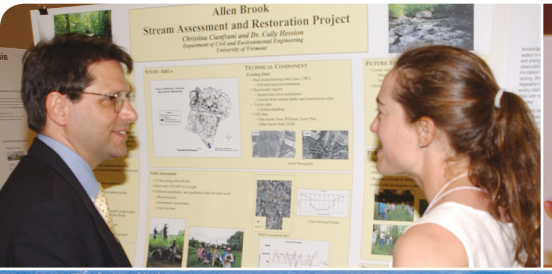

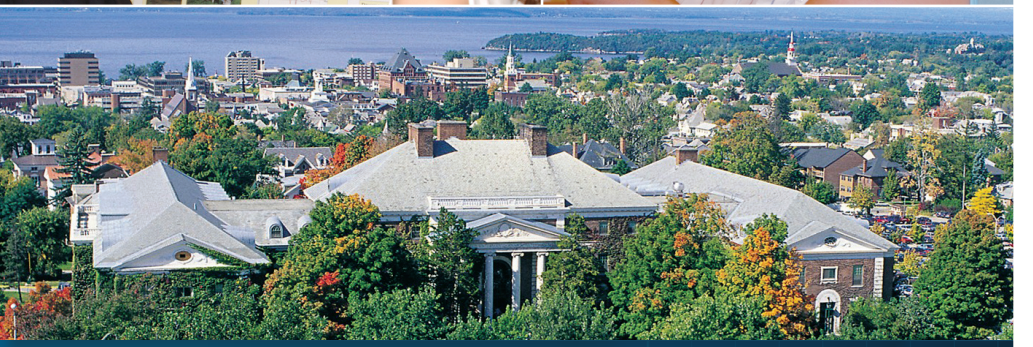

NSF RESEARCH DAY

VT EPSCoR Annual State Meeting
Grant Writing Workshop

June 6 & 7, 2008 | Davis Center, UVM Campus
Burlington, Vermont

Vermont EPSCoR

NSF EPSCoR

National Science Foundation

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Abstracts *

***Listed by first author or designated author**

NSF Presenter Biographies

Vermont Presenter Biographies

Davis Center Floor Plans

June 6, 2008

Dear Conference Attendee:

We welcome you to the first VT EPSCoR hosted **NSF Research Day.** We are combining this event with our ***Annual State Meeting and Grant Writing Workshop*** on **June 6 & 7, 2008 at the Davis Center** on UVM Campus in Burlington, Vermont.

We are *extremely* fortunate that the following representatives from the National Science Foundation will be present to talk to us about the mission and initiatives of their Directorates, Offices and funding opportunities at NSF. An important goal of the NSF EPSCoR program is to help our Vermont scientists and engineers to become more competitive for support of their research broadly across the NSF directorates and programs. Here is our opportunity to learn about the newest at NSF and to network with NSF visitors.

We are pleased that you have joined us for this incredible networking opportunity on June 6th and our Grant Writing Workshop on Saturday, June 7th when three of our NSF visitors and three Vermont scientists will talk about IGERT, CCLI, RUI, CAREER, SBIR and other award proposals.

Sincerely,

Judith Van Houten
Vermont State EPSCoR Director

Friday June 6, 2008

Davis Center, UVM Campus

7:30 a.m.
Registration and Poster Set Up and Continental Breakfast
Grand Maple Ballroom

8:00 a.m.
Opening Remarks and Welcome
Grand Maple Ballroom
Judith Van Houten, Director, Vermont EPSCoR
Frances Carr, VP Research UVM
Henry Blount, III, Office Head, NSF EPSCoR
The Honorable Governor of Vermont, James Douglas

8:15 a.m.
Presentation of Mission of NSF and Its New Initiatives

- Joann Roskoski, Executive Office, Directorate for Biological Sciences
- Suzi Iacono, Senior Science Advisor, Directorate for Computer Information Science and Engineering
- Margaret Cavanaugh, Deputy Assistant Director, Directorate for Geosciences
- Kevin Thompson, Program Director, Office of Cyberinfrastructure

10:15 a.m.
Break

10:30 a.m.
Presentations continue

- Thomas Weber, Director, Office of International Science and Engineering
- Jack Lightbody, Deputy Assistant Director, Directorate for Mathematical and Physical Sciences
- Scott Borg, Division Director, Office of Polar Programs
- Maria K. Burka, Program Director, Process and Reaction Engineering, Directorate for Engineering

12:30 p.m.
Buffet Lunch and Networking
Grand Maple Ballroom

1:30 p.m.
Presentations Continue
Grand Maple Ballroom

- Timothy Fossum, Program Director, CCLI, Directorate for Education and Human Resources
- Carol Van Hartesveldt, Program Director, IGERT, Directorate for Education and Human Resources
- Tyrone Mitchell, Program Director, Organic Dynamics, Chemistry, Directorate for Mathematics & Physical Sciences
- Thomas Allnutt, Program Director, SBIR, Directorate for Engineering

2:30 p.m.
Break Out Sessions
Dr. Blount introduces the Program Directors who will be leading breakout sessions in other rooms in the Davis Center.
Room assignments listed on Page 5.

Refreshments will be continuously available – Grand Maple Ballroom

4:00 p.m.
Poster Session and Networking
Fireplace Lounge

5:30 p.m.
Hors d'ouvers
Grand Maple Ballroom

6:00 p.m. - 8:00 p.m.
Grand Maple Ballroom
Dinner and Networking
Showing of an Emerging Science television episode about Vermont EPSCoR's science and engineering

Joe Merone, Executive Producer, Vermont Public Television

Saturday June 7

Davis Center, UVM Campus

8:00 a.m.
Mansfield Room – 2nd floor Davis Center
Continental Breakfast & Registration

8:30 a.m.
Mansfield Room – 2nd floor Davis Center
Vermont EPSCoR Annual Grant Writing Workshop
Welcome
Judith Van Houten, Director, Vermont EPSCoR
Henry Blount, III, Office Head, NSF EPSCoR

Successful Grant Writing Panel

- Carol Van Hartesveldt (NSF) IGERT proposals
- Paul Bierman (UVM) – CAREER proposals
- Mark Lubkowitz (SMC) – RUI proposals

10:15 a.m.
Break

10:30 a.m.
Presentations Continue

- Tony Fossum (NSF) CCLI proposals
- Thomas Allnutt (NSF) SBIR proposals
- Steve Arms, President, Microstrain, Inc. – SBIR Phase (I) and (II) proposals
- Paul Bierman (UVM) – MRI proposals

12:00 p.m.
Close of meeting
Judith Van Houten, Director, Vermont EPSCoR
Henry Blount, III, Office Head, NSF EPSCoR
Kelvin Chu, Associate Director, Vermont EPSCoR

Collect Box Lunches to be eaten at the conference or taken on your way home
Mansfield Room, Davis Center

Breakout Session Room Locations
June 6, 2008

NSF Name	Breakout Session Room Location
Allnutt, Thomas (SBIR, Directorate for Engineering)	Williams Family Room
Borg, Scott (Polar Programs)	Mt. Mansfield Room
Burka, Maria (Process and Reaction Engineering)	Boulder Society Room
Cavanaugh, Margaret (Geosciences)	Spruce Room
Fossum, Timothy (CCLI, Directorate for Education and Human Resources)	Handy Family Room
Iacono, Suzi (Computer Information Science and Engineering)	Olin Atrium
Lightbody, Jack (Mathematical and Physical Sciences)	The Summit Room
Mitchell, Tyrone (Chemistry, MPS)	Mt Mansfield Room
Roskoski, Joann (Biological Science)	Chittenden Bank Room
Thompson, Kevin (Cyber infrastructure)	Mt Mansfield Room
Van Hartesveldt, Carol (IGERT, Directorate for Education and Human Resources)	Mt Mansfield Room
Weber, Thomas (International Science and Engineering)	Olin Atrium

Program Notes –

- The Grant Writing Workshop has been moved to the following location on June 7th:
  - **Mansfield Room, 2nd Floor Davis Center**

- Parking tags are not necessary for Saturday, June 7th

- Posters may be taken down beginning at 6:00 p.m., Friday, June 6th. EPSCoR can not be responsible for any posters left in the Davis Center overnight.

- Please save meeting materials and name tags for all meetings – including June 7th Grant Writing Workshop.

- Wind to Wheels Hydrogen Car on display and available for viewing at the entrance to the Davis Building. Demo beginning at 5:00 p.m.

- Poster Session has been moved to the Fireplace Lounge on the 4th floor.

Kerensa M. Alley and Jane Molofsky – Department of Plant Biology

INTRASPECIFIC FREQUENCY DEPENDENCE AFFECTS SPECIES COEXISTENCE AND RANGE LIMITS ALONG ENVIRONMENTAL GRADIENTS.

Intraspecific frequency dependence increases or decreases the fitness of species according to its observed occurrence frequency and affects the distribution and abundance of species within plant communities. Frequency dependence can facilitate species coexistence and generate self-organized spatial patterns (e.g. clumping or patchiness) reflecting internal processes rather than external environmental factors. Other lines of research indicate that environmental gradients are ubiquitous and frequently responsible for species range limits. We therefore used cellular automata models of intraspecific frequency dependence and habitat suitability gradients to investigate 1) how the presence of an environmental gradient affects species coexistence due to frequency dependence, and 2) how frequency dependence influences the position and character of species range limits.

We expanded our model of intraspecific frequency dependence (e.g. Eppstein and Molofsky 2006) to incorporate habitat suitability defined as a location-specific factor influencing a species' probability of establishment, but not the number of propagules/seeds produced. Our simulations of ecologically equivalent species (i.e. identical frequency dependence, interaction neighborhoods, dispersal neighborhoods, and habitat preferences) are numerically identical with or without an environmental gradient. Coexistence due to frequency dependence was therefore not affected by gradients in establishment probability. Simulations where the habitat suitability of (otherwise-identical) species increases towards opposite environmental extremes tend to exhibit distinct geographical ranges for each species, separated by a transition (or coexistence) zone near the center of the gradient. The width of the transition/coexistence zone decreases with increasing frequency dependence (i.e. more positive or less negative), but positive frequency dependence no longer facilitates a patchy mosaic of coexisting species with or without patches of unsuitable habitat. Although future investigations will explore whether fundamentally different coexistence dynamics appear when habitat suitability is defined as affecting the number of propagules per individual, we demonstrate here that within-species processes are capable of influencing the location and character of species range limits.

Investigating the dynamics of savanna communities through computer simulation

Brian Beckage

Abstract

I propose to investigate the mechanisms that maintain southeastern pinelands as savannas rather than closed forests or open grasslands. Ecological theory has predicted either equilibrium savanna communities that result from niche partitioning or non-equilibrium savannas that result from disturbances. In the southeastern U.S., multiple disturbances such as hurricanes in conjunction with fire can bound savanna communities away from forested states toward grassland states. We have developed an alternative savanna model where vegetation-fire feedbacks can stabilize ecological communities in an equilibrial savanna state. We have explored the dynamics of mean field forms of this model and have implemented a simplistic spatial version of the model. I propose to use empirical demographic data to parameterize a spatially-explicit individual-based model in order to test model predictions against field data. We will compare the predicted demographic and spatial patterns simulated by the individual-based model to observed patterns of savanna vegetation in order to distinguish between alternative models of savanna dynamics. Our proposed research will develop a simulation model for pine savannas across the southeastern U.S. and will contribute to a general understanding of the processes that limit tree density in savanna systems worldwide.

Pediatric Imaging Technology, LLC

Reduced Radiation Injury and Risk for CT Medical Imaging of Children

VT EPSCoR SBIR Phase (0) Grant **July – December 2007**

Mark G. Benz, ScD, Principal Investigator
Matthew W. Benz, MD, Pediatrics
Steven B. Birnbaum, MD, Pediatric Radiology
Eric Chason, PhD, Materials Science
Brian W. Sheldon, ScD, Materials Science
C&G Technologies, Inc., CT Systems
UVM College of Engineering and Mathematical Science, and College of Medicine

Risk to Children

Pediatric CT medical imaging, while helping to save many lives, is causing x-ray ionizing radiation damage to children. This damage is projected to result in 3000 cancer deaths per year by the year 2040, when the children currently being imaged become middle age.

The absorption of x-ray ionizing energy by dividing human cells can disrupt the DNA structure of those cells. Normally this damage is repaired rapidly. However, sometimes this event can lead to cancer decades later in life.

Infants and children are particularly sensitive to this effect, as they have more dividing cells to be damaged, and they have a longer remaining life to live during which the consequences of the damage can be expressed

Medical professionals and equipment manufacturers are trying to reduce the projected cancer death rate by operating existing equipment at lower radiation levels when imaging children. The results are positive, but improvements are modest.

Opportunity

A 2007 grant from the Vermont Experimental Program to Stimulate Competitive Research (EPSCoR) allowed Pediatric Imaging Technology, LLC to assemble a team, define a new approach to reduce the risk, and envision an evaluation program. By placing a monochromator, diffraction or absorption type, between the x-ray source and the patient, the x-ray energy bandwidth would be reduced from ~ 50 keV to ~10 keV.

Image contrast is improved by narrowing the bandwidth, due to enhanced differential cellular absorption of the x-rays by the patient. Detector sensitivity is improved by centering the narrowed bandwidth on the region of highest relative sensitivity of the x-ray detector. The non-linear absorption characteristics of the detector scintillator provide for this opportunity.

With improved image contrast and with improved detector sensitivity, x-ray dose, and hence risk, can be reduced while still acquiring a high quality image. In a very encouraging result for a somewhat similar narrow bandwidth prototype mammography system, Baldelli, et al. have achieved comparable image quality with a dose reduction of 50%.

To evaluate this narrow bandwidth approach, an anthropomorphic abdominal phantom simulating a patient would be imaged in an existing CT system to which a monochromator had been attached. Radiological evaluation of the images taken at successively lower x-ray dose settings would be used to determine the lowest dose that produced an acceptable image. Comparison of these data to a similar set of images taken without the monochromator in place would be used to establish the dose reduction achieved. Risk reduction would be estimated from dose reduction by use of the Linear Non-Threshold (NLT) method, where risk is proportional to dose.

Short-term streamflow forecasting with a hierarchal generalized regression neural network: Application in the Winooski River basin, Vermont

Lance E. Besaw[1], Donna M. Rizzo[2], Paul R. Bierman[3] and William R. Hackett[4]

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[4] University of Vermont, Department of Geology, Burlington, VT 05405; PH: (802)- 656-4411; email: william.hackett@gmail.com

Sustainable water resources management is critical to both developing and established communities; particularly with the challenge of surface and groundwater contamination and the potential precipitation shifts associated with climate change. To more efficiently manage water resources during times of shortage and provide improved flood mitigation strategies, we have developed a method for forecasting short-term (daily) stream flow using a data-driven generalized regression neural network (GRNN). Network inputs consist of elevation adjusted climatic variables (*e.g.* precipitation and temperature) lagged in time; network output is streamflow over space and time. To capture the spatial and temporal variability of this complex watershed river network, a hierarchy of GRNNs has been implemented to forecast streamflow; where output from upstream (or lower order stream) GRNNs are used as inputs (in addition to climatic variables) to downstream (higher order) GRNNs. In Vermont's Winooski River basin, six USGS stream gage stations and a weather record based on the Burlington National Weather service station and adjusted to individual subbasins using precipitation and temperature lapse rates, provide the training, cross-validation and prediction datasets for this application. GRNNs have advantages over other ANN forecasting methods, namely their speed of training and guarantee of convergence due to circumventing stochastic training, as well as their advantage over traditional multilinear regression in that the order of the polynomial to be fit does not have to be specified *a priori*.

Advanced Techniques for Watershed Management: Using Artificial Neural Networks and Remote Sensing to Forecast Channel Instability

Lance Besaw[1], Keith Pelletier[2], Donna M. Rizzo[3], Leslie Morrissey[4] and Michael Kline[5]

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[4] University of Vermont, Rubenstein School of Natural Resources, Aiken Center, 81 Carrigan Dr., Burlington, VT USA 05405; ph: 802.656.2695; email: lmorriss@uvm.edu
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Managing watersheds and forecasting channel adjustments across spatial and temporal scales in response to natural and human stressors (*e.g.* impervious surface changes, grade controls, gravel extraction and channelization) requires an interdisciplinary approach by experts and stakeholders. The Vermont Agency of Natural Resources' (VTANR) is tasked with solving multi-objective problems associated with Vermont's dynamic river networks (*e.g.* mitigating property loss from channel erosion and/or flooding and reducing sediment and nutrient loading to receiving water bodies). To mitigate these complex problems, the VTANR River Management Program has been developing and testing field-based and remote sensing data collection protocols and a GIS-based data management system. In collaboration with the VTANR, this research focuses on 1) developing methods to predict channel instability and 2) exploring the feasibility of incorporating advanced remote sensing techniques into the protocols.

For the first research focus, we developed a hierarchical system of data-driven artificial neural networks (ANNs) that incorporate large amounts of disparate data (*i.e.*, RMP Phase 1 and 2 data, remotely sensed data, and expert opinion) for use in the operational management of channels and watersheds. These ANNs are used to further the development of region-specific fluvial geomorphic classification systems and/or predict channel instability. This provides several time and resource saving advantages that: (1) elicit governing factors controlling channel instability, (2) document the similarities among experts in determining instability, (3) provide a standardized, expert-trained approach for classifying instability of channels in various contexts (erosion

hazard mitigation, habitat restoration and conservation) and (4) provide truly adaptive management approach.

The second research focus combines Light Detection and Ranging (LIDAR) data in conjunction with high resolution digital orthophotography and an object based classifying software to (1) monitor channel sinuosity and migration over time, (2) accurately estimate total impervious area and important channel characteristics (*e.g.* slope) and (3) develop additional value-added products (bank slopes). Incorporating ANNs and high resolution remotely-sensed data has the potential to better quantify stream adjustment properties, while providing greater insight to a stream's state of dynamic equilibrium with higher accuracy, compared to traditional methods.

Stochastic Simulation and Spatial Estimation with Multiple Data Types using Artificial Neural Networks

Lance E. Besaw[a] and Donna M. Rizzo[b]

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A novel data-driven artificial neural network (ANN) is presented for performing stochastic simulation and/or spatial estimation that quantitatively combines large numbers of multiple types of soft data. A counterpropagation ANN is extended with a radial basis function to estimate parameter fields that capture the spatial structure exhibited in auto-correlated parameters. Applications involve using three types of geophysical properties measured on a slab of Berea sandstone and the delineation of landfill leachate at a site in the Netherlands using electrical formation conductivity as our primary variable and 6 types of secondary data (*e.g.* hydrochemistry, archaea and bacteria). The ANN estimation fields are statistically similar to the geostatistical methods (indicator simulation and cokriging) and reference fields (when available). The method is a non-parametric clustering/classification algorithm that can assimilate significant amounts of disparate data types with both continuous and categorical responses without the computational burden associated with the construction of positive definite covariance and cross-covariance matrices. The combination of simplicity and computational speed make the method ideally suited for environmental subsurface characterization and other earth science applications with spatially auto-correlated variables.

Key words: spatial estimation, counterpropagation algorithm, conditional simulation, artificial neural networks, joint data assimilation.

MEMS Gyros for the use in Controlling the Orientation of Small Satellites

Dylan Burns, Ph. D. Student*
Dryver Huston, Ph. D., PE, Professor*
Jianhong Cui, Ph. D. Student*

*University of Vermont

This project is to develop Microelectromechanical (MEMS) based Control Moment Gyros (CMG) for attitude control in small satellites. Small satellites have become useful and intelligent spacecrafts with sophisticated attitude control and determination systems. However, near future missions will require a higher degree of agility and better efficiency. CMG's are an ideal candidate technology with a unique capability to efficiently produce large torques and angular momentum with a small power consumption and savings in mass. Both the large scale and current MEMS devices will be researched and compared to see the applicability of MEMS gyros for use in controlling the orientation of small satellites. Currently MEMS gyros use the Coriolis affect for sensing, we will be looking into the possibility of inverting the mechanics of these devices to produce a torques that could then be used to control orientation.

As an environmental researcher, I am interested in pursuing research that will provide policy contributions to a changing environmental, social and cultural world. My previous experience as a field researcher in Queretaro and Oaxaca, Mexico has helped me with addressing policy recommendations. I hope to pursue similar goals while at the University of Maine at Fort Kent from a local, national and international perspective. I am currently working on a long-term project with fellow colleague Dr. Jenny Radsma on food production and health. This multi-perspective approach will first compare local and migratory farm workers' health conditions. I am also interested in broadening my research to encompass local, national and international impacts of food production in Maine and its affects on the local natural resources, community and economy. I also plan to travel to the migrant groups' country of origin to explore conditions that are pushing them into the far Northern corners of the United States. This project is especially important to the University of Maine at Fort Kent because we have just developed a Center for Sustainable Rural Development with the agenda to support projects such as mine.

An important key component of research is how poverty impacts certain decisions, especially those of field workers. I am attaching a paper that I wrote about how poverty affects the natural environment. I am plan too adapt some of theoretical concepts into my recent food production project.

Sincerely,

Soraya Cardenas, Ph.D.

Identification of phosphorylated CrkL-SH3 binding proteins from embryonic murine brain: Implications for reelin signaling during brain development.

Mujeeburahiman Cheerathodi and Bryan A. Ballif

Department of Biology, University of Vermont, 109 Carrigan Drive, Burlington, VT, 05405, USA.

Reelin is a large secreted glycoprotein that is essential for proper positioning of neurons during development of the central nervous system. The reelin signal is transduced through multimeric clustering of its receptors ApoER2 and VLDLR, leading to tyrosine phosphorylation of Dab1, a cytosolic adapter protein constitutively bound to reelin receptors. In addition to effecting the activation of Src family tyrosine kinases (SFKs) and the serine/threonine kinase Akt, phosphorylated Dab1 recruits the adaptor protein CrkL following reelin stimulation. CrkL binds to Dab1 via its SH2 domain permitting further recruitment of effector proteins to phosphorylated Dab1 via the SH3 domain of CrkL. C3G is one such protein that is recruited to phosphorylated Dab1 and itself becomes phosphorylated and activated in response to reelin. Given the multimeric nature of the reelin receptor complexes we hypothesized that the SH3 domain of CrkL recruits additional effector molecules to reelin receptor complexes where they may become activated by SFKs or Akt. Using affinity chromatography we have identified more than a dozen proteins from embryonic murine brain that bind to the SH3 domain of CrkL and are phospohrylated either on tyrosine or in an Akt consensus motif. We are now working to identify these proteins and their phosphorylation sites using liquid chromatography tandem mass spectrometry (LC-MS/MS) toward an ultimate goal of determining their potential roles in the reelin signaling cascade.

Spatial Distribution and Geomorphic Condition of Fish Habitat in Streams: An Analysis using Hydraulic Modeling and Geostatistics

Short Title: Spatial Distribution and Geomorphic Condition of Fish Habitat

Jessica S. Clark[1], Donna M. Rizzo[1], Mary C. Watzin[2], and W. Cully Hession[3]
[1]*School of Engineering, University of Vermont*
[2]*Rubenstein School for Environment and Natural Resources, University of Vermont*
[3]*Biological Systems Engineering, Virginia Tech*

Keywords: geomorphology, instream habitat, geostatistics, hydraulic modeling, spatial variability

ABSTRACT

Reach-scale physical habitat assessment scores are increasingly used to make decisions about management. We characterized the spatial distribution of hydraulic habitat characteristics at the reach and sub-reach scales for four fish species using detailed two-dimensional hydraulic models and spatial analysis techniques (semi-variogram analyses). We next explored whether these hydraulic characteristics were correlated with commonly used reach-scale geomorphic assessment (RGA) scores, rapid habitat assessment (RHA) scores, or indices of fish biodiversity and abundance. River2D was used to calculate weighted usable areas (WUAs) at median flows, Q_{50}, for six Vermont streams using modeled velocity, depth estimates, channel bed data, and habitat suitability curves for blacknose dace (*Rhinichthys atratulus*), brown trout (*Salmo trutta*), common shiner (*Notropis cornutus*), and white sucker (*Catostomus commersoni*) at both the adult and spawn stages. All stream reaches exhibited different spatial distributions of WUA ranging from uniform distribution of patches of high WUA to irregular distribution of more isolated patches. Streams with discontinuous, distinct patches of high score WUA had lower fish biotic integrity measured with the State of Vermont's Mixed Water Index of Biotic Integrity (MWIBI) than streams with a more uniform distribution of high WUA. In fact, the distribution of usable habitats may be a determining factor for fish communities. A relationship between predicted WUAs averaged at the reach scale and RGA or RHA scores was not found. Future research is needed to identify the appropriate spatial scales to capture the connections between usable patches of stream channel habitat.

Title: Developing a Temporary Winter Pavement for Friction Enhancement and Reduce Winter Application of Abrasives and De-icing Chemicals.

Principal Investigator: Susanne M. Conklin, M.S., P.E.
Conklin Engineering Services, PC. Burlington, VT

Collaborator: Jeff Padgett, P.E.
Engineered Solutions Inc. Burlington, VT

PROJECT SUMMARY

Currently, snow and ice control on the US Highway system consumes over $2 billion in direct costs each year. Indirect costs associated with corrosion and environmental impacts are estimated at greater than $5 billion. Spring snow melt and storm water laden with sand and salt brings elevated levels of Phosphorous and Chloride to nearby lakes, rivers, streams and groundwater causing deterioration in water quality that is difficult if not impossible to restore. This Phase 0 research focuses on examining the feasibility of developing a temporary winter pavement designed to increase friction on the roadway surface and thereby reduce the application of de-icing chemicals and abrasives. The ultimate goal is to develop a product that could be used only during winter months to alleviate or eliminate the application of chemicals and abrasives on roadways. As a result of this Phase 0 research, we have drafted several possible designs for temporary pavement prototypes based on engineering mechanisms to prevent ice formation, break up ice and increase rolling resistance. We have found several companies that specialize in manufacturing composite geotextiles that have agreed to help develop these designs into prototypes for testing. Once prototypes are developed for testing, the Cold Regions Research and Engineering Laboratory (CRREL) under the direction and guidance of Edel R. Cortez, P.E. will bench scale and full scale test the prototypes in the cold rooms of the pavement testing facility at CRREL as part of a Phase 1 & Phase 2 SBIR effort.

RuO_2 Nanorods for the Production of Hydrogen

Dr. Michael Cross
Dr. Walter Varhue

There is a need to develop an energy alternative to fossil fuels for transportation. The Department of Energy has been concentrating its efforts on work to develop a "Hydrogen Economy".[1] In this enterprise, hydrogen will be an energy carrier. The challenges required for the development of the "Hydrogen Economy" have been identified as: (1) Production, (2) Storage and (3) Utilization. Each of these tasks will require a tremendous effort by the scientific research community to find novel and innovative solutions. This investigation concerned itself with the issue of hydrogen production.

This goal of this venture was to develop an improved system for the electrolysis of water and thus the production of hydrogen. Electrolysis is typically carried out in dangerous solutions of potassium hydroxide (KOH) or sulfuric acid (H_2SO_4). Our process uses a 3.5% aqueous NaCl solution. Aside from safety concerns, this has the added benefit of being the same salinity level of ocean water. The hydrogen gas is produced through the following process:

$$2H_2O\ (l) \rightarrow 2H_2\ (g) + O_2\ (g)$$

Like all chemical reactions, the overall efficiency of this process can possibly be increased through the use of a catalyst. A catalyst is a material entity which participates in a chemical reaction in such a way as to reduce the activation energy required to change one chemical species "reactants" into a second chemical species "products." The performance of a catalytic material will improve when:

- The surface area exposed to the reacting species is large.
- The catalyst material is specifically suited to perform a desired chemical reaction.

The emergence of nanotechnology offers potential enhancement in both criteria. One of the fundamental advantages of a nanocatalyst is that it offers a large potential surface area of catalyst per mass of material. Our company has developed a process to produce high density, large surface area RuO_2 nanorods utilizing a scalable sputtering process, and the production of hydrogen using these nanostructures was characterized in this investigation.

[1] http://www.sc.doe.gov/bes/hydrogen.pdf#search=%22bes%20doe%22

Algae growing design for oil production guided by evolutionary forces

Anju Dahiya and Roelof Boumans

Algae as bio-feedstock for Biodiesel had been the focus of the U.S. Department of Energy's two decades of Aquatic Species Program. Thereafter, worldwide researchers have been exploring this potentially sustainable source of bio-fuel, but an efficient technology for cost effective algae oil production at commercial scales is yet to be found. An innovative approach to algae oil production is proposed - to develop a methodology of applying light and nutrient cycles to force the evolution of naturally growing algae aggregates towards oil production as formulated in following hypotheses: 1) that the algae evolution that leads to oil production requires organisms to experience light and dark cycles with low nutrient high nutrient conditions respectively; 2) that to grow algae at commercial scales it is important that the commercial operations mimic the evolutionary forces that caused algae to produce oil in nature; 3) that designing a system to mimic these forces need to account for light and nutrient regimes; 4) that a system if properly designed for algae to produce oil will not need the seeding of special/isolated species and could be reproduced at commercial scales to meet the current energy demands. Studies so far have focused on cultivating single species known for high oil content for highest production without considering the evolutionary forcing that enticed these organisms to develop this trait in the first place. Our approach, rather then identifying the oil producing organisms, will identify the ecosystems that have evolved algae aggregates within aquatic ecosystems towards oil production. Once we have identified these ecosystems, we intend to recreate them for commercial applications that are cost effective (less energy in than energy produced) and robust (stable in oil producing capabilities)

Based on these concepts a demonstrative computer model of oil-rich algae production is under development process, which has been initiated in close collaboration with researchers at UVM who are designing laboratory experiments. A prototype has been developed and lab-experiments will be conducted as soon as we have results. The researchers will be collecting water samples from different places in Vermont, to be acclimated and experimented upon.

The model would eventually serve the purpose of organizing and testing assumptions on system quantities and process rates associated with the possibility of Biodiesel industrial plant. It will also test a new set of economic and energetic data that values the byproducts resulting from oil-separation that has not been done, and the model simulations will be outputting economic returns under various options of future commodity price scenarios. Considering the potential scale of energy feedstock production, such information can assist greatly with local and regional energy planning. Publications, presentations and interdisciplinary collaborations are anticipated.

Complex Systems Modeling of Climate Regime Change in Chaotic Convection

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Abstract

Much of the weather we experience is the result of natural convection, whereby solar energy is re-radiated from the Earth's surface to the nearby air, causing it to rise. In the early 1960's, MIT meteorologist Edward Lorenz was looking for a simple mathematical model of convection that he could use to demonstrate to the scientists at the National Weather Service that their methods of linear prediction were inadequate for the problem of short-term weather prediction. He settled on a simple system of three ODEs and described numerical solutions to the system in a groundbreaking paper titled Deterministic Nonperiodic Flow. Danforth's Ph.D. advisor Jim Yorke then went on to coin the term chaos to describe the mathematical properties of sensitive dependence on initial conditions observed by Lorenz. Chaos leads virtually indistinguishable states of a nonlinear system to diverge quickly on small spatial scales, amplifying uncertainty in the initial conditions of a computational model, and is a major contributor to inaccuracies in weather and climate forecasts.

A thermal convection loop is a simple model of convection in the Earth's atmosphere in the form of a donut shaped tube, filled with fluid, and oriented vertically like a wheel. The bottom (top) half of the tube is warmed (cooled) uniformly; the forcing does not change with time. Differential heating decreases the density of fluid in the lower half of the tube, generating a buoyant force greater than that of gravity and viscosity, causing convection. Initially stationary, the fluid will accelerate until the effects of buoyancy and friction balance each other out and the fluid reaches a steady state. In this state, fluid in the tube rotates in only one direction from the moment conduction gives way to convection. However, under certain conditions, a steady state is never reached by the fluid. When the constant temperature difference between the heat sink along the top half and heat source at the bottom half is within a particular range, the fluid oscillates in a chaotic manner.

Funding for this project is being used to build a thermosyphon to investigate the possibility of predicting regime changes (flow reversals) using information on the local dynamics provided by ensemble forecasts made by a numerical model. The experiment will be used to validate advanced methods of data assimilation and ensemble forecasting (computationally intensive tools for predicting the future state of the Earth's climate) being developed by the PI. Mathematics and Physics major Kameron Harris is writing code in Matlab to assimilate observations from the experiment into a numerical model. Kameron is a junior and will be performing the work for this project as part of an honors senior thesis. He has won $3,000 from the URECA! program to fund his work on this project. Danforth and Hitt have submitted a proposal to NASA EPSCoR to fund a Postdoctoral student to develop a full 3D Computational Fluid Dynamics simulation of the toy climate.

Steel slag filter technology for phosphorus and metals reduction from non point pollution sources – preliminary proof-of-concept feasibility study

Aleksandra Drizo, Phosphoreduc LLC.

Due to phosphorus (P) pollution of freshwaters and subsequent eutrophication, finding a viable option for P reduction has become one of the most pressing water quality concerns throughout the world. A simple P removal system consisting of one or more filter units filled with electric arc furnace (EAF) steel slag material has been recently developed at the University of Vermont.
Recent results from demonstration projects installed to test P and metals reduction from industrial, urban (stormwater outflow) and agricultural (drainage tile) runoff in St Albans, Vermont, further confirmed the efficiency of steel slag (*Phoshoreduc*) filters in contaminants reduction from non-point pollution sources. After 8 months in operation, measurements taken during the month of April 2008 showed average dissolved reactive phosphorus (DRP) reduction of 62.6 % (agricultural runoff) and 85.44 % (industrial site), respectively. Average total phosphorus (TP) reduction was even higher: 93 (industrial site) and 78.3 % (agricultural runoff). Metals (Fe, Al, Cu, Zn, Ca, Mg, Na, K) reduction varied between 58 (K) and 87% (Fe).

Due to harsh winter conditions, the installation of the electric arc furnace (EAF) steel slag ("*Phoshoreduc*") filter at Cross Winds Dairy, Alburg, took place on April 21st. An automatic flow sampler (Isco 4210 Ultrasonic Flow Meter, Teledyne Isco, Inc., Lincoln, Nebraska) was placed upstream from the filter. In addition to composite samples taken by the ISCO flow meter, grab water samples were taken on 7 occasions between April 21st and May 27th and analyzed for DRP, pH, TP, Copper (Cu), Sulfur (S), Zinc (Zn), Calcium (Ca), Aluminum (Al) and iron (Fe). These data are currently being interpreted.

In order to begin to understand how the filters may be economically viable for use in a manufactured system for storm water treatment in cold climates, we need to conduct further assessment of filter performance during storm and spring snowmelt events. The slag filter system at Cross Winds Dairy was installed after the Spring snowmelt and very few storm events have occurred since the monitoring began. However, data from other demonstration projects showed that filters achieved highest removal efficiencies during large storm events [1]. This has been attributed to the EAF steel slag material P retention capacity rejuvenation phenomena [2]. When filters are placed in open channels, the natural hydrological cycles enhance the efficiency of the slag system due to alternating water levels (flooding and drying, or low and high flow) that allow rejuvenation to occur within the EAF steel slag material. The fact that EAF steel slag material has the ability to rejuvenate its P retention capacity therefore results in greater P reduction efficiency from diffuse sources.

References:

[1] Drizo, A., Twohig, E. and Darby, H. (2007). Sustainable Technologies for Phosphorus Removal from Storm water. Conference Proceedings of the 2nd International Congress Smallwat07 on Wastewater Treatment in Small Communities, held in Seville, Spain, November 11th-15th, 2007.

[2] Drizo, A., Cummings, J., Weber, D., Twohig, E., Druschel, G. and Bourke, B. (2008). New Evidence for Rejuvenation of Phosphorus Retention Capacity in EAF Steel Slag. *Environmental Science and Technology*, In press.

EPSCoR June 6th Poster Abstract
Maggie Eppstein
Breck Bowden
Karim Chichakly

"The Impact of Land Use on Water and Nutrient Flow in the Champlain Valley"

This project is concerned with the impact of land use and land use change within the Champlain Valley watershed on the flow of phosphorus and sediment to Lake Champlain. Increased phosphorus is linked to algal blooms within the lake and to eutrophication of sections of the lake. The output of UVM Transportation Research Center's program UrbanSim, which predicts changes in land use based on development trends, will be fed to hydrology and nutrient models to determine the changes in water and nutrient flows to Lake Champlain. Various scenarios to manage runoff from development will be explored, from doing nothing to using existing best management practices to low-impact development and green infrastructure (e.g., grass-covered roofs). One of the key outcomes of this research will be linking the established development planning tool UrbanSim to environmental outcomes. The case study area is the Winooski watershed.

Invasion vs. Naturalization in Plant Communities

Margaret J. Eppstein[1] and Jane Molofsky[2]

[1]Department of Computer Science, UVM
[2]Department of Plant Biology, UVM

The detrimental effects of invasive plant species on ecosystems are well documented. While much research has focused on discovering ecological influences associated with invasiveness, it remains unclear how these influences interact, causing some introduced exotic species to become invasive threats. Here we develop a framework that incorporates the influences of propagule pressure, frequency independent growth rates, feedback relationships, resource competition, and spatial scale of interactions. Our results show that these ecological influences interact in complex ways, resulting in expected outcomes ranging from inability to establish, to naturalization, to conditional invasion dependent on quantity and spatial distribution of propagules, to unconditional takeover. We propose a way to predict the likelihood of these four possible outcomes, for a species recently introduced into a given target community. Such information could enable conservation biologists to more efficiently and effectively craft strategies and target remediation efforts in order to help maintain biodiversity in ecological communities.

Abstract: VT EPSCor Annual Meeting – June 6, 2008

Wind to Wheels Hydrogen Project

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Gregory Wight, Professor Norwich University/Project Manager EVermont, 158 Harmon, Ave Northfield, VT USA 05663, tel: 802-485-2276; fax: 802-485-2260

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Ken W. Dreier, Distributed Energy Systems, 10 Technology Drive, Wallingford, CT USA 06492, tel: 203-678-2138, fax: 203- 949-8078

Abstract

Substantial research efforts are being directed to the potential use of hydrogen for transportation fuel, particularly in the development of fuel cell vehicles, and a "Hydrogen Economy". When this research bears fruit in the form of consumer-ready vehicles, will the fueling infrastructure be ready? Will the required fueling systems work in cold climates as well as they do in warm areas? Will we be sure that production of hydrogen as the energy carrier of choice for transportation is the most energy efficient and environmentally friendly option? Will consumers understand this fuel and how to handle it?

These and related questions are being confronted by the EVermont Wind to Wheels Hydrogen Project: Sustainable Transportation. The hydrogen fueling infrastructure consists of three primary subcomponents: a hydrogen generator (electrolyzer), a compression and storage system, and a dispenser. The generated fuel is then used to provide transportation as a motor fuel: displacing petroleum and its associated emissions and environmental impacts.

EVermont Inc., started in 1993 by then governor Howard Dean, is a public-private partnership of entities interested in documenting and advancing the performance of advanced technology vehicles that are sustainable and less burdensome on the environment, especially in areas of cold climates, hilly terrain and with rural settlement patterns.

EVermont has successfully demonstrated how renewably generated electricity can be used to support forecourt production of hydrogen to meet transportation needs. This project documents that existing technologies can be brought together into a system to provide sustainable transportation energy. These available technologies used in this manner could provide a 'technological bridge' to a future Hydrogen Economy and 'seed' the development and deployment of essential infrastructure necessary for hydrogen to contribute to meeting society's transportation energy needs.

For further information, contact:

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Partners for sustainable transportation:

26

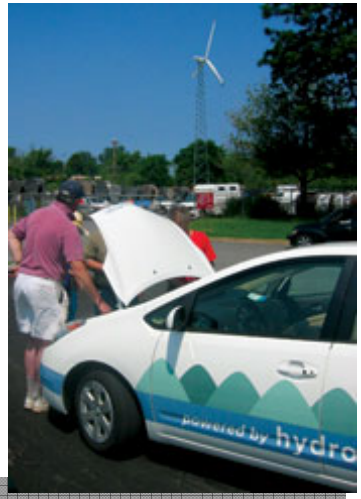
'Wind to Wheels'

The Vermont Sustainable Transportation Demonstration Project

**EVermont Hydrogen Generation/Refueling Station,
Burlington Vermont
Adjacent to 545 Pine Street, Burlington VT 05041**

**N 44° 27.7922
W 73° 12.9829**

**Wind turbine --
AOC 50; 50 kW capacity**



**Vehicle --
Quantum Technologies H2 Hybrid**

Electrolyzer – Distributed Energy Systems HOGEN; 12 kgH2/day capacity

**Dispenser -- Air Products
350 bar H2 dispensing;
CaFCP communication fill**

Project Objectives

To Demonstrate a Sustainable Approach to Transportation by:

- Developing advance PEM electrolysis fueling station technology
- Building and testing a validation system in Vermont that utilizes renewable electricity and is capable of providing hydrogen fuel to vehicles, and
- Procure a hydrogen fueled vehicle for testing and validation of this systems approach to transportation energy.

Vermont EPSCoR Innovation Fund

Project Title: ***Utilization of a Significant Waste Product for Mass Production of Specialized Insect-killing Fungi for IPM***

Award period: January 1, 2008 to June 30, 2008

Principal Investigators:
Dr. Vladimir Gouli, Research Assistant Professor
Dr. Svetlana Gouli, Research Associate
Dr. Bruce Parker, Professor
Dr. Adane Kassa, Postdoctoral Research Associate
University of Vermont, Entomology Research Laboratory
661 Spear Street, Burlington, VT 05405-0105

Project description

Specialized entomopathogenic fungi from the genus *Myriangium* are important regulating factors of scale populations. The scales are the most destruction pests for agriculture in the USA and around the world. Determination of the principal properties of these fungi is essential for ecologically sound plant protection in IPM systems. *Myriangium* fungi are a complex subject for research because these entomopathogens are difficult to isolate and cultivate. The principal goals of our research are to solve two problems. The first is determination of the optimal conditions for submerged cultivation of the specialized entomopathogenic fungus *Myriangium* sp. to maximize fungal biomass production. The second problem is the evaluation of the potential of fungal biomass processing using a combination of corn starch- packing material ("peanuts") for development of the air conidia.

The first part of this research has been completed based on several cultivation media including potato-dextrose agar (PDA), Sabouraud dextrose agar and yeast (SDAY), and mixture of PDA and SDAY (1:1). SDAY and mixture PDA with SDAY provided vegetative growth of the fungus, but PDA stimulated reproductive processes. As a result, the potato dextrose medium was used to produce mycelial biomass for subsequent development of the cryptogamic material using starch waste packing supplies. Submerged cultivation of fungus was conducted for 72, 144 and 288 hours. The fungal biomass was separated by centrifuge for 10 minutes at 1500 rev./min, after separation the sediment was dried. Augmentation of fungal biomass was observed after all cultivation periods. Economical efficiency (Y) was calculated by the formula: $\Delta x/\Delta s = Y$ (Δx = increase in fungal biomass corresponding to consumption of substratum in number equal Δs) with the following results: 0.063, 0.08 and 0.09 after 72, 144 and 288 hours of cultivation, respectively. The cryptogamic material of *Myriangium* sp. fungus was received after surface processing of fungal biomass with corn starch packing material. The corn starch was provided the formation of stable conidia and the same time was served as carrier for both fungal propagules and biological active substances. Future research will look at the problem subsequent optimization of mass-production of fungus, and relationship of this pathogen with target pests on different organization levels.

Analysis of Changing Climate and Hydrology in the Winooski River Basin, Vermont

William R. Hackett[1], Paul R. Bierman[2], Donna M. Rizzo[3] and Lance E. Besaw[4]

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Analysis of more than seventy years (1936 to 2008) of daily discharge and weather data in the 2,704 km^2 Winooski River Basin of northern Vermont shows statistically significant increases in both precipitation and river discharge. We analyzed data from six discharge stations, both on the Winooski River and on its major tributaries, as well as nine weather stations at five locations within the basin. Analysis of historical datasets is of particular value as concern over climate change heightens and questions surrounding the behavior of climate and hydrology (and how they interact) become more pressing.

At all five weather stations average annual precipitation is increasing. At a 95% confidence level, this trend was significant at three of the five locations. Similarly, each of the six discharge stations showed an increasing trend in total annual discharge; half of these were significant at a 95% confidence level. Lowest annual daily flows increased significantly at all stations. In contrast, highest daily discharges for each year increased at some stations while decreasing at others. This inconsistent trend between stations could be evidence of the factors associated with changing landuse, which affects the way the sub-basins respond to storm events. In addition to the overall trends in the data, a linear spline has revealed a ~10-year cyclicity in total annual precipitation and discharge data that is well correlated with the behavior of the North Atlantic Oscillation (NAO).

The relationship between weather and discharge has also been changing on a monthly scale, with precipitation increasing significantly at three stations during March or April, while the discharge is trending downward during those same months. This trend may be indicative of the changing timing of seasonality. If spring comes earlier on average, the increases in precipitation could be buffered from the river by earlier leafing out of the trees, which transpire the added precipitation. It is also possible that earlier snowmelt is reducing spring flows.

Automated Reasoner Technologies for Wind Turbines and Green Energy

Vermont EPSCoR SBIR Phase 0 Grant

John R. Hartin
Julie L. Marble
Sentient Corporation

Wind power currently supplies 48 billion kilowatt-hours of electricity annually in the United States, and the U.S. wind energy industry shattered all records in 2007 with 45 percent growth and more than 5,400 MW of generating capacity installed. Many large windparks are under construction or planned for Vermont and the northeast. Wind turbines are highly complex machines, often in remote locations, and have the bulk of the machinery inaccessible at the top of a tower. Early detection of the onset of machinery failure is the key to low maintenance costs and high reliability. After initial capital costs, the primary cost of energy for wind turbines is maintenance. The most effective maintenance strategy for rotating machinery, whether in an industrial, military/aerospace, or power generation application, is Condition-Based Maintenance (CBM) in which maintenance is performed only after a fault is found but prior to failure. The condition-based maintenance approach optimizes downtime, eliminates unnecessary maintenance, and prevents secondary damage from in-service failures. Monitoring the health of the complex rotating machinery in a wind turbine requires multiple sensors to acquire data (much of it vibration data acquired at high data rates) and onboard computers to process and transmit calculated health or condition indicators on an ongoing basis. An important requirement of this approach, and a current technology gap, is an automated capability to convert the massive data streams into actionable information to achieve the cost savings and improvements in reliability.

Sentient is performing research on automated data mining and reasoning tools that detect anomalies, classify health and maintenance data, and convert the raw data into information on system health. During the current EPSCoR SBIR Phase 0 project, Sentient is evaluating existing wind turbine health monitoring capabilities, developing reasoning and data mining tools such as a Wavelet-based diagnostic for bearing health and a detrending algorithm for condition indicators, and gathering operational data for a demonstration of data mining and reasoning capability. Research continues on automated techniques for data mining and rule-based reasoners, as well as development of methods to identify trends in the presence of noisy data, variable operating conditions, and normal component variability to reduce false alarms and allow for maintenance planning. Sentient is seeking SBIR and other opportunities for additional funding for this technology.

Scaling-up Bacterial Transport: The Development of Tools to Model Pathogen Migration at Multiple Scales

Dr. Jane E. Hill
Bree Mathon

Enteric pathogens, such as *E. coli* O157:H7 and *Salmonella typhimurium*, sicken millions of people each year. In September 2006, the death of three people and illness of 200 others due to the ingestion of spinach tainted with *E. coli* O157:H7 is thought to be a result of contamination of irrigation water by cattle manure from a feedlot 0.5 miles away. It has been determined that the *E. coli* and *Salmonella* species in manures are initially in the motile form, but little is known about their fate once in the subsurface. Most traditional models trying to understand the fate of bacterial transport have overlooked the fact that about 80% of known bacteria are motile. Motility can affect the extent of a bacteria's transport, i.e. motile forms are more likely to attach to surfaces, motile *E. coli* have been observed to travel upstream. These findings are contrary to the previous thought on the behavior of bacteria in low Reynolds number flow ($Re << 1$). Motility, therefore, must be considered when trying to model their fate.

The overall goal of this research is to begin with a model of motile bacterial behavior at the microscale, update the theoretical model with experimental data gathered from microchannel experiments and finally upscale the results and be able to model the transport of pathogens in the subsurface. The research has begun at the microscale level by identifying the forces acting on a bacterial cell in flow. Drag is a key force that acts on a bacterium in low Reynolds number flow. A comparison was done on the exact equation for drag force and a Stokes' approximation equation for drag force on a prolate sphere in low Reynolds number flow. The results of our calculations showed 1) the approximation and exact equation produced very similar results and 2) the cell body dimensions have less affect on drag force at low relative velocities (< 20 μm/s) than at higher relative velocities. We are currently developing a microchannel system to test our model.

Complex system models to estimate the benefits, costs and risks of large-scale wind power deployment

PI: Paul Hines
UVM School of Engineering

May 13, 2008

Abstract

Wind turbines are an attractive technology for reducing global greenhouse gas emissions. Spinning wind turbines do not emit CO_2 or other greenhouse gases, and in locations with good wind resources the cost of electrical energy from large wind farms is increasingly competitive with fossil fuel power plants. The problem is that wind speed varies rapidly with time. Because wind power increases with the cube of wind speed, wind farm power output can be even more variable than wind speed. This variability must be planned for in electric power networks because supply must meet demand at every instant. Thus other power plants, typically fossil fueled, must change their output when the output of a wind farm changes to maintain a balance between supply and demand. The cost, in terms of emissions and fuel costs, must be considered when estimating the costs and benefits of wind energy systems. The goal of this project is to estimate the costs, benefits and risks of large-scale wind energy (up to 20% of peak demand) systems. The project will use data from existing wind farms to build a non-linear dynamic and economic model of the Eastern US power grid with varying amounts of wind power deployed off the Atlantic shore. This model will allow us to use real wind farm data, which has been collected for this project, to compare wind energy with other technologies for reducing greenhouse gas emissions. With this model, and the analysis that will result, we will be able to provide timely advice to policy makers regarding the extent to which we should invest in large-scale wind energy development as a technology for reducing national, and global, greenhouse gas emissions.

Abstract for Fiber Optic Communications for Endoscopic Video

Kevin Holm-Hansen

5/21/2008

Surgeons are looking for ways to reduce the amount, size and weight of cables to connect the light sources and video camera systems to arthroscopes, laparoscopes and other endoscopes. Currently it is necessary to have a video cable, which includes the electrical input power conductors, and a separate light source cable. Both of these cables are a minimum of .25 inches in diameter. In addition with the introduction of high resolution or high definition (HD) video the cable size and weight has increased.

Our proposal is to eliminate the video cable that connects the camera head to the control unit, by sending the digital video data via a high speed serial fiber optic link. The digital video data produced by the imager in the camera head is usually in a parallel bus format of a specified width. A Field Programmable Gate Array (FPGA) will be used to interface the imager to the encoder and serializer. The data will be encoded with a DC balanced coding scheme, referred to as 8 bit 10 bit encoding. This encoding improves the noise immunity at the receiver and provides a level of error detection. Once the data is encoded it is serialized at an increased rate which is proportional to the ratio of the bus sizes, in this case 10 to 1. The serialized data is sent to the optical transmitter where the data is converted from an electrical signal to an optical signal. At the other end of the optical fiber, the photo-detector in the receiver converts the optical signals back to electrical signals. The receiver's primary function is to recover the digital data. To do this the receiver must also recover the clock signal from the data. The clock recovery can be accomplished by providing a training period for the receiver to synchronize with the transmitter clock. The approach that will be utilized will be to export the raw image. This will help to minimize the size and power consumption of the camera head and minimize the bandwidth requirement of the link. The bayer conversion, if a color imager is utilized, and other image enhancing techniques can be applied in the control box where the size and power consumption are not critical. The exporting of the digital data from the camera head to the control box requires a high band width link. The control box also needs to provide some data to the camera head for camera control, but at a much lower relative bandwidth. The techniques being considered for providing this communication path are optical, I^2C, and modulation of the input power lines, but the optimum technique has not yet been determined.

For the prototype build, off the shelf components will be utilized where ever possible to minimize cost and development time. A commercially available small form factor pluggable optical transceiver will be utilized in the prototype. For a production design, the optical transceiver will be a custom design as we will not need the device to be pluggable, and a lot of printed circuit board area can be saved from compacting the physical layout of this device, and possibly only utilizing the transmitter section. Also, optical links typically have a range that greatly exceeds the requirements for this endoscope application. So that this technique could be utilized for other applications that require greater range or the transmitter can be depowered for this endoscope application for the greatly reduced range thereby saving critical power in the camera head.

Also, by utilizing the latest LED technology we believe we can reduce the light source cable to be half of its common diameter. The eventual result would be a single composite cable carrying light and two small electrical conductors for powering the camera head.

Tandem Cyclization of Dialkynylarenes: A Low-Temperature Formal Bergman Cycloaromatization

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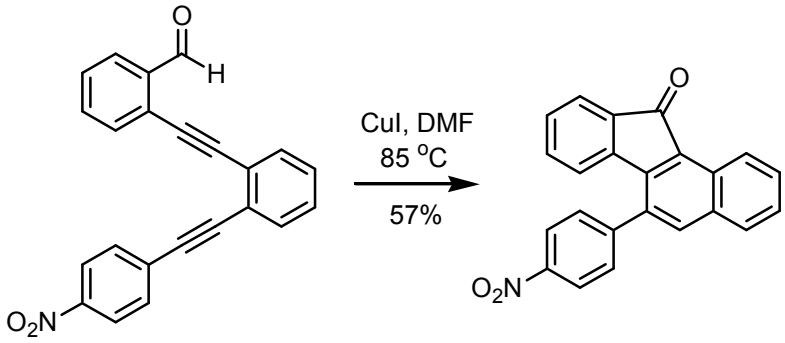

A novel tandem cycloaromatization reaction has been shown to convert an electron-poor 1,2-di(arylethynyl)benzene to a benzo[a]fluoren-11-one as shown. Such cycloaromatizations usually require photolysis or very high temperatures (~ 250 °C) that result in accompanying phenyl migrations. The reaction described is the lowest temperature at which a formal, thermal Bergman cycloaromatization has been shown to occur. The diyne was easily synthesized by successive Sonogashira cross-couplings. Reaction of the diyne with copper iodide and methanol in DMF gave a precedented cyclization to an isochromene product, but exclusion of methanol gave the novel rearrangement product. The structure of the polycyclic aromatic product was determined by 2-D NMR spectroscopy, including COSY, HMBC and HMQC techniques. The mechanism of the reaction is still unknown, but analogs of the nitroaldehyde starting material have been subjected to the reaction conditions. Both copper iodide and DMF appear to be required for the rearrangement to proceed, and non-electron withdrawing substituents appear to favor the tandem cyclization reaction more than the nitro-substituted analog.

Self-Sealing Pressure Vessels

Dryver Huston[1], Frederic Sansoz[1], Daniel Savin[2], David Hurley[1]
[1]Mechanical Engineering, [2]Chemistry, University of Vermont

This research focuses on using self-sealing technologies to improve the safety and performance of hydrogen fuel storage and transportation systems. The renewable and pollution free characteristics of hydrogen make it a candidate fuel of the future. Nonetheless, the generation, storage, transportation, and distribution of hydrogen poses significant technological hurdles. To approach the energy densities currently available to the public in the form of gasoline, gaseous hydrogen must be liquefied at cryogenic temperatures, highly compressed, stored using a physical medium such as metal hydrides, or some combination of the three. Limitations in sealing and insulating liquefied hydrogen, and the lack of viable reversible metal hydride storage systems, presently make high-pressure hydrogen the most viable solution.

Storing sufficient hydrogen fuel on a vehicle to meet the Department of Energy target for driving ranges of 200km-600km requires storage pressure of 35 – 70 MPa. These pressures are at the upper limit of modern pressure vessel technology. Leaks are problematic in any sort of liquid storage system. Numerous technologies are available for self-sealing low pressure applications, such as fuel tanks on military aircraft, or stop-leak additives for automobile radiators. High-pressure systems pose special challenges including a higher occurrence of leaks and higher consequences in the event of pressure vessel failure. High-pressure hydrogen is particularly challenging due the difficulty in sealing the low atomic weight gas, the extreme pressures involved, embrittlement of storage materials, and the broad volumetric ratios over which hydrogen is combustible.

This project consists of two main phases. The first being a thorough investigation into current self-sealing and self-healing technologies and advanced materials to assess their capacity for a high-pressure hydrogen self healing system. The second phase is construction of a low-pressure (0.69 MPa or 100 psi) pneumatic test bed to evaluate prototype self-sealing technologies, see Fig. 1. Results from both phases will be used to develop concepts and material requirements for a self-sealing high-pressure hydrogen system.

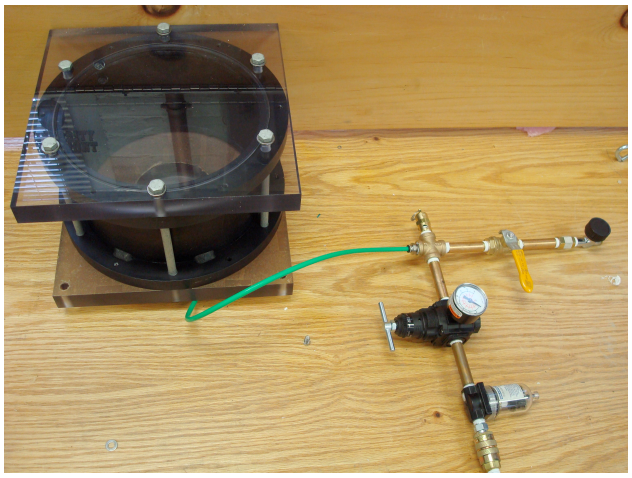

Figure 1 Transparent Pressure Vessel and Self-Sealing Test Bed

The Diskyes Technology: Reducing the Visibility of Cell Towers and Other Objects Viewed with the Sky as Background.

John L. LaRue, Ph.D.
Natural Horizons
Underhill, Vermont 05489

There are often conflicts between economic and esthetic, or environmental values. Examples of this are cell phone towers and hanging wires. Many members of a community would gladly trade-off the esthetic for the economic, or convenience gain whereas others in the same community would gladly reverse the trade-off. Most would like the benefit of both. The Diskyes technology greatly reduces this conflict in cases where the object is viewed against the sky. Current methods of reducing this conflict include placing cell phone antennae in existing structures, or affixing man-made "tree limbs" so that the tower would sometimes be confused for a tree.

For an object to be visible as viewed against a nearly uniform background like the sky it must have contrast with that viewed background. The contrast could be in one or more of the three: brightness, hue, or saturation. It then follows that for an object to be less visible – to the point of being invisible – it must have low contrast in all three.

A small region of the sky approximates a uniform viewing background. Thus objects viewed with the sky as background will be of low visibility, to the point of being invisible, when the viewed brightness, hue, and saturation of the object approaches that of the nearby sky.

The Diskyes Technology accomplishes this matching of brightness, hue, and saturation by emitting light similar to that of the sky from the object desired to be of low visibility. This is done by capturing light that strikes the object, then transporting that light to other parts of the object and emitting that light from the object. Since the light coming from the object has similar character to that of the light of the sky, that object appears less visible to the point of being invisible. The extreme localized brightness and yellow appearance of the sun is addressed by including a diffuse reflector and "yellow" absorbent in the surface coating.

The transporting of light on the surface of the object is made possible by applying a multi-layer coating to the object surface where the refractive index of the first layer is lower than that of the next light-conducting layer. This produces a sheet "optical fiber" light conducting sandwich as the coating material. The ratio of the refractive index of the two layers needs to be at least 1.1. To facilitate the capture and emission of light, there are elements of low refractive index embedded in the light-conducting layer. These elements could be air bubbles or hollow (gas-filled), transparent micro-spheres.

These techniques and others are defined in greater detail in U.S. patents 6,655,102 and 7,216,463.

Energy-Efficient Data Storage and Retrieval in a Large-Scale Wireless Sensor Network

Byung S. Lee (PI) and Mohammed Al-Kateb (GRA)
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College of Engineering and Mathematical Sciences
University of Vermont

Abstract

In wireless sensor networks, storing data within the network and retrieving the stored data (through queries) are two important interrelated operations for supporting data collection applications. There have been efforts made in the research community to perform those operations in an energy-efficient way, but to our knowledge there exists only one work done considering both operations in the same framework. The existing work, however, employs a global optimization algorithm and a global index structure. This makes the developed technique become quickly infeasible as the scale of the network increases. In the proposed research we will develop a local optimization algorithm using a local index structure assuming a hierarchical, large-scale wireless sensor networks with resource-constrained nodes. The key approach is to build a set of local heuristic rules for prioritizing where to store each reading produced by each sensor node and develop a model for estimating the costs of the various storage options. Another key approach is to organize the index as a hierarchy of local indexes which together form a logically global index and support efficient retrieval of data stored in the sensor nodes. The heuristic rules, cost model, and index structures will be refined toward improving the achieved network lifetime over the course of experiments conducted using a wireless sensor network simulator.

NUMERICAL SIMULATIONS OF LIPID BILAYERS SUBJECTED TO MECHANICAL STRESS

Sreedhar Manchu[1] and Yves Dubief

School of Engineering, University of Vermont

Lipid bilayers are ubiquitous to biological systems. They isolate the interior of cells from the exterior, they cover cartilages in articulations, they also can be used to deliver drugs inside the body. The uniqueness of lipid bilayer is their self-assembling nature. The head of iipid molecules is hydrophilic and their tail is hydrophobic causing these molecules to assemble according to minimum of energy principles. Although bonds between adjacent molecules are not covalent, a lipid bilayer membrane or vesicle can withstand significant mechanical stress. We are developing multiscale numerical simulations of lipid bilayers under shear and compression with the objective to (i) understand the role of phospholipids in natural joint lubrication and (ii) study the effect of shear on the adhesion of macromolecules transported by a flow on lipid bilayers with application to blood coagulation. Our poster presents our current effort towards effort (i), in particular using numerical simulations to provid an explanation for the exceptional lubricant properties of synovial fluid.

[1] Supported by the Graduate Research Assistanship award in biocomplexity

Particle Clustering and Aggregation under Periodically-Oscillating Straining Flows

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Abstract

Numerous biomedical and industrial applications require separation or sorting of particles systems in systems where it is undesirable to allow particle adhesion to a surface, such as a centrifuge wall or filter. Such systems typically involve either adhesive particles which could easily foul such surfaces or very delicate particles, as is the case in many biological applications involving suspensions of cells. One such system is the human colon, which exhibits on-going contractions with frequency and amplitude varying depending upon colonic contents. These contractions of the colon often do not result in net motion of the intestinal fluid (chyme), except during emptying events, but instead induce the fluid to slosh back and forth between the haustral pockets that make up the colon. Investigators have speculated that the function of contractions is to enhance fluid mixing, but little detailed understanding exists. In a preliminary computational study of particle transport in an oscillating straining flow, we observe that the oscillating contractions under a broad range of conditions in fact lead to clustering of particles near the center of straining - exactly the opposite of mixing. Our research suggests that while in some cases colonic contractions induce mixing, in other cases the contractions may induce clustering of particles near the channel axis, leaving higher water-content fluid near the absorbing cells making up the colon wall. Our on-going computational study employs a discrete-element model for particle transport in a channel with wall motion forced by parametric contractions, including periodic, multiply periodic and aperiodic forcing. The study is examining how the particle interactions with the oscillating fluid flow and with each other lead to different emergent system states – (1) particle clustering, (2) particle dispersion, or (3) particle settling. Results of the study will be applied to improving understanding of intestinal function and to developing new approaches for separation of adhesive particles in various engineering devices, such as microfluidic devices for biological assays and processes involved in biodiesel production from algae.

Riparian Vegetation Influence on Stream Channel Dimensions:
Key Driving Mechanisms and Their Timescales

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Combined results from field-based investigations and flume experiments demonstrated key mechanisms driving channel widening following the reforestation of riparian zones in small streams. Riparian reforestation is common either due to restoration efforts or to passive reforestation following the decline of agricultural land uses. Previous studies have documented the influence of riparian vegetation on channel size, but driving mechanisms and the timescales at which they operate have not been evaluated.

Field-based investigations were conducted in the Sleepers River basin in northeastern Vermont to revisit streams that were previously surveyed in the 1960s. We measured channel dimensions, large woody debris (LWD), and stream velocities in reaches with non-forested and forested riparian vegetation, in reaches currently in transition between vegetation types, and reaches with no change in riparian vegetation over the last 40 years.

Flume experiments were performed with a 1:5 scale, fixed-bed model of a tributary to Sleepers River. Two types of riparian vegetation scenarios were simulated: 1) forested, with rigid, wooden dowels; and 2) non-forested, with synthetic grass carpeting. Three-dimensional velocities were measured during flume runs to determine turbulent kinetic energy (TKE) during overbank flows.

Results showed that stream reaches with recently reforested vegetation have widened since the mid 1960s, but are not as wide as reaches with older riparian forests. LWD was more abundant in reaches with older riparian forests than in reaches with younger forests; however, scour around LWD did not appear to be a significant driving mechanism for channel widening. Velocity and TKE measurements indicate that TKE was significantly elevated in reforested reaches. Given that bed and bank erosion can be amplified in flows with high TKE, channel widening may be driven by increased turbulence generation in reforested reaches and may operate on a much shorter timescale than previously thought. A conceptual model was developed that describes a multi-phase process of incision, widening, and recovery following riparian reforestation of non-forested areas.

Understanding the driving mechanisms and the timing of this channel widening phenomenon is important to predict geomorphic change due to riparian reforestation efforts, inform stream restoration designs, and evaluate the ultimate impact on aquatic ecosystems.

Norway-United States IPY Scientific Traverse: Climate Variability and Glaciology in East Antarctica

Investigators:
Jan-Gunnar Winther (lead PI, Norwegian Polar Institute), Mary Albert (lead U.S. PI, Dartmouth College), Jon-Ove Hagan (U. Oslo), Kjell Hogda (Norut IT), Gordon Hamilton (U. Maine), Svein-Erik Hamran (U. Oslo), Kim Holmen (Nor. Inst. Air Res.), Elisabeth Isaksson (Norwegian Polar), Jack Kohler (Norwegian Polar), Glen Liston (Colo. St. Univ.), Joe McConnell (Desert Res. Inst.), **Tom Neumann (U. Vermont)**, Ted Scambos (U. Colorado), Rune Storvold (Norut IT).

One of the most pressing environmental issues of our time is the need to understand the mechanisms of current global climate change and the associated impacts on global economic and political systems. In order to predict the future with confidence, we need a clear understanding of past and present changes in the Polar Regions and the role these changes play in the global climate system. A significant portion of the fresh water on Earth exists as snow and ice in the Antarctic ice sheet. A massive, largely unexplored region, the East Antarctic ice sheet looms large in the global climate system, yet relatively little is known about its climate variability or the contribution it makes to sea level changes.

The core of this project involves scientific investigations along two overland traverses in East Antarctica: one going from the Norwegian Troll Station (72º S, 2º E) to the United States South Pole Station (90º S, 0º E) in 2007-2008; and a return traverse starting at South Pole Station and ending at Troll Station by a different route in 2008-2009. This project will investigate climate change in East Antarctica, with the goals of: **(1)** Understanding climate variability in Dronning Maud Land of East Antarctica on time scales of years to centuries, **(2)** determining the surface and net mass balance of the ice sheet in this sector to understand its impact on sea level, **(3)** investigating the impact of atmospheric and oceanic variability on the chemical composition of firn and ice in the region, and **(4)** revisiting areas and sites first explored by traverses in the 1960's, for detection of possible changes and to establish benchmark datasets for future research efforts.

This project is a genuine collaboration between nations: the scientists involved have complementary expertise, and the logistics involved relies on assets unique to each nation. It is truly an endeavor that neither nation could accomplish alone.

At the University of Vermont, Dr. Tom Neumann will coordinate analyses of stable isotope ratios of H and O on samples collected from the snow surface and ice cores. The objectives of these measurements are: (1) determine the distribution of mean annual stable isotope ratios across East Antarctica for use in coupled ocean-atmosphere climate models, (2) determine to what extent isotopic ratios are modified by metamorphic processes in the near-surface firn, drawing on collaborative studies of the physical properties of the firn, (3) if possible, use stable isotope records from ice cores to reconstruct large-scale climate patters in this sector of East Antarctica.

Project Title: Regionalized Sensitivity Analysis of SWMM (Storm Water Management Model) for a Suburban Headwater Tributary of Potash Brook Watershed

Project Investigators: Joel Nipper (Graduate Student) and Breck Bowden (Advisor)

Sensitivity analysis is a critical component of the simulation modeling process. For the model end user, input parameters which most affect model outputs can be identified for site specific conditions, allowing data acquisition efforts to be more focused and output uncertainty better defined. In this study a modification of the Regionalized Sensitivity Analysis procedure was applied to a parameterization of the EPA's Storm Water Management Model (SWMM) in the headwaters of Potash Brook watershed, in Chittenden County, Vermont. Ten soil and surface parameters were sampled from uniform distributions and the resultant simulations were classified based on an aggregate measure of hydrologic performance. Preliminary results show hydrologic performance to be highly sensitive to the soil conductivity parameter and moderately sensitive to the watershed width, impervious roughness coefficient, and impervious depression storage. Other included parameters were found to produce similar performance across large ranges of values, suggesting a lack of influence on model performance. Ongoing research will address the sensitivity of water quality parameters and together these data will be used to quantify predictive uncertainty in subsequent simulations.

Biodiesel - Application of a Novel Analytical Method: Photoelectron Resonance Capture Ionization Aerosol Mass Spectrometry (PERCI AMS)

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Biofuels are touted as a sustainable alternative to petroleum-based fuels. Furthermore, they are billed as environmentally friendly, purportedly leading to reduced emissions and having only a moderate negative impact to human health. To date, the manufacture of biofuels, specifically biodiesel, has not been regulated and many "garage operations" have sprouted across the country to produce biodiesel primarily for commercial use. Biodiesel is composed largely of methyl esters derived from the methylation of fatty organic acids common to vegetable oils. The chemical composition, in terms of fatty acid content, unsaturation and chain lengths, remains highly variable between different producers and batches from the same producer. The chemical composition impacts biofuel stability, usable environmental conditions and emissions profile.

Photoelectron resonance capture ionization aerosol mass spectrometry has been used to analyse biodiesel samples from a local manufacturer (Green Technologies Ltd), with emphasis on identifying the main chemical classes, the degree of fatty acid contamination and oxidative degradation of the biodiesel in the presence of ozone. PERCI AMS utilises photoelectric generation and subsequent capture of low energy photoelectrons (< 1 eV) by the volatilized components of biodiesel. The ionization process is extremely soft, resulting primarily in formation of M-H ions, greatly simplifying deconvolution of the mass spectrum and allowing detailed analysis of complex chemical mixtures as found in biodiesel samples.

In this presentation, we show that PERCI AMS is a viable method for the analysis of biofuel feedstocks, allowing direct measurement of major and minor components. The high sensitivity of PERCI to highly oxygenated compounds, such as fatty acids common in biodiesel fuels, make it especially well suited to measurement of combustion emissions, which have been shown to be rich in organic fatty acids. Finally, application of PERCI AMS to measuring oxidation products of the ester content of biofuels is demonstrated, yielding information about processing, degradation and storage.

Description of Calculated Technology, LLC and Brief Abstract of Project

Calculated Technology, LLC is a woman-owned small business, providing electro-mechanical design services, research assistance and technical documentation expertise to Montpelier-area clients. Formed in 2004, the business has grown from a part-time hobby to full-time employment for Danielle O'Hallisey, the owner of the business. Danielle's life partner Sara Baker – an educator and researcher in the field of Energy Conservation Education – acts as CFO and Business Manager.

Over the past year of operation, Calculated Tech has enjoyed remarkable growth. Notable highlights include:

1. Engaged in contract research in the study of practical Ohmic Heating system for use in industrial processes
2. Conducted studies of materials used in the fabrication of advanced capacitors, under contract to SB Electronics, Inc.
3. Designed capacitor system for use on nuclear submarines (also at SBE)
4. Designed and oversaw implementation of systems used in anodic bonding of microchip wafers (for Suss Microtec)
5. Collaborated with Dessureau Machines, Inc., in designing Diamond Wire Saw with 62" cutting wheels; used in the fabrication of large glass structures (for Schott Glass)
6. Became area reseller of OptisWorks software, an advanced opto-mechanical modeling package that seamlessly interfaces with SolidWorks mechanical design tools
7. Received EPSCoR funding for R&D of solar concentrator with dynamic input aperture
8. Most recently, received commitment of funding for Technical Feasibility Grant from Vermont Community Loan Foundation; a follow-up to the work done under the EPSCoR grant

The Project:

While limited as to the discussion I can currently engage in, regarding the ongoing research on my solar concentrator design (I am seeking patents and am still too early in the process to disclose the work), I can say that EPSCoR funding allowed me to move my design from a rough concept through initial proof-of-concept. The premise of the work is to make a very inexpensive, simple system that will concentrate sunlight throughout the day, any time of year, allowing efficiency improvements in all types of solar energy use. The system will not employ servos and software to track the movement of the sun; it will be stationary and will direct sunlight into the P.V. or solar heating system.
The promise of the system is not to make massive solar generation systems more ubiquitous; this technology is mature and impressive enough already. Instead, the promise of my system is a reduction in cost of solar systems for use in homes and small businesses. The hope is to make affordable solar power generation a reality for all of us.

Simulation of Subsurface Biological Systems using Cellular Automata

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The growth in bacterial biomass brings about a change in hydraulic conductivity of the host soil which, in turn, changes the distribution pattern of the contaminant as it undergoes biodegradation. The modeling of growing biomass can be studied using cellular automata (CA) at the pore level. On the other hand, the modeling of contaminant distribution is based on balance equations formulated at the porous medium scale obtained by averaging the extensive quantities, like mass and momentum, at the pore level,. The momentum balance equation at the porous medium scale involves terms describing the resistance offered to the flow of water as it passes through the porous medium. The CA is specifically designed to calculate the resistance offered by solid surface-biomass combination. Thus it is possible for the CA to provides an input at the microscopic level to be used to define terms in the macroscale momentum balance equation that describe the resistance offered to the flow of water; thus changing the hydraulic conductivity of the soil. The resulting equations provide the mathematical foundation upon which a biodegradation simulation model is constructed. Computed results show the feasibility of this approach to biodegradation simulation.

Sampling of Constructed Gravel Wetlands for Stormwater Treatment in Cold, Mountainous Environments

Parminder K. Padgett and Jeffrey A. Padgett, P.E.

Design and construction of stormwater treatment features can be difficult and tricky in mountainous regions with steep slopes. Typical wet stormwater treatment ponds verge on mammoth in size when designed on steep slopes with long side slope run-outs. As such, at Jay Peak Resort, Engineered Solutions, Inc. designed treatment systems with 3 component parts: a forebay, a constructed gravel wetland, and an extended dry detention pond. Typically the extended detention volume is housed over the wetland. In this case, it is separated into a "vault" and combined with storage for the CP_V, Q_{10}, and Q_{100}. This approach minimizes the wet storage volume and thus minimizes the footprint of the system.

One question that has arisen as part of this design process is the actual functioning of the gravel wetland. The State of Vermont guidelines prescribe 5% of the treatment in this process to the wetland. This number is not based on any scientific method, theoretical or empirical. The University of New Hampshire recently completed studies showing gravel wetlands are one of the best treatment strategies for stormwater, achieving 99% reduction in total suspended solids in a controlled environment (UNH Stormwater Center Annual Report, pp 14-15). Our goal is to measure the amount of treatment provided by the wetland in a mountainous field environment.

To this end, we utilized an EPSCoR Facilities Grant to rent two auto-samplers from the University of Vermont (UVM) to complete our studies. The auto-samplers would sample influent and effluent from a wetland throughout a rain event. Unfortunately, we were not able to obtain the two samplers previously available. Therefore, we worked with UVM to use our funding to help purchase an additional sampler. This allows us one sampler to use for this study and provides UVM with an additional resource.

Because we only have a single auto-sampler, the inlet sampling is now collected as a manual grab sample and the auto-sampler was set up at the outlet of the wetland. During a rain event, the sampler is turned on and collects one sample an hour for 24 hours. A Jay Peak employee has been trained to turn on the sampler and collect an inlet sample at the beginning of a forecasted rain event. An outlet sample is collected 24 hours after the start and the samples are all analyzed for turbidity using a field turbidimeter (provided by Jay Peak).

The data collection and analysis is ongoing, and initial results are encouraging. The real challenge of this project has been the coordination of all the players involved: EPSCoR, UVM, Jay Peak Resort, and ESI. Thanks to the involvement of these organizations, and future grants, we hope to provide foundational science that will inform the design of future stormwater treatment systems.

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Teaching a New Generation of Students: Developing an Interdisciplinary Watershed Field Course

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As the scientific world becomes more interconnected, careers in geosciences regularly require cooperation, communication, and comprehension across disciplines. In response, faculty at the University of Vermont (UVM) have developed and are modifying an interdisciplinary watershed field course to provide both a valuable learning experience in watershed science for students and a tested prototype for collaboration and cooperation between faculty, departments, and administrators. The field course introduces concepts of watershed science, an inherently interdisciplinary field of study for which there is often no specific academic department (www.uvm.edu/watercamp). The field exercises begin in Lake Champlain, New England's largest inland water body. To maximize relevance, the focus is on threats and current problems associated with large water bodies. The students then move to the mountainous headwaters of a major drainage into Lake Champlain and follow it back down into Lake Champlain.

The 3.5-week, 4-credit course consists of exercises created by faculty from different academic departments representing three different schools within the university, including civil and environmental engineering, geography, geology, and natural resources. A pair of faculty members from different departments lead each day's activities ensuring that students are exposed to a range of faculty interaction, connections, and cooperation between specialties. The general design of the course is modular; content and faculty can be changed as desired from year to year to take advantage of current field research projects, visiting or absent faculty, or unusual and unique field opportunities.

Surveys collected from students taking the first offering show learning over a broad range of disciplines and positive attitudes about the teaching and learning styles associated with field courses. Knowledge surveys completed by the students before and after the class showed an overall increase in self assessed knowledge of the course concepts, with a positive mean survey increase of one on a three point scale (n=8). Before and after class attitude surveys showed significant increases in the students perceived benefit of writing lab reports, working in groups and using computer based materials (Wilcoxon Signed Rank Test n=7: $p>t = 0.063$; Wilcoxon Signed Rank Test n=7: $p>t=0.063$; and Paired t-test n=7: $p>t = 0.0391$, respectively). There was also a significant decrease in the perceived usefulness of lectures (Wilcoxon Signed Rank Test n=8: $p<t = 0.015$). These survey results demonstrate that this field course develops skills needed to participate effectively in interdisciplinary research and learning.

Mapping Aquifer Zones Based on Microbial Ecology and Geochemistry in a Landfill Leachate Plume with a Self-Organizing Map

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Abstract

We implemented a self-organizing map (SOM) to delineate aqueous geochemistry and microbial ecology in landfill leachate. In subsurface ecosystems microorganisms mitigate a myriad of chemical processes such as contaminant degradation and immobilization, redox cycling and nutrient transport. Resident microbial communities depend on geochemical energy for their metabolism, thus microbial diversity and survival depends on geochemical and contaminant variations in groundwater. Environmental systems analysis would benefit from including microbial diversity; yet traditional multivariate statistical methods are not suited for multi-dimensional data.

We developed an SOM (non-linear clustering algorithm) to reduce high-dimensional data to a lower dimension. The SOM is effective with multiple data types (*e.g.* microbial communities and the environmental parameters that describe their habitat). We tested the SOM on data from monitoring wells in a shallow landfill leachate-contaminated groundwater aquifer. The dataset available from the Schuyler Falls Landfill in Schuyler Falls, NY includes detailed site-wide apparent conductivity as well as hydrochemical and microbiological data from 28 different monitoring wells. Groundwater samples were analyzed for temperature, pH, redox potential, turbidity, specific conductance and a suite of organic and inorganic contaminants. Microbiological ecology is described with 16S rRNA gene surveys using primer sets specific for Bacteria, Archaea and *Geobacteraceae* and DNA sequences were identified as operational taxonomic units (OTUs) for further analysis.

The SOM clusters and delineates the hydrochemical and microbial data, identifying redox zones in the subsurface. Identification of different zones using this clustering algorithm is an important step in linking microbial activity to biogeochemical processes that are important for site characterization and long-term monitoring stewardship (*i.e.* delineating groundwater plumes, identifying changes in redox condition, types of contamination or potential for biodegradation or immobilization).

A Complex Systems Based Simulation of the Interrelationship between Biomass Growth and Changes in Hydraulic Conductivity of Soil

Investigators :- George F. Pinder, Ganesh K Oka

Abstract:-

The degradation potential of bacteria present in the soil or injected in to the soil is put to use in the strategy of bioremediation of contaminants present in the groundwater. Typically these bacteria grow attached to the soil particles, thus reducing the permeability/hydraulic conductivity of the soil. The reduction in permeability is due to the decreased pore volume and increased resistance to the flow of water as the bacteria grow. The reduction in permeability affects the distribution pattern of contaminants. Since these contaminants are used by the bacteria for their growth, the reduction in permeability in turn affects the bacterial growth. Thus the relationship between permeability and biomass growth is dynamic and exhibits complex behavior. This research study attempts to simulate this interrelationship using a complex systems based approach. The interrelationship is simulated using a coupling of two computer models. One of the models simulates the distribution of contaminants and works at the macroscale. The other model simulates the growth in biomass and works at the microscale.

The BIONAPL computer code is used to model the transient distribution of contaminants inside a given domain. It is a model code that simulates multiphase flow in a porous medium and considers three phases, namely, water, air and NAPL (Non-Aqueous Phase Liquids). The permeability is an important parameter that is accepted by the BIONAPL code as an input. The BIONAPL code will be coupled to the Cellular Automata (CA) code for the growth in biomass. The CA code will compute the reduction in pore volume and changed surface area offering the resistance to the flow of water. This will give the changed values of permeability to the BIONAPL code for computing the new distribution of contaminant concentration.

VT EPSCoR Fellowships with the Vermont Center for Emerging Technologies

The Vermont Center for Emerging Technologies (VCET, www.vermonttechnologies.com) is a high-technology business incubator serving the State of Vermont. The program offers selected early stage businesses a menu of traditional incubator services, such as flexible rental space, office equipment and support services, coupled with substantive business mentoring. Vermont EPSCoR Fellows were selected from UVM's School of Business Administration, and were paired with VCET clients to put into practice the concepts taught in the MBA program. The following paragraphs highlight the outcomes per client engagement.

Bell Global: (www.ebeefind.com) Bell Global's product, a personal locator device with superior GPS and communications technology, has tremendous sales potential in this growing market. The work with Bell Global was focused on marketing and sales: 1) outlining the competitive marketplace, 2) identifying and researching potential distribution channels and customer segments, and 3) composing a succinct value proposition for their product. By summarizing and evaluating the various features of competing products, we have been able to identify both overlapping features and areas where Bell Global's product offers identifiable and marketable benefits to various consumer segments. As Bell Global enters the US market, clarifying who they intend to serve and how they intend to reach them, with both product and messaging, is a crucial part of a successful product launch.

Global Classroom: (www.globalclassroom.us) Global Classroom has created a network of classrooms and learning communities to make education more personal, mobile, virtual & digital for the "net-generation" of learners and teachers. The outcome of the EPSCoR Fellowship work with Global Classroom was an actionable marketing strategy for its products and services. Issues addressed included: 1) pricing strategy, 2) sales and distribution, 3) target market assessment, 4) competitive analysis, 5) advertising and promotions plan, 6) and revenue diversification

Skedwool: (www.Skedwool.com) Skedwool delivers a simple, streamlined linked calendaring solution to reduce the organizational back-and-forth required to juggle all of the groups in your life. It aims to be a resource helping simplify the coordination of multiple parties in scheduling events. The outcome of the EPSCoR Fellowship work with Skedwool was: 1) a product adoption plan, including identifying likely customer segments, speed of adoption, and barriers to adoption; 2) a market segmentation analysis; and 3) product promotion channels, including blogs, search engine optimization, social networking widgets, advertising, and viral marketing; and 4) a focus group to generate feedback on product technology, functionality, barriers to adoption, and go-to-market strategy.

PIEmatrix: (www.piematrix.com) PIEmatrix offers a web-service application that enables businesses to centralize and integrate project processes, people, and deliverables. The EPSCoR Fellow worked with the company's founder and director of business development to investigate the viability of contracting third-party specialists to author process-specific (best practice) content to be offered as an add-on to the existing platform. The fellow also completed market research on consulting firms that are engaged in business process assessment and improvement through the use of on-demand software (or 'Software-as-a-Service'). The Fellow's research provided PIEmatrix with data used to identify consulting firms that could use the platform and act as re-sellers to improve operations for their clients. The data is also used to identify companies that will be end users of the software.

SemiProbe: (www.semiprobe.com) SemiProbe is a global supplier of semiconductor probing and testing equipment for applications ranging from R&D to niche production. The EPSCoR Fellow focused on strengthening the firm's position for attracting venture capital investment. Through a review of the company's existing product mix and the markets served by each offering, followed by analysis of the business plan and financial statements, the Fellow was able to work with the firm's executives to identify both strengths and weaknesses in SemiProbe's supply chain, inventory management and cash flow, and to locate attractive venture capital firms that invest in the semi-conductor industry.

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VCET VERMONT CENTER FOR EMERGING TECHNOLOGIES

Automated tracking and analysis of freely behaving *C. elegans* populations

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We demonstrate our efforts to develop a commercial software program for performing locomotion analysis in freely behaving *Caenorhabditis elegans* (*C. elegans*) nematode worm populations. *C. elegans* is a model organism used by many disciplines for the study of neurobiology, genetics, development, toxicology and disease. Computer controlled time-lapse microscopy techniques and algorithms are used to model and quantify dynamic behavior of multiple worms simultaneously. Pixel-based change-detection and image registration techniques are then used to identify and track nematodes even when worms are entangled or exhibiting complex behaviors. This program will greatly reduce the effort needed for analysis and quantification of time-lapse studies of nematodes compared with current methods of study. In addition, the software will make it easier to generate high-throughput, quantitative data about changes observed in diverse *C. elegans* strains, enhancing the accuracy and repeatability of *C. elegans* locomotion studies, which is especially important for toxicology analyses.

Analysis of Spatial and Temporal Variations in Longitudinal Strain Rates near Swiss Camp, Greenland.

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We investigate the evolution of the longitudinal strain regime over the melt season by using continuous data collected at 15 second resolution from ten GPS receivers installed along a flowline through Swiss Camp, Greenland. Network baseline solutions are used to calculate strain rates throughout the 2006 and 2007 melt seasons. Analyses of 2006 data show that the strain rate over a 36 km longitudinal baseline has a background rate of $\sim -11 \times 10^{-4}\ a^{-1}$ but becomes highly variable shortly after the onset of melt around day 200, changing by as much as $\sim 15 \times 10^{-4}\ a^{-1}$ within a span of 24 hours. Longitudinal strain rate reversals occur intermittently over short-lived intervals of one to three days, with rates returning to background magnitudes around day 240, coincident with the decline of seasonal melt, strongly suggesting a hydrologic link. The phasing of strain rates along the flow line are analyzed and used to determine the locus of initiation, and the spatial extent of strain related to each event. During the 2006 season, we focus on 2 time periods of interest. The first event was initiated in the ablation zone, and the second was initiated in the accumulation zone, indicating that short-term altered stress conditions are not confined to the ablation zone. Associated strain rate changes spanned more than 15 km along flow. The geometry of the GPS array was rearranged for the 2007 field campaign to improve our ability to resolve phasing of strain and location of strain initiation. Preliminary results show a background strain rate of $\sim -7 \times 10^{-4}\ a^{-1}$ for a 37 km longitudinal baseline, and analysis is focused on one time period of interest. The event is initiated in the equilibrium zone, and phasing of strain is evident both up flow and down flow from the initiation site. Strain changes are most consistent with changes in basal stress conditions likely from increased basal water pressure at the ice-bedrock interface. Results from this study may be useful in making broader inferences regarding the response of grounded portions of the ice sheet to seasonal changes in stress.

TITLE: Regulation of Synapsins by Phosphorylation and by their Interaction with 14-3-3.

AUTHOR: Madhurima Saha and Bryan A. Ballif, University of Vermont, Burlington, VT-05405.

ABSTRACT:
Synaptic connections enable the nervous system to relay critical information to tissues throughout an organism's body. Essential to this process is the generation and regulation of neurotransmitter-filled synaptic vesicles in pre-synaptic cells. Genetic and biochemical experiments have identified an important role for the Synapsin family of proteins in maintaining an appropriate pool of ready-releasable pre-synaptic vesicles. The molecular mechanism for this is unknown. Synapsins are known to be phosphorylated and pharmacological modulation of kinases and phosphatases affects the trafficking of pre-synaptic vesicles. Recent biochemical and proteomic experiments have identified that Synapsins interact with the phosphoprotein regulator 14-3-3ε. This leads to the hypothesis that 14-3-3ε binds to phosphorylated Synapsins and that this interaction influences the number of readily-releasable pre-synaptic vesicles. We are focusing on the first part of this hypothesis, the identification of the domains and/or phosphorylation sites required for the interaction of Synapsins with 14-3-3ε

Counter propagation Artificial Neural Networks to Predict Disease Risk

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Host biodiversity can impact disease risk; however, whether increased biodiversity increases or decreases disease risk is not always predictable. We are developing computational models examining a parasite that alternates between vertebrate and invertebrate hosts, namely stream tubificid communities that are the alternate hosts of the parasite *Myxobolus cerebralis* which causes whirling disease (WD) of salmonids. The tubificid communities are a tractable model system for manipulative experiments identifying mechanisms that contribute to variation in parasite transmission. The model is based on the observation that biodiversity of the invertebrate host community is a major contributor to spatial and temporal variation in disease incidence of the vertebrate.

Myxobolus cerebralis shows marked spatial variation in its devastating effects on stream salmonid assemblages in the Continental United States. As with most zoonotic diseases with a two-host life cycle including malaria, Chagas disease, West Nile virus and Lyme disease, we hypothesize host biodiversity is a key factor influencing spatial variation in disease incidence. Biodiversity is measured by the parmeters β (probability of an invertebrate host being infected), λ (parasite reproduction in an infected host); and the emergent property *CVIS*, *C*ommunity production of *V*ertebrate *I*nfective *S*pores ($= \sum_{i=1}^{N} \beta_i \lambda_i$, where N = number of tubificids). Our model is based on the following observations. First, tubificid taxa vary in β and λ. Second, frequency and density dependent interactions influence β and λ and thus, *CVIS*. Third, vertebrate disease risk is correlated with *CVIS*.

Classification Artificial Neural Networks (ANNs) will be developed to predict vertebrate disease risk by linking information from the field to results of laboratory experiments. We are using Classification ANNs because of their strengths in prediction, classification and developing containment strategies.

Pathogens with multiple hosts are a significant cause of human disease emphasizing the need for increased understanding of how biodiversity in host communities influences disease risk. Developing this model system will allow us to integrate field and laboratory studies with computational modeling to increase understanding of the ecology and evolution of infectious disease as well as advance knowledge for developing containment strategies.

Title of Project: Free-Shape Dose-Response Curves in Bioassay

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Poster Title:
Generalized equivalence testing for similarity of Free-Shape Dose-Response Curves in Bioassay

A core concept in bioassay analysis is to use the constant horizontal distance between similar-shaped dose-response curves to estimate the relative potency of two preparations. In recent years, assessment of similarity has migrated from comparing slopes of straight-line fits to comparing multiple parameters of parametric nonlinear fits. Even more recently (as in the current draft of a revision of USP Chapter 111) it has been established that the appropriate paradigm for similarity assessment is equivalence-based, with a requirement for evidence that the the difference between curve shapes is small. Under our guidance, such bioassay experiments are frequently carried out within blocked designs and analyzed using multilevel models. For some assays, such as those with partial curves or hooks in their dose-response curves, parametric models (such as the four-parameter logistic) may be too limiting. While any curve shape can be used to estimate potency, the assessment of similarity for arbitrary-shaped curves is not well defined. We generalize the concept of equivalence testing for similarity to dose-response curves having arbitrary curve shape by devising a functional dissimilarity measure within the penalized spline smoothing paradigm that has the same interpretation regardless of dose-response shape.

Adaptive Sampling by Sensor Networks

Investigators: X. Sean Wang (Computer Science) and Jeff Frolik (Electrical Engineering)
Ph.D. Student: Biyu Liang (Computer Science)

Data acquired with a wireless sensor network are often noisy due to various disturbances and as such redundancy, in terms of additional sensors, can provide much needed reliability and data quality. However, to conserve energy, not all the redundant sensors should actively sample at all times.

We have developed a data acquisition method called ASQ (Active Sampling with Quality requirements) and integrated it with the cluster spatial resolution control method (LARC[1]) we proposed in our prior work. ASQ adaptively predicts the population of available sensors in a cluster and determines optimal sample size based on user requirements. Experimental results show that our proposed approach is effective in acquiring quality data with reduced energy consumption when compared with alternative methods such as fixed-size sampling and an ideal benchmark.

To complement this work, we are developing a data suppression scheme in which a sensor node autonomously and probabilistically decides whether to transmit a new piece of data. Under this scheme, the transmit probability depends on the amount of novelty in the new piece of data. The greater the novelty in the measurement obtained at the sensor node, the more likely the transmission. Applying this scheme on UC-Berkeley Redwood and Intel Lab data sets shows that the method can save up to 90% to 95% of energy cost and still achieves a relatively high data accuracy (~1.5% to ~7% using a 95% confidence interval) even though the sensor node suppresses a large percentage of the transmissions. We are currently working on an accuracy estimator for the suppression scheme so that the quality of the transmitted data (after suppression) can be gauged without having to be compared with the actual measured data (without suppression).

[1] B. Liang, J. Frolik and X. Wang, Energy-efficient dynamic spatial resolution control for wireless sensor clusters, in press, Int. Journal of Distributed Sensor Networks, accepted: August 2007.

Catalysis Involving Low-Valent Main-Group Fragments and Synthons

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Group 4 metals supported by triamidoamine ligands are effective catalysts in the synthesis of element–element bonds in the main group. Zirconium complexes of the general type $(N_3N)ZrX$ ($N_3N = N(CH_2CH_2NSiMe_3)_3^{3-}$; X = anionic ligand) have been demonstrated to undergo selective P–P bond formation by dehydrocoupling of primary and secondary phosphines [1]. Based on mechanistic study, which established that bond formation proceeds via σ-bond metathesis steps, heterodehydrocoupling schemes involving P–Si and P–Ge bond formation have been discovered using these same catalysts [2]. Recently, these systems have been shown to generate low-valent species by direct or indirect routes resulting in the catalytic preparation of element–element double bonds. Thus, $(N_3N)ZrX$ complexes dehydrocoupled 2,6-dimesityphenylarsine ($dmpAsH_2$) to give the diarsene product, dmpAs=Asdmp. Studies on the related mesitylarsinido complex, $(N_3N)ZrAsHMes$ supported the hypothesis that extrusion of a low-valent arsenic fragment (an arsinidene, "AsR") termed via α-arsinidene elimination occurs [3]. Indirect generation of a phosphinidene synthon has been achieved via a combination of insertion and rearrangement. Zirconium primary phosphido complexes, $(N_3N)ZrPHR$, reacted rapidly with isocyanides to give insertion products, $(N_3N)ZrC(PHR)=NR$. These products thermally rearrange to form amido ligands featuring phosphaalkene (P=C) linkages [4]. Recent developments suggest that this transformation can be made catalytic, which is the first catalytic synthesis of phosphaalkenes.

References

1. Waterman, R. *Organometallics* **2007**, *26*, 2492.
2. Roering, A. J.; MacMillan, S. N.; Tanski, J. M.; Waterman, R. *Inorg. Chem.* **2007**, *46*, 6855.
3. Roering, A. J.; Davidson, J. J.; MacMillan, S. N.; Tanski, J. M.; Waterman, R. *Dalton Trans.* **2008**, *in press*.
4. MacMillan, S. N.; Tanski, J. M.; Waterman, R. *Chem. Commun.* **2007**, 4172.

Spatial patterns of snow distribution in a northern New England mountain landscape and implications for runoff modeling

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Tiffany Larsen, Department of Geology, University of Vermont

Snowpacks in mountain settings exhibit extreme variation over small spatial scales, due to the influence of complex topography and vegetation on snow inputs and energy fluxes. Here, we describe the preliminary results of a field study in northern New England documenting spatial patterns of snow distribution in a watershed where snow processes exert important controls on runoff production. We attribute spatial patterns in snow cover to elevation gradients, characteristics of the forest canopy and canopy openings, and activities associated with recreational use and management of the landscape. Preliminary modeling results point to the implications of spatial variability in snow distribution on runoff production.

Statistical Modeling of VCO Phase Noise due to Up-converted MOSFET 1/f Noise

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Most of the previous studies on 1/*f* noise have either concentrated on random telegraph signals (RTSs), which are observed on very small area transistors [1], or assumed a technology specific trap density which is only valid for large-area transistors [2]. Many analog circuits utilize moderately sized MOSFETs ($W \approx 10\ \mu\text{m} - 100\ \mu\text{m}$, $L \approx 2 * L\text{min}$), where unlike RTS, the noise level shows a 1/*f* roll-off, and yet, a constant trap density cannot be assumed, since there is significant site-to-site variability in measured 1/*f* noise. This variability is attributed to the disparity in the number of traps in otherwise very similar FETs [3], [4]. We show that the variations in measured low-frequency noise are largest under extensive pinch-off conditions, where the density of inversion charge has the largest spatial gradient along the channel length. The spread in the noise level lessens as gate overdrive is increased and the inversion charge profile becomes more uniform. We develop a general formulation for the trap-induced mobility fluctuations as a function of inversion charge density. We investigate the correlation between 1/*f* noise variations and inversion charge spatial profile. Through noise data from populations of FETs, TCAD simulations, and theoretical analysis, we shed light on the physical basis of the bias dependence of noise statistics.

In addition, we apply the proposed 1/f model to study the phase noise in voltage-controlled oscillator (VCO), which is one of the most important circuit components in mobile and wireless consumer systems.

VCOs are widely used in RFICs for frequency synthesis, therefore the spectral integrity of the VCO output is of paramount importance. RF CMOS Voltage Controlled Oscillators suffer from high levels of close-in phase noise due to the upconversion of device 1/f noise. It has been reported that a large device-to-device variation is observed in MOSFET 1/f noise. This variability has been shown to be due to the statistical nature of the number and spatial location of traps found in each MOSFET. However, up to now there has been no published data or analysis on the statistical variability of VCO phase noise that can be seen in a population oscillator circuits. In this study, we present experimental data, theoretical analysis, and model-to-hardware correlation on VCO phase noise statistics. An accurate model that predicts the statistical variations in VCO phase noise will be presented.

Developments of Capillary Technologies to use Intensified CCD Camera and Microscopic Imaging for Online Laser Light Scattering.

Jie Yang

Abstract:

With the development of capillary engineering, it is possible to couple microscopic imaging with laser light scattering. The detection uses a CCD camera mounted on a microscope that allows not only to monitor the scattering intensities but also to record flow structures of objects in capillary flow. With an intensified CCD camera, the detection sensitivity is readily comparable to that with conventional laser light scattering instruments. The observed flow structures have revealed that the capillary flow of solutions is generally governed by the micro-fluidics and statistical physics and greatly enhances the aggregation probability. This phenomenon can be useful for practical devices in addition to the need for an understanding of details of the underlying mechanisms.

The application of *p*hoto*e*lectron *r*esonance *c*apture *i*onization *a*erosol *m*ass *s*pectrometry (PERCI-AMS) to oxidation of internally mixed organic nitrogen-lipid fine particulate of atmospheric relevance

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Amines represent an important contributor to organic nitrogen in the atmosphere and may play a role in secondary aerosol formation. Atmospheric chemical processing of amines may lead to formation of new particles and may have implications on the cloud condensation nuclei ability of these particles, affecting global climate through indirect aerosol effects through the formation of more polar, water soluble compounds in aerosols. Herein we report on the oxidative processing by ozone of the particulate amines. Photoelectron resonance capture ionization aerosol mass spectrometry was used to measure strong NO_2^- and NO_3^- ion signals that increased with ozone exposure, suggesting a mechanism of progressive oxidation of the particulate amines to nitroalkanes. Additionally, a strong ion signal at 125 m/z is assigned to the ion $NO_3^-\bullet(HNO_3)$. Amide and imine products were measured for ozone pressures as low as 3×10^{-7} atm. These products most likely arise from reactions of amines with aldehydes (for imines) and stabilized Criegee intermediates (SCI) or secondary ozonides (for amides) from the lipid compound in the particle. Finally, direct evidence is provided for the formation of a surface barrier in mixed particles of octadecyl amine + oleic acid (OL) that resulted in the retention of OL at high ozone exposures (up to 10^{-3} atm for 17 s). This effect was not observed in other mixed amine + OL or single component OL particles, suggesting that it may be a species-specific surfactant effect from an in situ generated amide or imine. Implications to tropospheric chemistry, including particle bound amines as sources of oxidized gas phase nitrogen species (e.g. NO_2, NO_3), formation of nitrogen enriched HULIS via ozonolysis of amines and source apportionment are discussed.

SonoUroFlowmetry – Home-Based Method for Urinary Flow Measurement

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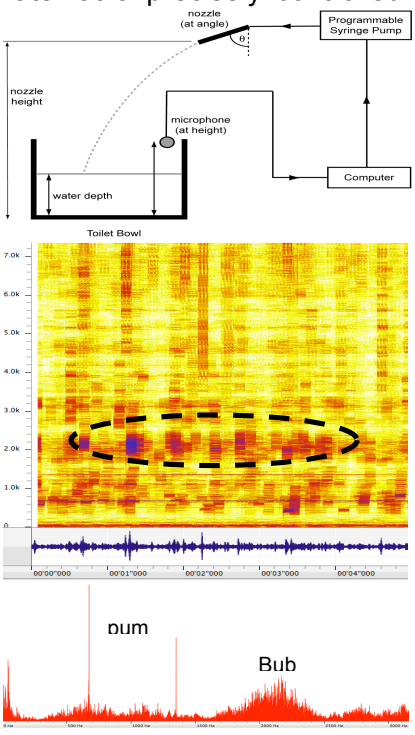
Background: This study is aimed to further development of a novel home-based system for assessing of voiding function. The system captures sound generated during micturition and transforms the acoustic signal into sonourogram – a measure of urinary flow rate. This work is aimed at developing means for correlating the recorded sound with key flow parameters. This is a "proof-of-concept" study that addresses the feasibility of measuring the peak and mean flow rate via signal analysis of the digital sound intensity records. A limited set of experiments was designed to address two fundamental questions:

1) Can the flow characteristics of the urine stream be directly correlated to the acoustic emissions produced by the liquid stream impacting the water surface using home-based sonouroflowmetry system?

2) Is it possible to develop an empirical model for this correlation that provides clinically acceptable limits of accuracy?

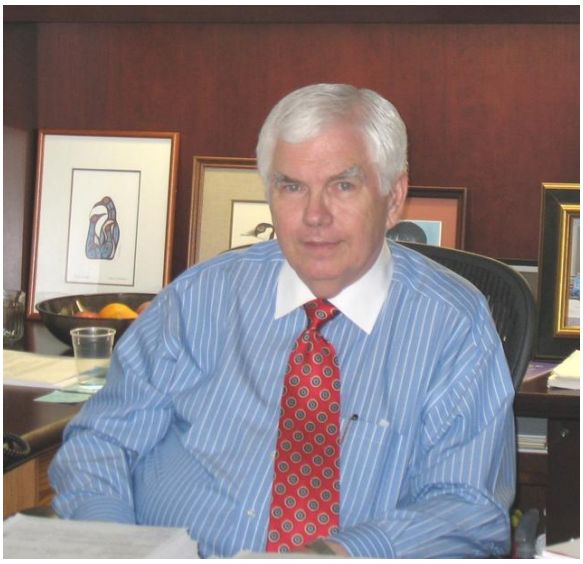
Experimental Methods. An experimental apparatus has been designed and constructed which affords an engineering model of steady (male) urination into a toilet bowl (refer to schematic diagram). The apparatus delivers a steady jet of water at a precisely controlled flow rate using programmable syringe pump(s) which empties into a standard toilet bowl. The acoustic emissions resulting from the jet impact on the free surface in the bowl are digitally recorded using a studio microphone. Splash patterns are simultaneously captured using digital video. Experiments have thus far been performed for different geometric configurations for a range of flow rates (4 -8 ml/sec); the flow rates are relatively low in physiological terms but, nonetheless, are useful in evaluating the feasibility of the sonouroflowmetry concept. Acoustic records are analyzed using spectral analysis to evaluate both average and time-varying frequency content. Shown in the figure is a sample "spectrogram" for a 5 second period along with average spectrum for the period.



Conclusion: The results of this work are encouraging, however, additional experiments will be required to assess the level of accuracy for which acoustic signatures may be correlated with flow rates.

Dr. F. C. Thomas Allnutt is a Program Director and Biotechnology/Chemical Technology Cluster Lead in the SBIR/STTR Program (Small Business Innovative Research/Small Business Technology Transfer) at the National Science Foundation. The SBIR/STTR program provides grant funding to small businesses on commercially relevant projects in Software and Services (SS), Biotechnology and Chemical Technologies (BC), and Electronics, Components, and Engineering Systems (EL) research. A goal of the program is to leverage governmental funding to facilitate more rapid development of high impact and commercially viable products that might otherwise not be attempted by a small business due to the level of risk required. Dr. Allnutt comes out of the small business community where he spent over seventeen years. He was an early employee of Martek Biosciences Corporation where he was a Research Director for twelve years. He later moved to Advanced BioNutrition Corporation, a start up company as the third employee and Vice President of Research & Development. Both companies are located both in Columbia, MD. He joined the National Science Foundation in 2006. Dr. Allnutt's area of expertise is algal biotechnology but he has acquired broad knowledge of related areas and the business of science as he worked to commercialize algal products in a variety of fields. He is the inventor on over 17 patents filed or pending and has published over 25 papers in peer reviewed journals.

Experimental Program to Stimulate Competitive Research (EPSCoR)



Henry Blount is Head of the Office that administers the National Science Foundation's Experimental Program to Stimulate Competitive Research (EPSCoR). EPSCoR is a program designed to fulfill the NSF's mandate to promote scientific progress nationwide. The EPSCoR program directs its resources at those states that have historically received lesser amounts of NSF Research and Development (R&D) funding. Through this program, NSF establishes partnerships with government, higher education and industry that are designed to effect lasting improvements in a state's or region's research infrastructure, R&D capacity and hence, its national R&D competitiveness.

Prior to being named Head of the EPSCoR Office, Dr. Blount served as Head of the Office of Multidisciplinary Activities in NSF's Directorate for Mathematical and Physical Sciences; Acting Executive Officer for the Division of Chemistry; Acting Deputy Division Director for Chemistry; Director of Program Operations in the Research Facilities Office, Office of the Director; Head of the Chemistry Division's Office of Special Projects; Program Director for Analytical and Surface Chemistry; and Program Director for Chemical Analysis.

Dr. Blount received the B.S. in Chemistry from the University of North Carolina and the Ph.D. in Chemistry from the University of Georgia. He was a Research Associate and Teaching Fellow in Chemistry at Case Western Reserve University. From 1970 until 1984 Blount was a member of the faculty of the University of Delaware. He was Visiting Professor of Chemistry at the University of Guelph in 1978-79 and served the National Science Foundation as Program Director for Chemical Analysis in 1981-82. In 1984 Blount moved from his position as Professor and Director of Graduate Studies in Chemistry at the University of Delaware to the Foundation as Program Director for Chemical Analysis.

Biographical Sketch
Scott G. Borg

Dr. Scott G. Borg currently serves as Division Director for the Division of Antarctic Sciences in the Office of Polar Programs at the National Science Foundation. His responsibilities include oversight of six research programs which constitute the core of the science activities within the US Antarctic Program. The six programs are: Antarctic Aeronomy and Astrophysics, Antarctic Ocean and Atmospheric Sciences, Antarctic Earth Sciences, Antarctic Glaciology, Antarctic Organisms and Ecosystems, and Antarctic Integrated System Science. The Division works with the research community to understand the most pressing research needs in Antarctic sciences and accepts proposals for research that advance understanding of the Antarctic or that require the Antarctic as a platform for research. The Division conducts the NSF merit review process for these proposals, manages the resulting research grants, and works with US Antarctic Program logistics and science support organizations on plans for accomplishing the field work. Proposals and the resulting portfolio of awards often include partnerships with other federal agencies and international organizations. In addition, the Division manages the Antarctic Artists and Writers Program whose goal is to enrich public understanding of the Antarctic region as well as the research, research support, and educational activities of the US Antarctic program.

Prior to his current position, he served for 10 years as Program Director for the Antarctic Geology and Geophysics Program (now Antarctic Earth Sciences) within NSF. Prior to coming to NSF, he worked on the Yucca Mountain Project while employed by the US Department of Energy. Prior to his federal service, he was a research scientist at the University of California and staff scientist at Lawrence Berkeley Laboratory. He has participated in six research expeditions in the Antarctic, leading 4 of these, and has conducted applied geological studies in support of environmental assessment for land use and management.

He received his B.A. with a concentration in Geology from Pomona College, and M.S. and Ph.D. degrees in Geology from Arizona State University. His research background is in geology and isotope geochemistry, with particular interest in using chemistry for determining the origin of granitic rocks.

He is a Registered Geologist in California and Oregon, and a member of the American Geophysical Union and the Geological Society of America.

Biographical Sketch
Maria K. Burka

Dr. Maria K. Burka is the program director of the Process and Reaction Engineering (PRE) program in the Chemical, Bioengineering, Environmental and Transport Systems (CBET) Division of the National Science Foundation. Her responsibilities include evaluation and management of research and educational grants to academic institutions in the areas of chemical and biochemical reaction engineering, process control and process design as well as reactive polymer processing. Past employment positions have included Senior Scientist with the U.S. Environmental Protection Agency (EPA), a member of the faculty of the Chemical Engineering Department of the University of Maryland/College Park, and process design engineer with Scientific Design Company in New York City.

She received B.S. and M.S. degrees from the Massachusetts Institute of Technology and M.A. and Ph.D. degrees from Princeton University, all in chemical engineering. Her research interests are in chemical process design and control.

She is active in a number of professional organizations, including the American Institute of Chemical Engineers (AIChE), the American Chemical Society (ACS), the Society of Women Engineers (SWE) and the American Association of University Women (AAUW). A past member of the Board of Directors of AIChE , at the present time she is on the Steering Committee and the International Committee of AIChE.

Margaret A. Cavanaugh
Deputy Assistant Director
Directorate for Geosciences
National Science Foundation

Margaret A. Cavanaugh joined the Directorate for Geosciences at the National Science Foundation as Deputy Assistant Director in 2004. For the five previous years, she served as Staff Associate for the Environment in the Office of the Director, during which time she chaired a staff advisory committee on environmental research and education that guided the Foundation's *Biocomplexity in the Environment* competition and was the Executive Secretary for the NSF Advisory Committee on Environmental Research and Education (AC-ERE).

Dr. Cavanaugh came to NSF in 1989 as Program Director for the Inorganic, Bioinorganic, and Organometallic Chemistry Program. While in the Chemistry Division, she managed programs on *Environmentally Benign Chemical Synthesis & Processing*, *Environmental Molecular Science Institutes*, and *Environmental Geochemistry and Biogeochemistry*.

Prior to joining the NSF, Dr. Cavanaugh was Professor and Chair of the Chemistry Department of Saint Mary's College, Notre Dame, Indiana. Dr. Cavanaugh received her B.S. degree from the University of Pittsburgh, her Ph.D. from the Catholic University of America, and carried out postdoctoral research at Louisiana State University in New Orleans.

She currently chairs the ACS (American Chemical Society) Committee on Ethics. She is a founding member of COACh, the Committee on the Advancement of Women Chemists. In 1995, she was honored by the ACS with the Award for Encouraging Women into Careers in the Chemical Sciences.

Timothy Fossum

Program Director, Scholarship for Service (SFS) Program
National Science Foundation

Dr. Fossum is the lead NSF program director for the NSF/DHS Federal Cyber Service: Scholarship for Service (SFS) program. The SFS program provides scholarship support to students pursuing Information Assurance (IA) careers and grants to institutions for faculty development in IA.

Dr. Fossum is serving NSF while on leave from the State University of New York College at Potsdam, where he has served as Professor and Chair of the Computer Science Department since 2005. Dr. Fossum previously held faculty positions in the University of Wisconsin system (Kenosha and Milwaukee).

Dr. Fossum received his Ph.D. in mathematics at the University of Oregon. He has a publications in areas as diverse as finite-dimensional algebras, differential equations as applied to tracker-truck jackknifing, operating systems, gender issues in computing, and measures of knowledge acquisition. He has engaged in several computer-related consulting activities. His teaching experience includes computational theory, programming languages, operating systems, computer networks, and information security.

Experimental Program to Stimulate Competitive Research (EPSCoR)

Simona L. Gilbert is the administrative manager in the NSF EPSCoR Office. She has served in various administrative positions at the NSF. She began her NSF career in the Office of Polar Programs (OPP) in May 1992 as a program assistant for one of the NSF's largest global change programs. From August of 1997 until October of 1999, Ms. Gilbert served as Arctic Coordination Specialist in OPP. Ms. Gilbert was selected to serve as the administrative manager in the Office of International Science and Engineering (INT) from October, 1999 until May, 2002.

Ms. Gilbert has an undergraduate degree in Business Administration, and will complete her Master's in Education Administration from Strayer University in September 2008.

Bio for Dr. C. Suzanne (Suzi) Iacono

Dr. Suzi Iacono is currently Senior Science Advisor for the Directorate for Computer and Information Science and Engineering (CISE) at the National Science Foundation (NSF). Among other responsibilities, she is the Directorate's Advisor for International Activities. For most of the 2007 Fiscal Year, she was Division Director (Acting) for the Division of Computer and Network Systems (CNS) and during the 2006 Fiscal Year, Division Director (Acting) for the Division of Information and Intelligent Systems, also in CISE. From 2003 to 2005, she headed up the Information Technology Research (ITR) Program, an NSF-wide Priority Area. Previously, she was Program Director for Digital Society and Technologies in CISE. She also has interagency duties. She serves on the Executive Committee of the Interagency Task Force on Advance Networking (ITFAN) and is also the co-chair of the Social, Economic and Workforce (SEW) Implications of Information Technology and Information Technology Workforce Development Coordinating Group, which gives policy, program and budget guidance on SEW activities to the Subcommittee on Networking IT R&D (NITRD) under the National Science and Technology Council (NSTC). Prior to coming to NSF, she held a faculty position at Boston University, was a Visiting Scholar at the Sloan School, Massachusetts Institute of Technology, and was a Research Associate at the Public Policy Research Office at the University of California, Irvine. Over the years, she has written journal articles, book chapters and conference papers on Social Informatics, an area of interdisciplinary research and education that integrates aspects of computer and social sciences. Suzi received her PhD from the University of Arizona in Information Systems and her MA and BA from the University of California, Irvine in Social Ecology.

Dr. John ('Jack') W. Lightbody
Deputy Assistant Director, Mathematical and Physical Sciences,
National Science Foundation (NSF)

Dr. Lightbody received a B.S. degree in Physics from Rensselaer Polytechnic Institute (1961) and a PhD in Physics from the University of Maryland (1970). He became a Staff Scientist at the National Institute of Standards and Technology and worked there 1962-1985. During that period he worked as a bench scientist, as Group Leader for Nuclear Physics (1985-1990), and, later, as Scientific Advisor to the Director, Center for Radiation Research, (1990-91). While at NIST, he went on detail to NSF as a 'rotator', serving as Program Director for Nuclear Physics. He later joined NSF as a permanent Program Director in 1991. While at NSF he has served as Acting Deputy Director, Division of Physics (1994-1995), Executive Officer, Division of Physics (1995-2002), Acting Director, Division of Physics, NSF (1998), Senior Facilities Official, Division of Physics (2002-2007). In the latter capacity he led NSF oversight of a number of large NSF-funded facility construction projects, including the IceCube Neutrino Observatory at the South Pole and the Large Hadron Collider in Geneva, Switzerland. He is now the Deputy Assistant Director for Mathematical and Physical Sciences. His personal research interests include: experimental high energy electron scattering and photonuclear reactions, nuclear charge distributions and nuclear structure, studies of rotational and vibrational nuclei, quasi-elastic electron scattering, sum rules, few-nucleon studies, and short-range NN interactions. He is a Fellow of the American Physical Society and has over 60 publications in refereed journals, books, and proceedings.

Experimental Program to Stimulate Competitive Research (EPSCoR)

Douglas MacTaggart has worked as an analytical chemist in commercial environmental and clinical laboratories in California, Colorado and Ohio, specializing in instrumentation and data analysis. He also has experience in atmospheric chemistry research at academic institutions, with research interests focusing on emissions of sulfur compounds from biogenic sources, validation of measurement systems, and the use of statistics in analytical chemistry. His service in the EPSCoR Office has included co-funding liaison and management, jurisdiction RII management, evaluation program development, and program data analysis.

Dr. Douglas MacTaggart received his B.S. in Professional Chemistry and Ph.D. in Chemistry from the University of Idaho.

BIOGRAPHICAL SKETCH

Tyrone D. Mitchell, Ph.D.

Dr. Mitchell was born in New Orleans, LA and attended New Orleans Public Schools until enrolling at Dillard University in New Orleans, where he received a B.A. degree in Chemistry. Subsequently, he received a M.S. degree in Organic Chemistry from the University of Pittsburgh and a Ph.D. degree in Polymer Chemistry from Rensselaer Polytechnic Institute in Troy, NY. He worked 25 years at General Electric Co. where he co-authored 16 technical publications and holds more than 25 US patents in the areas of organosilicon chemistry, polymer chemistry, and the synthesis of adhesion promoters for use in silicone sealants. While at GE he worked at their Corporate Research and Development Center and at the Silicone Products Division. At the time of his departure from GE in 1990, products he helped to develop were producing over $100M in annual sales.

He joined Corning Incorporated after GE where his work there involved the development of new coatings for optical fibers. He held a number of management positions at Corning Incorporated where his responsibilities included seeking new technology that could impact Corning's research and development activities. This included helping to establish university interactions and working proactively to monitor and maintain these relationships. He has served on the Board of Directors of the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers and he has served on the Chemistry Section Committee of the American Association for the Advancement of Science. In November 1999 he completed a five-year tenure as a Board Member of the Center for Advanced Materials Processing at Clarkson University and in July 1999 completed a three-year commitment to the Board of Directors of the Technology Transfer Society. He completed a four-year term as Member-at-Large to the Industrial Science & Technology Section of the American Association for the Advancement of Science. In January 2006, he was inducted as a Fellow in the American Association for the Advancement of Science.

Dr. Mitchell retired from Corning Incorporated in 2001 and is now a Program Director in the Chemistry Division at the National Science Foundation in Arlington VA.

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Joann Roskoski received a BA in Bacteriology from Douglass College in 1969, a Masters in Ecology from Rutgers University in 1971 and her doctorate from Yale University in Forest Ecology in 1977. From 1977 through 1983, she studied tropical-cropping systems in Mexico first as a Rockefeller postdoc, then as a Research Associate with a Mexican research Institute and then at the University of Arizona. From 1983 through 1988, she was director of research for an international agricultural research program at the University of Hawaii. After managing a forestry grants program at the National Research Council (1988-89) for 2 years, she came to NSF in 1989 where she ran the Ecology Program, was Deputy Director for the Division of Environmental Biology, and is now the Executive Officer for the Directorate for Biological Sciences.

Kevin Thompson

Kevin Thompson serves as a Program Director at the U.S. National Science Foundation's Office of Cyberinfrastructure. He is responsible for the International Research Network Connections (IRNC) program, is lead Program Director for the Software Development for Cyberinfrastructure (SDCI) program, and is a member of the management teams for several other programs. He started at NSF in January 2003. Prior to NSF, he was Senior Manager in MCI's Advanced Internet Technologies department, responsible for engineering and operation of the vBNS, a national research and education network.

Biographical Sketch
Carol Van Hartesveldt, Ph. D.

Carol Van Hartesveldt, Ph. D., has been Program Director for the Integrative Graduate Education and Research Traineeship (IGERT) Program in the Division of Graduate Education at the National Science Foundation since 2004. Before taking this position she was Associate Dean for Research at the Florida State University College of Medicine, where she established the Office for Research. She was previously Program Director for Behavioral Neuroscience in the Biology Directorate at the NSF as a rotator from the University of Florida, where she was Professor of Psychology and Neuroscience and Co-Director of the Center for Neurobiological Sciences. As Co-Director for the Center she was also Co-PI of an interdisciplinary graduate training program in the neurobiological sciences funded by the NIMH for over 20 years. At various times she served as Graduate Coordinator in the Psychology Department and Assistant Dean of the Graduate School at the University of Florida. Her research in the areas of brain mechanisms of learning, behavioral functions of neurotransmitters in the basal ganglia, and the development of neural mechanisms of locomotion is published in over 60 journal articles and was funded by the NIH, the NIMH, and the Whitehall Foundation. She has served on numerous grant review panels for the NSF, the NIH, and the NIMH. She received her Ph. D. degree in Psychology and Neurobiology from University of Rochester Center for Brain Research and her B.A. in Psychology from Oberlin College.

Anthony Walters has over thirty years of experience, including information management, assessment of liability/risk, analysis of regulatory options, applications of systems analysis to management considerations, application of activity-based costing and management techniques to the private sector and Federal agencies, development of industry and government policy positions, and evaluation of business systems. He has worked effectively with Federal and state agencies, trade associations, and resource information and data sources in Washington D.C.

Dr. Walters has a Bachelors degree in mathematics and a Masters and Ph. D. in operations research/systems analysis. He was Assistant Dean and Assistant Professor at Carnegie-Mellon University for almost 6 years, and Associate Professor of Public Systems and Quantitative Methods at Cornell University for 4 years. His experience expanded through corporate and government consulting, and over 6 years with the American Petroleum Institute participating in policy development, addressing issues pertaining to environment and health effects, and developing expert testimony for Congress. He served as a member of the senior professional staff of a Federal IT consulting firm managing projects in systems analysis, performance measurement, benchmarking, business process reengineering, and information management.

Thomas A. Weber Received his PhD in chemical physics from The Johns Hopkins University (1970). He was a member of Technical Staff, AT&T Bell Laboratories, Murray Hill, NJ (1970-1987) and Program Officer for Theoretical and Computational Chemistry, Chemistry Division, NSF (1987-1988), Division Director, Advanced Scientific Computing, NSF (1988-1992), Division Director, Information Systems, NSF (1992-1994), White House, Executive Office of the President (1993 detail).

Steven Arms Biography:

Mr. Arms received his Master's Degree in Mechanical Engineering at the University of Vermont in 1983. He has been awarded 25 US patents, and has over 10 pending. He has contributed to 18 journal publications as well as 44 abstracts/presentations in areas of advanced instrumentation, wireless sensing, and energy harvesting. Mr. Arms is founder and President of MicroStrain, Inc., a Vermont manufacturer of micro-displacement sensors, inertial sensing systems, and wireless data logging nodes for recording and transmitting strain, vibration, temperature, and orientation data. MicroStrain has been recognized as an innovator in the sensors industry – the firm has received eight (8) Best of Sensors Expo Gold awards for its new products. MicroStrain is currently funded by the US Navy to develop wireless sensor networks which use strain energy harvesting to eliminate battery maintenance.

Specialty: Environmental Geology, human-landscape interaction, glaciers, earthquakes, dating, geochemistry, weathering, geoscience education

Bierman is a Geomorphologist with wide-ranging interests including environmental geology, hydrology, isotope geochemistry, glacial geology, surface process, and rates of weathering and denudation. He works at the interface between active research, education, and science literacy at all levels. He is involved in the Governor's Institutes of Vermont and in National Science Foundation's CAREER program, and involves students in service learning projects in a great deal of his research. Funded by several National Science Foundation grants, he currently is working to understand the recent evolution of New England landscapes, in particular, the timing and distribution of major storms and floods over the past 10,000 years. He also is involved in a study of land use and shrinking "green space" in Burlington. Bierman has examined Earth Surface Processes at scales ranging from micron thick coatings of rock varnish to the evolution of Australian landscapes. Research interests include the rate of bedrock weathering involves field work in such locations as central Australia and the Canadian arctic. Bierman directs UVM's Cosmogenic Nuclide Extraction Lab -- one of only a handful of laboratories in the country dedicated to the preparation of samples for analysis of 10-Be and 26-Al from pure quartz (uvm.edu/cosmolab). He manages the Landscape Change Program, an NSF-supported digital archive of historic Vermont Landscape images used for teaching and research, available at uvm.edu/landscape. Bierman is the recipient (1996) of the Donath Medal as the most promising young geologist in the country. He was also the recipient of NSF’s highest award, the Director’s award for Distinguished Teaching Scholars, in 2005.

Frances E. Carr, Ph.D.
Vice President for Research and Graduate Studies
Professor of Pharmacology, College of Medicine

As the Vice President for Research and Graduate Studies, Carr is responsible for enhancing the University's research and scholarship enterprise; ensuring the responsible conduct of research; expanding the university's technology, innovation and related entrepreneurial endeavors; and strengthening graduate education. She also oversees the development and expansion of research partnerships to enhance economic development. She serves on the Boards of the Vermont Technology Council, the Vermont Council on World Affairs and was a founding member of the Vermont Center for Emerging Technologies.

Prior to joining UVM, Carr was the Vice President for Research and Economic Development and Professor of Biological Sciences at Binghamton University at the State University of New York. Carr served on the Board of Directors of the Research Foundation of the State University of New York, the Board of Directors of the Innovative Technologies Corporation, a Binghamton University technology incubator, the Southern Tier Opportunity Coalition, an industry collaboration to enhance innovative technologies among others.

As senior science advisor with the U.S. Agency for International Development (USAID) she advised a $260M research portfolio and authored foreign policy documents and strategies. She also served on the National Science & Technology Council as co-chair of the Committee for International Science, Engineering and Technology and as co-chair for the US-EU Committee on Emerging and Re-emerging Infectious Diseases. She is a recipient of a Meritorious Honor Award from USAID.

Carr received a BS in biology and psychology from Boston College and a PhD in physiology and biophysics from the University of Illinois Medical Center. Her subsequent appointments at the University of Minnesota and Harvard Medical School fostered her research in proteomics and thyroid cancer, thyroid hormone action in development and environmental disruption of thyroid hormone action. She is an active member of a number of professional societies and has been a reviewer for numerous journals including the *Journal of Biological Chemistry*, *Thyroid*, *Endocrinology*, and *Molecular Endocrinology*.

Mark Lubkowitz graduated with a BS in Biology from Washington and Lee University in 1991 and proceeded into a PhD program at the University of Tennessee in Jeff Becker's laboratory in 1992 where he studied peptide transport systems in pathogenic and non-pathogenic fungi. After completing his doctorate, Mark received a NIH post-doctoral fellowship to study leaf development at UC Berkeley in the laboratory of Mike Freeling. From the Berkeley, he proceeded to Saint Michael's College in 2001 where he has developed a research program that investigates the role of peptide transport systems in germinating rice seeds. His research program is integrated with his teaching through student involvement in the laboratory and by exploring experimental questions in courses. Since joining the faculty at Saint Michael's College he has mentored thirteen students in his research lab resulting in 16 poster presentations with undergraduate co-authors at regional, national or international conferences.

Judith Van Houten, Ph.D.

Dr. Judith Van Houten, George H. Perkins Professor of Biology at the University of Vermont (UVM) and State Director of the Vermont Experimental Program to Stimulate Competitive Research (VT EPSCoR).

Appointed as the **EPSCoR State Director** in 2005, Dr. Van Houten also serves as the program's Principal Investigator. The Vermont EPSCoR Research Infrastructure Improvement (RII) award, funded by the National Science Foundation (NSF), builds science and engineering infrastructure in Vermont and promotes collaborative research at UVM and beyond. VT EPSCoR also supports the development of basic research programs for early career faculty at UVM, and for faculty at Vermont's baccalaureate institutions. The Tibbetts Award winning program for research and development in the private sector (SBIR Phase (0)) prepares businesses for submission of SBIR grant applications to federal agencies. Graduate, undergraduate and high school students also benefit from VT EPSCoR sponsored programs.

Dr. Van Houten also serves as the **Director of the Vermont Genetics Network** (VGN), a $16.5M program awarded in 2005 by the National Institutes of Health (NIH). This remains as the largest single investigator grant ever received at UVM. VGN is funded by a five year award from the National Center for Research Resources, and is part of the NIH initiative called IDeA Networks of Biomedical Research (INBRE). VGN is a collaboration among the University of Vermont, and five baccalaureate colleges throughout the state of Vermont to build biomedical research infrastructure and workforce in biomedical research.

In addition, Dr. Van Houten is the **Director of the HELiX** (Hughes Endeavor for Life Science Excellence) Program, which supports undergraduate research at the University of Vermont. HELiX strives to encourage students to stay in science and consider careers in the sciences by involving them in research projects and informing and exposing them to as many opportunities as possible in the sciences.

Dr. Van Houten has a long record of administration and mentoring, including service as Director of the Cell and Molecular Biology Graduate Program for 6 years, Associate Dean of the College of Arts and Sciences for 5 years, Chair of Biology from 1995-2005. Perhaps most importantly, she has served as Associate PD of VT EPSCoR from 1996 –2005, and as Associate Director for research 1991- 1996. Dr. Van Houten has a record of extramural funding from NIH and NSF. She has received a 7-year Pepper award from NIDCD and the Manheimer Award for career achievements in Chemosensory Sciences. The University of Vermont has recognized her as a University Scholar and the George H. Perkins Professor. She is well regarded in her field, has been elected to offices, including President, in the Association for Chemoreception Sciences, and serves on editorial boards. She is familiar with federal funding mechanisms at NSF and NIH, has served for 6 years on the CMS study section (2 years as chair) and is currently a member of CMBK study section.

Dr. Van Houten's style of management is inclusive. Most recently she received the **Jackie M. Gribbons Leadership award** from the Vermont Women in Higher Education. This award is presented to a woman who has demonstrated leadership ability, served as a model and mentor, developed innovative programs, and contributed significantly to the institution and profession.

Dr. Van Houten received a BS from Pacific Lutheran University and her PhD from the University of California at Santa Barbara. Her research investigates the molecular mechanisms of how

cells detect chemicals, and she uses organisms as simple as Paramecium and as complex as mice. Her work provides insights into the sense of smell. A full description of Dr. Van Houten's research areas may be found at http://www.uvm.edu/%7Ebiology/Faculty/VanHouten/VanHouten.html

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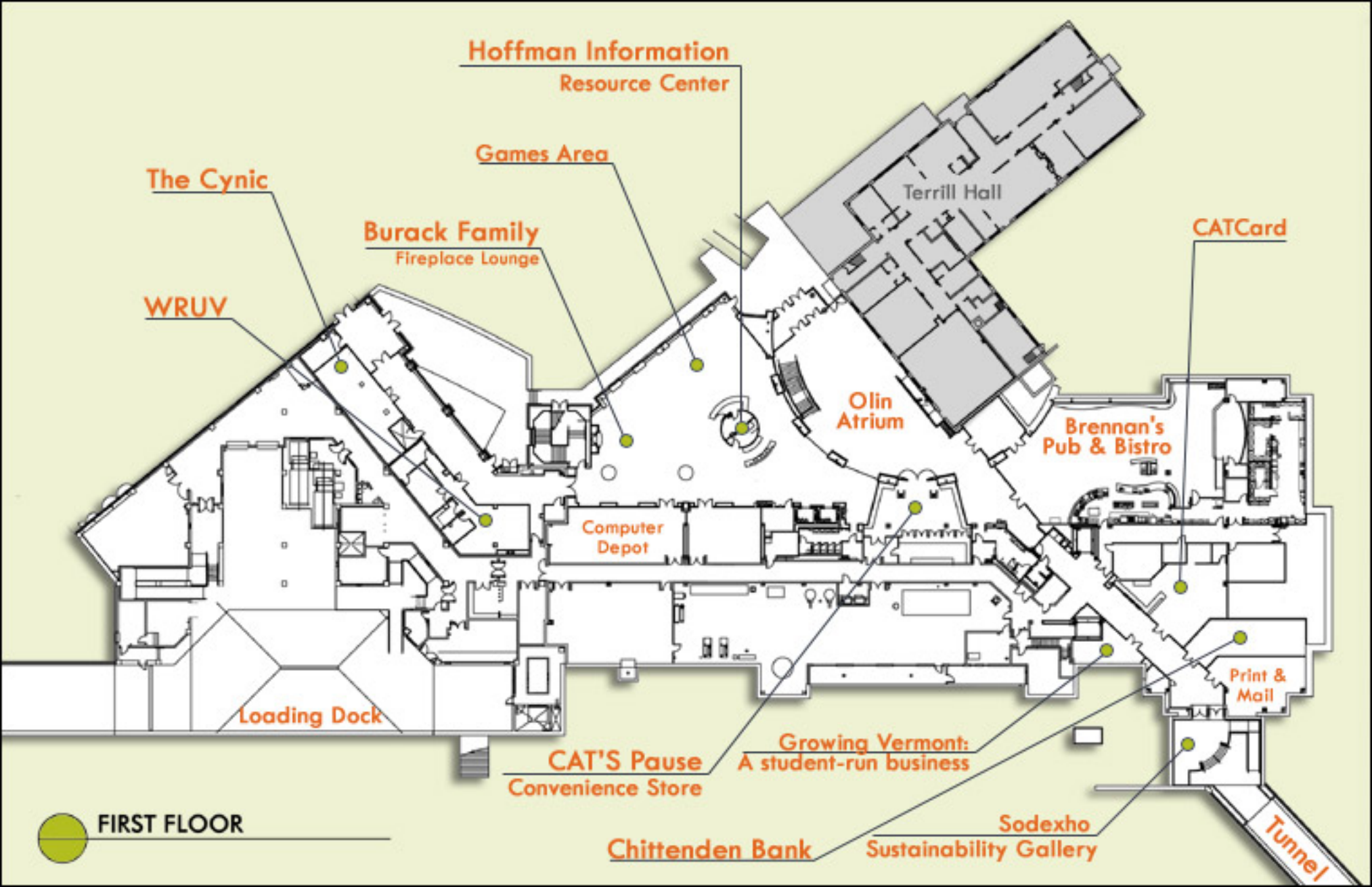
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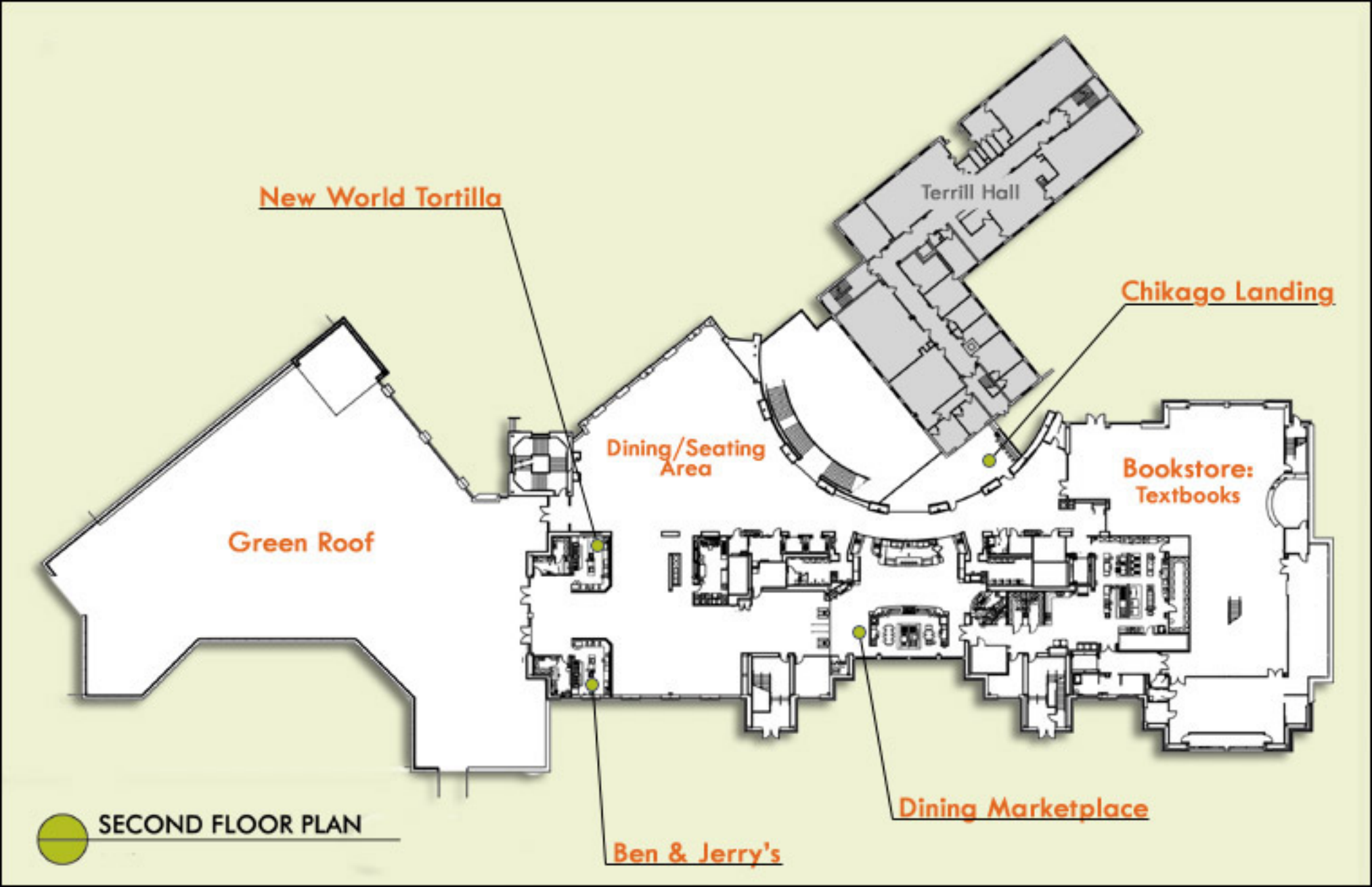
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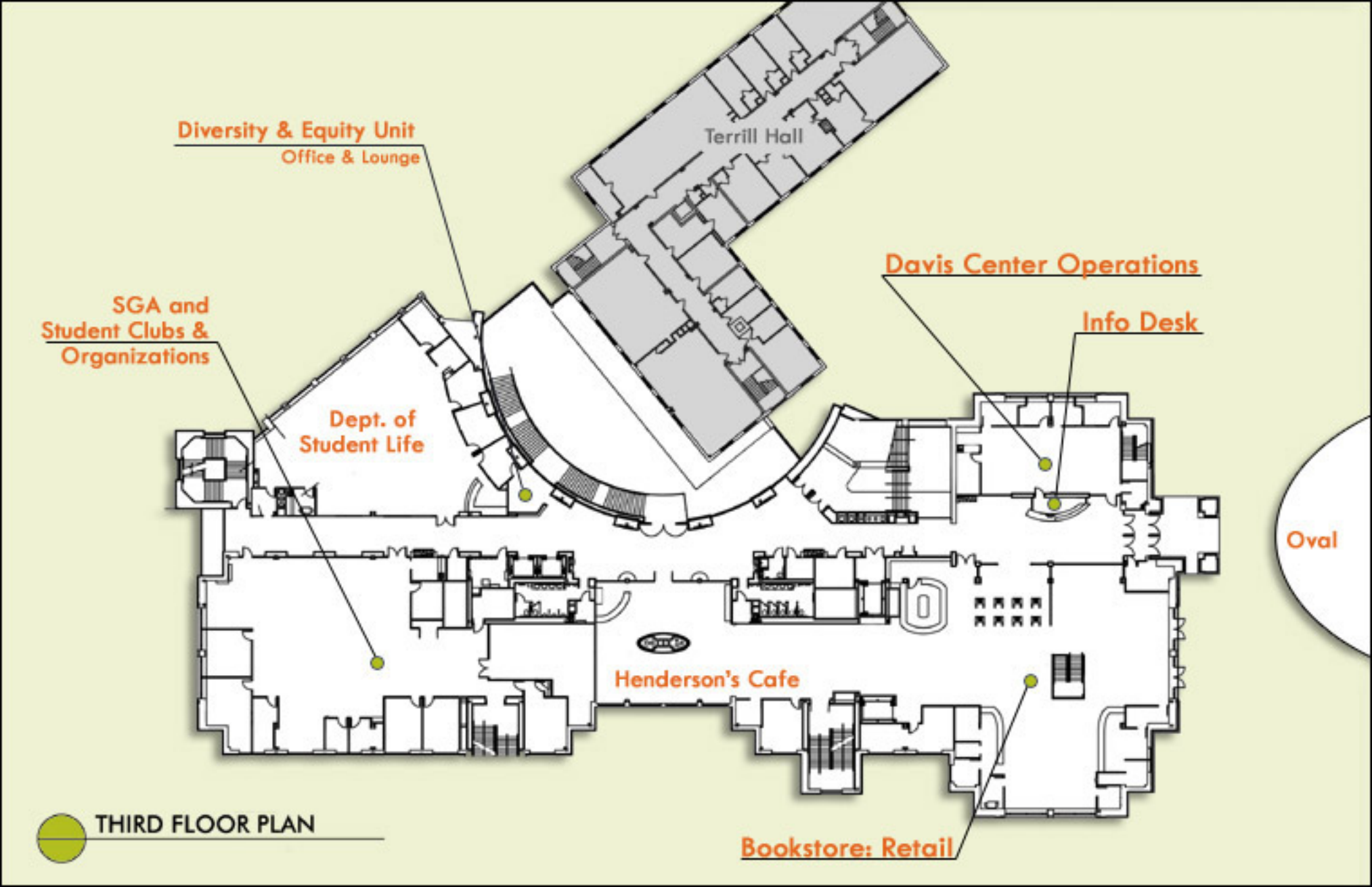
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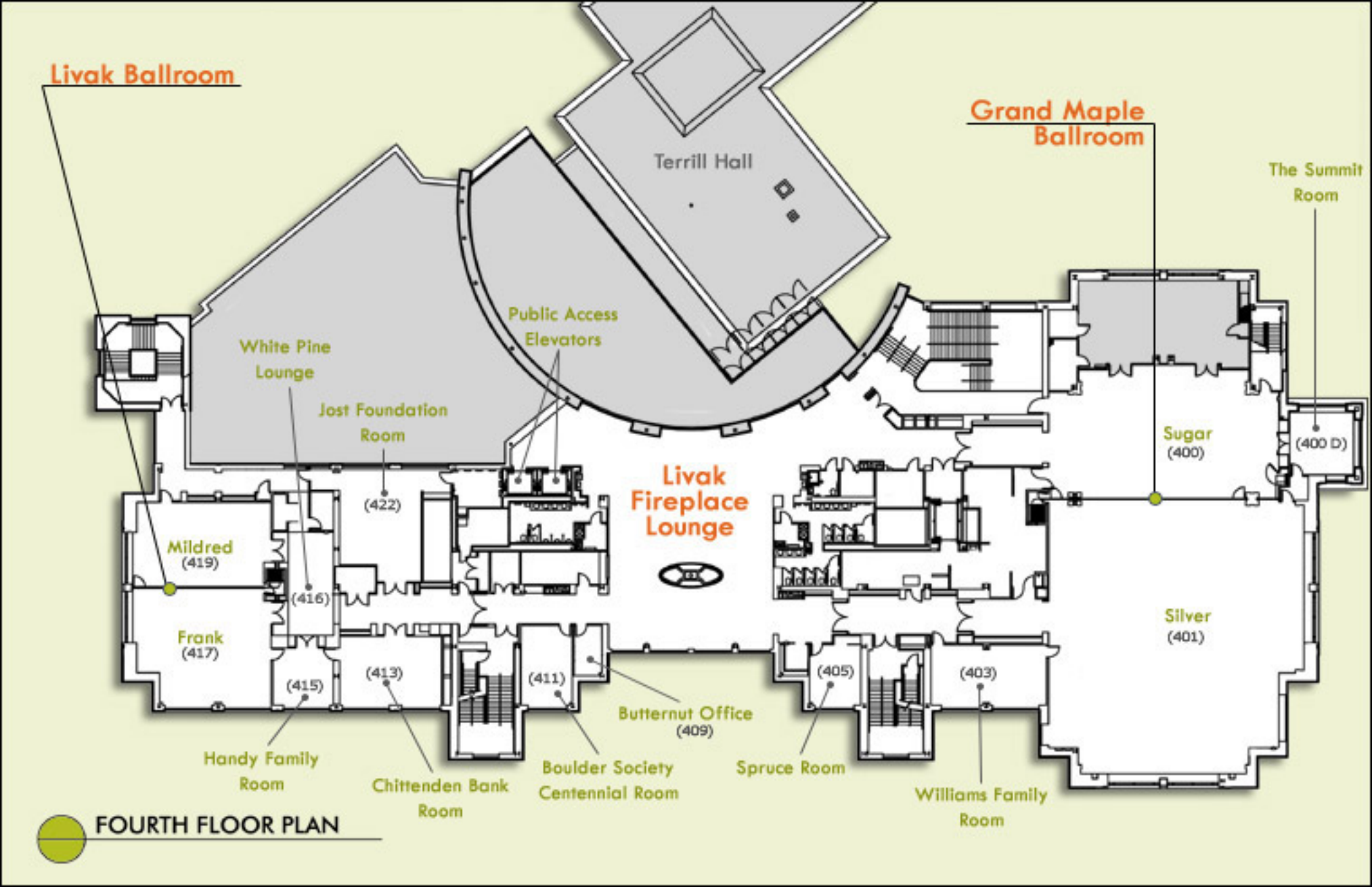
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