building a whole-body PET scanner with unprecedented sensitivity and body coverage that would represent an advanced imaging platform for new molecular imaging agent assessment. Ultimately, it is envisioned the Center will grow to provide support, expertise and resources for all translational molecular imaging activities at UC Davis.

**ANSWER: Amyloids for Nanoparticle Synthesis, Wiring, Energy, and Remediation**

| | | |
|---|---|---|
| *Theme Leader:* | Daniel Cox | Physics |
| *Theme Faculty:* | Rrajiv Singh | Physics |
| | Xi Chen | Chemistry |
| | Josh Hihath | Electrical and Computer Engineering |
| | Gang-yu Liu | Chemistry |
| | Michael Toney | Chemistry |
| | Ted Powers | Molecular and Cellular Biology |
| | Gergely Zimanyi | Physics |

The "amyloid" proteins are most known for the damage they do in unintended accumulations which can lead to such diseases as Alzheimer's, Mad Cow, or Type II Diabetes. In the end, these proteins collect into one dimensional, nearly crystalline structures called "fibrils" which can be very long and are robust against exposure from high temperature, sunlight, and other extreme conditions. Indeed, some organisms have evolved mechanisms for employing these accumulated proteins in useful means, such as one component of spider silk, and the stocks of lacewing eggs.

The goal of ANSWER (Amyloids for Nanoparticle Synthesis, Wiring, Energy, and Remediation) is to harness the unique abilities of amyloid proteins to self-assemble and modify them slightly so they can grow nanometer scale particles capable of carrying out useful functions when collectively brought together in these amyloid ensembles. Notably, we hope to develop ways to generate photovoltaic devices with aligned nanoparticle rods, and thermoelectric refrigerant/heating devices with aligned wiring and materials. We also want to examine whether the intrinsic amyloid structures bacteria and yeast employ in biocolony formation can be modified to template growth of photocatalytic materials that can break down environmental contaminants or potentially produce solar fuels.

**Protecting the Fragile Intestine: Integrating Microbiota and Mucosal Health**

| | | |
|---|---|---|
| *Theme Leader:* | Satya Dandekar | Medical Microbiology and Immunology |
| *Theme Faculty:* | Bruce German | Food Science & Technology |
| | Mark Underwood | Pediatric Neonatology |
| | David Mills | Viticulture & Enology |
| | Ralph deVere White | Urology, Comprehensive Cancer Center |
| | Richard Pollard | Infectious Diseases |
| | Thomas Prindiville | Gastroenterology & Hepatology |

The human gastrointestinal (GI) tract harbors >80% of the immune cells in the body and also hosts 10 times more commensal bacteria than the total number of cells in the body. The immune cells are essential for protection against pathogens yet uncontrolled immune activation can cause chronic inflammatory diseases. The interplay of the gut immune system with pathogens and commensal microbiota shapes the integrity and protection to the gut epithelial barrier and immune cells that in turn controls inflammation. Unresolved inflammation contributes to tissue injury, changes in the gut microbiota and inflammatory diseases. Despite the intense interest in developing therapeutic strategies to repair the gut damage and renew intestinal epithelial barriers, effective treatment regimens are lacking. We will apply novel approaches for repairing and protecting the fragile intestine in critical clinical populations: premature infants, HIV infected adults with incomplete immune recovery, cancer patients on chemotherapy and adults with inflammatory bowel disease.

A novel combination of milk derived oligosaccharides and uniquely human Bifidobacterium species will be used that have anti-inflammatory effects on immune cells. The program will combine our previous findings and collective expertise in human milk glycobiology and bioactive molecules, gut mucosal immunology, commensal bacteria, pediatrics/ neonatalogy, infectious diseases, cancer, clinical research, genomics and single cell analysis platforms. It will provide a dynamic and innovative platform for multidisciplinary training and mentoring of students and to generate collaborative opportunities among researchers and private sector to develop biomarkers, diagnostics and new products for protection of the fragile intestine and prevention/resolution of inflammation.

**RNA-based, Amplification-free, Pathogen Identification using Nano-Enabled Electronic Detection (RAPID-NEED)**

| | | |
|---|---|---|
| *Theme Leader:* | Bryce Falk | Plant Pathology |
| *Theme Faculty:* | Paul Feldstein | Plant Pathology |
| | Maria Marco | Food Science and Technology |
| | Josh Hihath | Electrical and Computer Engineering |
| | Erkin Seker | Electrical and Computer Engineering |
| | Andre Knoesen | Electrical and Computer Engineering |

Rapid, efficient, and low-cost detection and identification of specific microbial pathogens including bacteria, viruses, and fungi is a grand challenge facing human, animal and plant health. Current technologies, such as Q-PCR, require a relatively large amount of target and rely on multiple assays to accurately identify distinct pathogens. There is a clear and evident need to develop new technologies that can quickly, efficiently, and inexpensively identify pathogens of animals and plants. This Theme effort will utilize complementary approaches and expertise in biology, molecular biology, nanotechnology and electrical engineering, and develop new tools for detecting/identifying microbial pathogens of animals and plants. All organisms use RNA to express their genetic information and the nucleotide sequences of these RNAs differ even for homologous genes of closely-related variants of a given pathogen species which may have important differences in host range and/or pathogenicity.

We will utilize a novel two-stage sensor platform to electrically screen for sequence differences in order to detect and identify pathogen RNAs with sufficient sensitivity and specificity that will circumvent the otherwise necessary sample preparation steps. The first stage will utilize nanostructured sensor arrays coated with densely-packed short single-stranded DNAs that enhance sensitivity to rapidly narrow down the target RNAs to a specific pathogen group. The second stage will employ nanoscale electrical conductance measurements of RNAs that reveal minute differences in sequences and thus allow for the identification of specific pathogens. We envision this will pave the road for cell-phone sized devices which are field-ready for agriculture and food industries.

**Center for Content Rich Evaluation of Therapeutic Efficacy (cCRETE)**

| | | |
|---|---|---|
| *Theme Leader:* | Katherine Ferrara | Biomedical Engineering |
| *Theme Faculty:* | Steven Currall | Graduate School of Management |
| | Ralph deVere White | Urology, Comprehensive Cancer Center |
| | Bruce Hammock | Entomology |
| | Alexander Revzin | Biomedical Engineering |
| | Clifford Tepper | Biochemistry and Molecular Medicine |
| | Frederic Gorin | Neurology |

A major challenge for the pharmaceutical industry is the lack of tools to identify promising candidates early in the development process. To address this critical need, a team of cancer biologists, social scientists, bioinformatics experts and bioengineers has been created to develop and validate high throughput biomarker assays for the effect of new therapeutics on invasive cancers such as bladder, colon, pancreas, lung, breast, and glioblastoma. In addition, members of the group have developed novel small molecule therapeutics that effectively inhibit key pathways in these cancers; the success of these new therapeutics will require the development of biomarkers. Therefore, the important problem to be solved is the creation of high throughput and content rich assays to summarize the impact of therapeutics on cellular functionality. The "rich" content required to fully characterize the response to therapy must go beyond the quantification of proliferation and apoptosis to evaluate invasive potential, inflammatory markers, markers of "stem-ness", autophagy, metabolic pathways and senescence.

In cCRETE (pronounced "secrete"), we focus on assays of invasive potential and inflammatory markers which will be accomplished by measuring cell secreted factors in vitro and *in vivo*, including peroxide, TNF-alpha and matrix metalloproteinases (MMPs). We propose to develop cell microsystems where micropatterned co-cultures of cancer and non-cancer cells will be juxtaposed with arrays of sensing elements for monitoring downstream readouts of cell-drug interactions. Our group has also applied *in vivo* imaging to assess therapeutic efficacy and will validate the new assays with *in vivo* assays of cell invasion and inflammation.

**iWHW: initiative for Wireless Health and Wellness at UC Davis**

| | | |
|---|---|---|
| *Theme Leader*: | Jay Han | Physical Medicine and Rehabilitation |
| *Theme Faculty*: | Prasant Mohapatra | Computer Science |
| | Thomas Nesbitt | Family and Community Medicine |
| | Heather Young | School of Nursing |
| | Lars Berglund | Internal Medicine, Clinical and Translational Science Center |

The future of rising demand for healthcare services, driven largely by increasing chronic disease incidence and aging population, will also be challenged substantially by constraints on human and economic resources. Emerging wireless and mobile health (mHealth) technologies promise scalable and affordable solutions that promote wellness and preventive care by empowering individuals to help themselves, and provide innovative models of care delivery through pervasive "user-centered networked healthcare". The initiative for Wireless Health and Wellness (iWHW) at UC Davis brings together an interdisciplinary team leveraging UC Davis' unique combination of excellence in: telemedicine, computer science, engineering, nursing, clinical translational research, and disability research. The core themes of the iWHW are: 1) advancing wireless and mHealth technologies, 2) capacity-building and education, 3) improving health and health care through clinical application of mHealth technologies, 4) advancing research in mHealth security, privacy, and policy.

The initial collaborative research project will examine the feasibility and effectiveness of innovative nurse-health coach model of care delivery that is informed by an unprecedented "contextually-rich and personalized" data (physical activity, energy expenditure, geo-location, and ecologic momentary assessment) that utilizes "cloud computing" integrated with electronic health record system, all enabled simply through an individual's mobile phone during daily life. The developed analytic tools and sophisticated visualization techniques will provide interpretable data for researchers and/or actionable data for healthcare providers. The iWHW at UC Davis will provide the foundation for innovative interdisciplinary research with active industry collaboration, and serve at the vanguard of mHealth's progress towards improved, cost-effective healthcare and wellness.

**Cyber-security for Critical Infrastructures:**
**Smart Grid, Financial and Human-centered Mobile Networks**

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|---|---|---|
| *Theme Leader:* | Karl Levitt | Computer Science |
| *Theme Faculty:* | James Bushnell | Economics |
| | Anna Scaglione | Electrical and Computer Engineering |
| | George Barnett | Communication |
| | Nicole Woolsey Biggart | Graduate School of Management |
| | Hao Chen | Computer Science |

Pervasive use of networked computer systems has provided enormous societal benefits. These cyber technologies are embedded into all aspects of modern human life. While previous cyber-security work has focused upon attacks against and damage to computer systems themselves, relatively little attention has been given to vulnerabilities in the associated social and market structures. The question of how computers might be protected from attackers evolves to how the social and market systems governing the service might be protected from attacks against the computing ecosystem upon which they depend. Moreover, can attacks against the social and economic functionality serve as a way to affect the reliability of the tightly embedded cyber systems? We pursue a novel line of research focusing upon cyber-security, but with an aim toward addressing reliability of both the cyber and the supported social and economic services.

Our collaboration is inherently cross disciplinary, with team members in the social sciences to model the social and economic structures and the properties that affect reliability and trustworthiness. To motivate this research agenda we focus upon three thrust topics: 1) the security and reliability of next generation Smart Grids supplying electric power and the associated market-based control system, 2) techniques to design and protect financial markets with embedded cyber-enabled transactions and 3) emerging cyber-attacks and novel new security services from the pervasive use of powerful mobile computing devices. Our approach is to achieve resiliency properties through run-time monitoring to alert for and recover from malicious attacks. We are pursuing opportunities for collaboration with and outreach to public utilities, national labs, government agencies and industry contacts.

## UC Davis Center of Excellence for Visualization

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|---|---|---|
| *Theme Leader:* | Kwan-Liu Ma | Computer Science |
| *Theme Faculty*: | Fu-Tong Liu | Dermatology |
| | Ramsey Badawi | Radiology |
| | Robert Faris | Sociology |
| | Susan Verba | Design |
| | Thomas Turrentine | Institute of Transportation Studies |

We observe an explosive growth of data in almost all scientific research and practices, which creates tremendous challenges to people who attempt to manage and utilize the data. The data will only grow at faster rates demanding new approaches to data management and analysis. Visualization, which transforms raw data into vivid pictures conveying the most essential information in the data, has proven to be a very effective tool for understanding and explaining large, complex datasets. The UC Davis Center for Visualization is dedicated to providing advanced visualization solutions to researchers on campus. The Center will foster cross/interdisciplinary research and teaching as well as building of large-scale project teams pursuing the most challenging and pioneering research. With access to cutting-edge visualization technology, UC Davis faculty and students will become more productive in data driven research and more effective at communicating with others about their work, leading to more successful research publications and grant proposals and creating greater impact to their respective communities.

The Center will begin with a small core faculty team and is expected to grow by drawing faculty and students from different disciplines to create new collaborative projects. Our expertise includes advanced graphics and visualization techniques, artistic design, data management, and high performance computing. By working with domain scientists, we will create high-resolution, interactive, data-driven visualizations, providing new insight into scientific data and social media data. The Center will also develop a unique cyber infrastructure, which includes visualization, interface and display technologies that can inspire faculty to develop new research and teaching methods.

**New Tools for Understanding, Monitoring, and Overcoming Plant Stress**

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|---|---|---|
| *Theme Leader:* | Nelson Max | Computer Science |
| *Theme Faculty:* | Julin Maloof | Plant Biology |
| | David Slaughter | Biological and Agricultural Engineering |
| | Neelima Sinha | Plant Biology |
| | Jinyi Qi | Biomedical Engineering |

In the near future, population increases combined with climate change are expected to place unprecedented demands on agriculture. Droughts are predicted to become more prevalent, nitrogen and phosphorous will become limiting, and saline environments may be accessed as arable land becomes depleted. Developing crop varieties to cope with such stresses under unpredictable climate conditions will require a nuanced understanding of genetic responses to environmental changes. Additionally, valuable water and fertilizer must be efficiently triaged to those plants facing the greatest deficit of resources.

In this project, we will study responses to drought, salinity, and nitrogen and phosphorous deprivation in tomato, the second most valuable vegetable crop in California and worldwide. We will use RNA expression profiling to identify those genes most responsive to environmental stresses not only in domesticated tomato, but also its wild relatives, which may harbor sensitized responses to environmental change. We will develop high throughput methods to measure biochemical markers of stress, including remote multi-spectral sensing, thermal imaging, and stereo reconstruction. Additionally, we will analyze changes in the development and morphology of organs using Micro Computed Tomography to image the meristem and observe changes in leaves from their inception. We will direct our understanding of stress response towards the creation of genetically engineered tomato varieties that, from the outset of specific stresses, will visibly express a reporter, changing the color or structure of the plant. Such “sentinel” plants will allow the application of water and fertilizer as needed, rather than broadcasting these resources on potentially wasteful schedules.

**I-CAN SZ (Interdisciplinary, Collaborative, Analysis of Neuroimmune-based Schizophrenia)**

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|---|---|---|
| *Theme Leader:* | Kimberley McAllister | Neurology; Neurobiology, Physiology and Behavior; Center for Neuroscience |
| *Theme Faculty:* | Cameron Carter | Psychiatry |
| | David Amaral | Psychiatry |
| | Julie Sutcliffe | Biomedical Engineering |
| | Simon Cherry | Biomedical Engineering |
| | Judy Van de Water | Internal Medicine: Rheumatology |
| | Paul Ashwood | Medical Microbiology and Immunology |
| | Melissa Bauman | Psychiatry and Behavioral Sciences |

Schizophrenia (SZ) is a disabling brain disorder that affects 1% of the population worldwide. The social and economic costs of SZ are enormous and current treatments do little to reduce the devastating social and occupational disability associated with the disorder. Although SZ is usually diagnosed in young adults, it is believed to result from changes in how brain connections are formed during early development. SZ is heritable but the genes that cause this disorder in most people remain unknown. A wide range of environmental exposures also contributes to SZ and many of those factors alter immune function.

This initiative brings together 8 research groups to test the idea that maternal infection during pregnancy contributes to the development of SZ by altering immune molecules in the brains of offspring, which leads to changes in the way cells in the brain make connections. This will be the first study to characterize changes in immune responses, brain inflammation, brain anatomy, and behaviors, simultaneously in high-risk individuals during their first-break for SZ as well as two non-human model systems. In addition, this initiative will provide a unique environment for training in innovative, multidisciplinary approaches to bench-to-bedside research. Most important, our project has the potential to improve the lives of individuals with SZ through the discovery of novel diagnostic tools and new therapies for treating the currently untreatable negative symptoms of this disease.

**The UC Davis Eye-Pod: Functional Imaging of Single Cells in the Eyes of Living Animals under Normal, Pathogenic and Regenerative Conditions**

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| *Theme Leader*: | Edward Pugh | Physiology and Membrane Biology; Cell Biology and Human Anatomy |
| *Theme Faculty:* | Paul Fitzgerald | Cell Biology and Human Anatomy |
| | John S. Werner | Neurobiology, Physiology and Behavior |
| | Jan Nolta | Hematology & Oncology, Institute for Regenerative Cures |
| | Susanna Park | Ophthalmology |
| | Scott Simon | Biomedical Engineering |
| | Fitz-Roy Curry | Physiology and Membrane Biology |
| | Nadean Brown | Cell Biology and Human Anatomy |
| | Hwai-Jong Cheng | Neurobiology, Physiology and Behavior |
| | Marie Burns | Opthamology |
| | Larry Hjelmeland | Opthamology |
| | Tom Glaser | Cell Biology and Human Anatomy |

A major challenge of 21st century biomedical science is to translate advances in mechanistic understanding of molecular and cellular events into effective therapy. A major obstacle to achieving this goal is the difficulty of observing cellular function in the living organism. An iconic example is the ability to induce a stem cell to express markers of differentiation in vitro, suggesting commitment to a particular adult cell type, tantalizing us with the dream of functional tissue regeneration. But we generally lack the ability to observe *in vivo* the localization of a stem cell to its targeted site, follow the time course of its differentiation, and then in that same animal demonstrate acquisition of proper cellular function, as required for definitive therapy. Other state-of-the art potential therapies are likewise stymied by the problem of assessing treatment efficacy at the cellular level in live animals.

The UC Davis RISE Eye-Pod Facility is comprised of a team of engineers, biologists and clinicians from six departments of the Schools of Engineering, Medicine and Biological Science, who will apply adaptive optics (AO) imaging to non-invasively observe marked individual cells in the eyes of live animals over their lifespan. AO technology will enable simultaneous, quantitative assessment of cellular morphology and many basic functions, to be used in testing of stem-cell and other therapeutic strategies in animal models of major diseases. This effort will also create a model of interdisciplinary, team-based problem solving in which students and postdoctoral scholars will learn the skills to assemble and administer such teams.

**Transforming Consumer Energy Use in Vehicles, Buildings and Appliances**

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|---|---|---|
| *Theme Leader*: | Thomas Turrentine | Institute of Transportation Studies |
| *Theme Faculty:* | Alan Meier | Institute of Transportation Studies |
| | Ken Kurani | Institute of Transportation Studies |
| | Kwan-Liu Ma | Computer Science |
| | Nina Amenta | Computer Science |
| | Glenda Drew | Design |
| | Dan Sperling | Civil Engineering, Environmental Science and Policy, Institute of Transportation Studies |

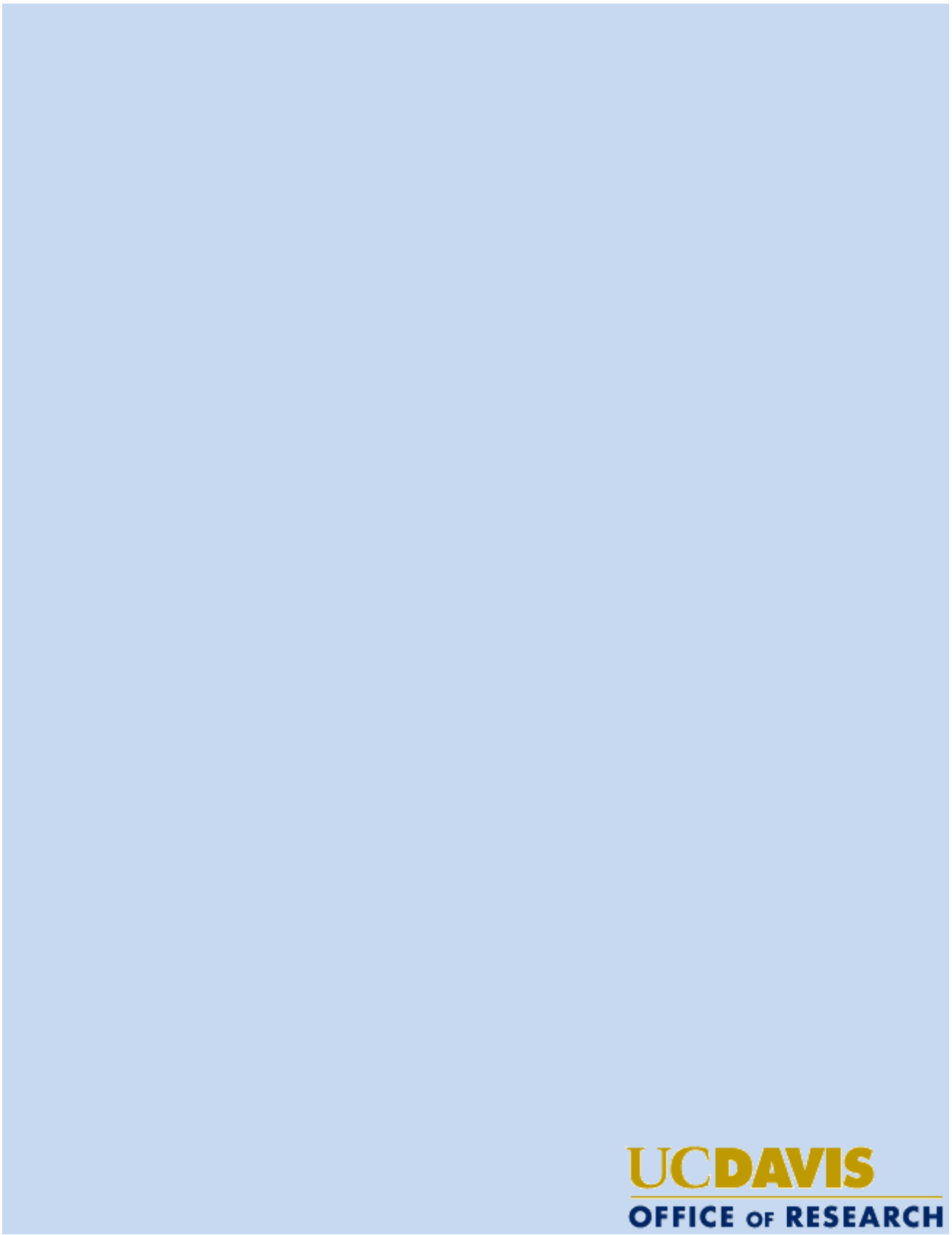
To reduce energy use and emissions, our proposal fundamentally alters how consumers experience energy. Our team from the behavioral science, design, computer science, and engineering fields will collaborate to create and evaluate innovative user feedback tools and media to save energy and reduce emissions by leveraging behavioral and cultural change. Our initial focus at West Village "Transportation and Energy Cluster" allows us to study the practical impacts of social-technical systems of energy use in these four project areas:

Project 1: Design new energy feedback systems for vehicle-building interactions: First, we define data sharing requirements between households and vehicles. Second, we collaborate with energy management companies, utilities, and automakers to create a data-sharing protocol. Third, we collaborate with residents of West Village to design an integrated residential and transportation energy feedback system.

Project 2: Better geographic visualization for consumers: We investigate and develop new representations of driver energy use that help them to understand their present energy consumption and foresee potential future needs.

Project 3: Design of user-friendly controls: We focus on the design of controls for energy using devices, beginning with residential thermostats. We will build on earlier work to develop more intuitive controls, communications protocols, and technologies.

Project 4: Technological-social energy feedback systems: We will investigate the role that social media and feedback may play on consumer energy use by linking consumers in existing and new social networks to encourage energy efficient behaviors.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