Presentation Days 2006

A Celebration of Student Projects

May 1, 2 & 3

Harvey Mudd College
Claremont, California

Presentation Days 2006
A Celebration of Student Projects

Research is an integral part of the education of all students at Harvey Mudd College. The ability to conduct original investigations, to plan an approach to a problem, and to see it through are essential to success in any scholarly endeavor. We set time aside during the spring semester to celebrate the work of Harvey Mudd College students as they present their original projects in design or research. Whether this work is done in the context of the Clinic Program, as an individual research project with a faculty advisor, or as part of a class project, the emphasis is on the students' own achievements. Some of this work has already been published; much more of it will be published in the future.

This year, 275 students are participating in Presentation Days, including more than 100 research talks from students in each of the majors. Students in the Department of Humanities and Social Sciences are displaying their black and white photographs and playing new works created for the Harvey Mudd College American Gamelan, while students in the Computer Science Department will be presenting computer animation projects and demonstrating computer games built as software engineering projects. The results of the Introduction to Engineering Design projects, involving 21 teams of first-year and sophomore students, will also be presented.

The keynote speaker for Presentation Days 2006 is Sally Blower, Ph.D., Department of Biomathematics and UCLA AIDS Institute, David Geffen School of Medicine, University of California Los Angeles, Monday, May 1, at 4:00 P.M. in Galileo Hall.

For more information, please contact the Office of the Dean of the Faculty, Harvey Mudd College, at (909) 621-8122.

The Presentation Days Committee consists of William Alves, Robert Cave, Eric Ditwiler, Ann Esin, Esther Hughes, Catherine McFadden, Elizabeth Orwin '95, Sally Rich Arroyo and Christopher Stone, and is chaired by Andrew Bernoff.

Presentation Days 2006 Schedule

Monday, May 1

■ **9:00 A.M. Research Presentations Begin**

All Day Chemistry Poster Session—Galileo Hall Foyer

All Day Humanities and Social Sciences Poster Session—Galileo Hall Foyer

	Biology Beckman 126	Chemistry Galileo-McAlister	Computer Science Galileo-Pryne	Mathematics Beckman 126	Physics Galileo-Edwards
9:00 A.M.		Chem 168: Special			A. Fischer
9:15 A.M.	N. Bennardo	Topics in Physical			S. Moyerman
9:30 A.M.	M. Leeds	Chemistry			J. Pugh
9:45 A.M.	A. Voorhees				D. Strenge
10:00 A.M.		Reception, Chemistry and Physics Departments—Galileo Hall Foyer			
10:15 A.M.					
10:30 A.M.		Chem 112: Mock	F. Briggs	S. Stump	K. Hainline
10:45 A.M.		Coroner's Inquest	D. Turner		L. Corrales
11:00 A.M.			C. Erickson	J. Gjorgjieva	A. Sederberg
11:15 A.M.			F. Briggs		K. Shakespear
11:30 A.M.				J. Majkut	
11:45 A.M.					
12:00 NOON	Lunch Break				

■ **1:00 P.M. Research Presentations Begin**

	Chemistry Galileo-Pryne	Engineering Galileo-McAlister	Humanities and Social Sciences Galileo-McAlister	Mathematics Beckman B126	Physics Galileo-Edwards
1:00 P.M.	C. Kalcic	Remote-controlled Launcher Team		J. Hearn	J. Leonard
1:15 P.M.	K. Gray	Wireless Sensor Network Team			P. Arpin
1:30 P.M.	R. Harris	Closed-Space Environment Team		T. Brand	S. Feldman
1:45 P.M.	M. Yarnall	Quadruped Robot Team			W. Gannett
2:00 P.M.					
2:15 P.M.	A. Rusmevichientong	S. Thomson		K. Maples	
2:30 P.M.	S. Rodenburg	L. Fullerton, R. Chambers			
2:45 P.M.	A. Tan	Small Molecule Diffusion Team	Hum2: Building	T. Seacrest	
3:00 P.M.	P. Dossa	L. Wray	Community		
3:15 P.M.	B. Lyon-Roberts				
3:30 P.M.		All Campus Reception—Galileo Hall Foyer			
3:45 P.M.					

4:00 P.M. Presentation Days Address—Galileo-McAlister
"Predicting the Unpredictable: The Evolution of Drug-resistant HIV in the U.S. and Africa"
Sally Blower, Professor, Department of Biomathematics and UCLA Aids Institute, David Geffen School of Medicine, UCLA

Tuesday, May 2 Projects Day 10:30 A.M.–5:00 P.M.
Please See Projects Day Program for further details or visit http://www.hmc.edu/acad/clinic/.

Presentation Days 2006 Schedule

Wednesday, May 3

■ **9:00 A.M. Research Presentations Begin**

All Day — Humanities and Social Sciences Art Exhibit—Galileo Hall Foyer

	Biology Galileo-Pryne	Chemistry Galileo-Pryne	Engineering Galileo-McAlister	Mathematics Beckman B126	Physics Galileo-Edwards
9:00 A.M.		S. Hummel	E168A: Introduction	A. Eustis	T. McQueen
9:15 A.M.		W. Kurlancheek	to Fiber Optic		M. Driscoll
9:30 A.M.		E. Hart	Communication	T. Powell	C. Parker
9:45 A.M.		S. Edwards	Systems		S. Feldman
10:00 A.M.		Reception, Biology and Mathematics Departments—Galileo Hall Foyer			
10:15 A.M.					
10:30 A.M.	L. Beckman			J. May	O. Semonin
10:45 A.M.	S. Fogarty				A. Bernard
11:00 A.M.	A. Enriquez			N. Rauh	A. Skalenakis
11:15 A.M.	T. Staab				A. Himmel
11:30 A.M.				E. Segarra	
11:45 A.M.					
12:00 NOON	Lunch Break				

■ **1:00 P.M. Research Presentations Begin**

	Computer Science Galileo-McAlister	Computer Science Galileo Foyer	Engineering Galileo-Pryne	Engineering Galileo-Edwards	Mathematics Beckman B126
1:00 P.M.					
1:15 P.M.			E4 Design	E4 Design	
1:30 P.M.			Presentations	Presentations	
1:45 P.M.	CS 157:				ICM Presentation
2:00 P.M.	Computer				MCM Presentation
2:15 P.M.	Animation				D. Gross
2:30 P.M.					
2:45 P.M.		Reception, Computer Science and Engineering Departments—Galileo Hall Foyer			
3:00 P.M.					
3:15 P.M.		CS 121: Software			Mathematics 55:
3:30 P.M.		Development			Discrete
3:45 P.M.					Mathematics
4:00 P.M.					
4:15 P.M.					
4:30 P.M.					
4:45 P.M.					
5:00 P.M.					

7:00 P.M. — Humanities and Social Sciences—Joseph B. Platt Campus Center Living Room
Music 49: American Gamelan

8:30 P.M. — Humanities and Social Sciences—Galileo Hall-McAlister
MS 127s: The Harmony of Sound and Light

Monday, May 1, 2006

9:00 A.M.–12:00 P.M.
■ Research Presentations

All Day **Chemistry Poster Session, please see below**

All Day **Humanities and Social Sciences Poster Session, please see page 6**

9:00 A.M. **Chemistry Presentations, please see page 6**

9:00 A.M. **Physics Presentations, please see page 6**

9:15 A.M. **Biology Presentations, please see page 8**

10:30 A.M. **Mathematics Presentations, please see page 9**

11:00 A.M. **Computer Science Presentations, please see page 9**

Chemistry Poster Session—Galileo Hall Foyer

All Day **Chemistry Research Posters Presented at the American Chemical Society Meeting**

Fang-Yuan Chang: ***Trapping the hOGG1—Nucleosomal DNA Complex***

Human 8-oxoguanine DNA glycosylase (hOGG1) protects the integrity of cellular DNA by excising the damaged base 8-oxoguanine (oxoG) from the DNA. The nature of the transient complex that is formed when hOGG1 binds to nucleosomal DNA is not known. Sodium borohydride trapping was shown to be successful as a method for isolating the covalent imine enzyme-substrate complex. This technique will be used to trap hOGG1 onto nucleosomal DNA containing oxoG and the structure of this trapped complex will be probed by restriction enzyme sensitivity assays.

Faculty Advisor: *Karl A. Haushalter, Chemistry and Biology*

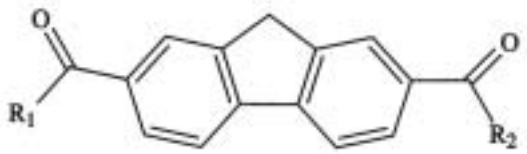
Stephen Edwards: ***One-electron Approximations to Electron Transfer—Implementation and Testing of the KT-GMH Method***

(please see abstract Wednesday, May 3 at 9:45 A.M. on page 18)

Rachel Harris: ***A Library of Mesomorphic Materials for the Systematic Study of Structure and Physical Properties—The Smectogenic 2,7 diacyl fluorenes***

A library of liquid crystalline materials was studied, each with the same fluorene core but with different side chain lengths R_1 and R_2, where $R_1 = CH_3(CH_2)_{n-2}$ and $R_2 = (CH_2)_{m-2}CH_3$, such that each molecule had the same overall molecular length and weight by fixing n+m =18. These different chain lengths lead to a range from completely symmetric to very asymmetric. Asymmetry here is the |n-m| for the chains. Trends due to this asymmetry were found in the mesogenic phases formed, their phase transition temperatures and the enthalpies and entropies of these phase transitions. This library was chosen in particular to have only one variable—that of asymmetry.

Faculty Advisor: *Gerald R. Van Hecke '61, Chemistry*



Elaine Hart: ***Peptide Bridge-mediated Electron Transfer Between DMPD and Pyrene***

(please see abstract Wednesday, May 3 at 9:30 A.M. on page 18)

Chemistry Poster Session Continued

Amanda Hickman: ***Electronic Coupling of Metalloporphyrin Oligomers***

The electronic coupling element (HDA) between metal centers in metalloporphyrin dimers can be determined from the energy, molar absorptivity, and full-width half maximum of the intervalence charge transfer band in the near infrared (NIR). A series of ruthenium(II) porphyrin monomers were synthesized photolytically. Pyrizine-capped octaethylporphyrins and tertraphenylporphyrins exhibited no NIR transitions, whereas pyridine-capped monomers exhibited NIR transitions at approximately 5000 and 7000 cm-1. These observations confirm the hypothesis that both the axial and equatorial substituents have an effect on the electronic properties of the metal.

Faculty Advisor: *Hal Van Ryswyk, Chemistry*

Sara Hummel and Matt Hoss: ***Sequence Specificity of Human 8-oxoguanine DNA Glycosylase***

Reactive oxidative species in cells covalently modify the genome, and this DNA damage is linked to cancer and aging. One lesion, 8-oxoguanine (oxoG), leads to G:C to T:A mutations if left unrepaired. The body prevents this mutation with human 8-oxoguanine glycosylase (hOGG1), an enzyme that excises oxoG from DNA. Recombinant hOGG1 was overexpressed in bacteria and purified using chromatography. The activity of hOGG1 was analyzed by treating synthetic DNA oligomers with the enzyme. The use of multiple DNA oligomers of varying sequence will allow the determination of how sequence context around the oxoG affects the rate of repair by hOGG1.

Faculty Advisor: *Karl A. Haushalter, Chemistry and Biology*

Christine L. Kalcic: ***Excess Thermodynamic Functions of Alkanol + n-alkane Mixtures Using Viscometry and Laser Light Scattering***

The non-idealities of binary liquid mixtures of hexanol and cyclohexanol with octane and nonane were investigated through densitometry, refractive index, viscometry, and Rayleigh light scattering measurements between 15°C and 45°C. Excess volume results are highlighted, and trends with increasing alkane chain length are discussed. Excess Gibbs potential and excess Gibbs potential of activation for viscous flow are compared, while deviations in viscosities are presented and fit with McAllister's 3- and 4-body models. The intermolecular forces between the primary or secondary alkanol and alkanes are analyzed in light of these trends in excess functions.

Faculty Advisor: *Gerald R. Van Hecke '61, Chemistry*

John-Andrew Kouzelos: ***Theoretical Studies of Electron Transfer for a Variety of Metalloporphyrin Systems***

In this research, both Ruthenium and Zinc porphyrin systems were studied using density functional theory, optimized structures and a variety of methods to calculate electronic excitation energies. Methods include the INDO S/CI semi-empirical method, time dependent density functional theory as well CI singles. Using information from these computations, we compare our theoretical spectra to experiment, qualitatively characterize the low-lying electronic states, and use the generalized Mulliken-Hush method to determine electronic coupling elements for various electronic states in these systems.

Faculty Advisor: *Robert J. Cave, Chemistry*

Westin Kurlancheek: ***Theoretical Investigation of Through-bond, Through-space and Hydrogen-bond Mediated Electronic Coupling Using*** **Ab initio** ***Methods***

(please see abstract Wednesday, May 3 at 9:15 AM. on page 18)

Humanities and Social Sciences Poster Session—Galileo Hall Foyer

All Day **Political Science 179 Poster Session**

Kevin Byram, Daria Draganova, Jennifer Du Mond, Julian Evans, Maxsim Gibiansky, Karl Janich, Joshua Kao, Krystle McBride, Steven Ning, Bart Oegema, Matthew Reed, Christopher Roberts, Marielle Wardell, Noel Godinez

politicAL INNOVATION

Under what conditions do novel political ideas become realities? In this poster session, 14 students in Political Innovation will provide summaries of their research on the origins and impacts of political innovations large and small—from the Paris Commune to tradeable pollution permits, customer-oriented strategies in government agencies, nonprofit organizations serving inner city youth, protest tactics of the Civil Rights Movement, and many more.

Course Instructor: *Paul Steinberg, Humanities and Social Sciences*

Chemistry—Galileo Hall-McAlister

9:00 A.M. **Chemistry 168: Special Topics in Physical Chemistry**

Chemistry 168 has focused on the study of bioinorganic chemistry. The diversity of metals in biology have been examined, along with the principles underlying their use and the methods used to study them. Examples of two fundamental bioinorganic systems, cytochrome c oxidase and the oxygen evolving complex of photosystem II, will be presented and discussed.

Course Instructor: *J. Christopher Thomas, Chemistry*

10:00 A.M. **Reception, Chemistry and Physics Departments—Galileo Hall Foyer**

10:30 A.M. **Chemistry 112: Mock Coroner's Inquest**

Students in Chemistry 112 (Instrumental Methods Laboratory) will present their findings regarding the physical evidence gathered in a fictional investigation into the untimely death of Alexander George, HMC '06. A list of the physical evidence and crime scene photos are available at http://www4.hmc.edu/chemistry/112/CSI. Members of the community are invited to participate as the jury in this mock coroner's inquest.

Course Instructor: *Hal Van Ryswyk, Chemistry*

Physics—Galileo Hall-Edwards

9:00 A.M. **Andrew Fischer:** ***Properties of the Particulate Photon***

I demonstrate an effective technique of producing single photons at high count rates. I explore the use of this technique in an undergraduate laboratory, testing fundamental predictions of quantum mechanics. In an investigation of $g^{(2)}$, the second order coherence function for our system, I find a violation of classical predictions by more than 700 standard errors and support our findings with a control experiment.

Faculty Advisor: *Richard C. Haskell, Physics*

9:15 A.M. **Stephanie Moyerman:** ***Effect of Grain Size on Exchange Anisotropy in Spin Valves***

I have investigated the mechanism of weak exchange bias for a spin valve with threshold layer AFM thickness using Giant Magnetoresistance and Polarized Neutron Reflectometry. Results show that the sample exhibits instantaneous switching of the free layer followed by a gradual reorientation of the magnetization in the pinned ferromagnetic layer via domain wall formation. During subsequent field cycles, I found that relaxation in the pinned FM layer is induced not only by an increasing field, but also in a static field over a relatively long time scale.

Faculty Advisor: *James C. Eckert, Physics*

Physics Presentations Continued

9:30 A.M. **Jacob McCormmach Pugh:** ***Numerical Simulation of Domain Relaxation in Langmuir Films***

Langmuir layers are flat, effectively two-dimensional fluid layers resting on the surface of a subfluid. When stretched into a non-circular shape, the domain relaxes back to the minimum-energy circular configuration over a time-scale of several seconds. This relaxation is driven forward by the Langmuir layer's line tension (the two-dimensional analog of surface tension) and slowed by the viscosity of the subfluid. We numerically simulate the dynamics of the relaxation process using a boundary integral formulation of the equations of motion. We are able to determine the line tension of a Langmuir layer by fitting the numerical results to empirical data. We discover that the methods which had previously been used to estimate the line tension in Langmuir layers were incorrect by roughly 10 percent. We determine the line tension of a Langmuir layer of *8CB* polymer to be (88 $\pm$ 12) pN; this precision is limited only by the spatial resolution of the available empirical data.

Faculty Advisor: *Andrew J. Bernoff, Mathematics*

9:45 A.M. **Daniel Strenge:** ***Studies of Frog Embryonic Development Using a 1300 nm Optical Coherence Microscope (OCM)***

I imaged the early development of the frog *Xenopus laevis*, a popular model for vertebrate development, using two Harvey Mudd College OCM instruments operating at 850 nm and 1300 nm respectively. I found 35 percent greater depth penetration at 1300 nm than at 850 nm. The increased depth penetration at 1300 nm allowed me to image the blastocoel floor throughout gastrulation. By observing the blastocoel floor, I found evidence in support of vegetal rotation as the initiator of mesendodermal migration. I also inverted the microscope head to image from below the frog embryo and observed bottle cells and the formation and closure of the blastopore.

Faculty Advisor: *Richard C. Haskell, Physics*

10:00 A.M. **Reception, Chemistry and Physics Departments—Galileo Hall Foyer**

10:30 A.M. **Kevin Hainline:** ***Photometric Studies of the Young Clusters Berkeley 87 and NGC 3532***

This work presents optical observations of two young open clusters Berkeley 87 and NGC 3532. Berkeley 87 was observed at Table Mountain Observatory during the Summer of 2004. From the color-magnitude diagram, I determined the distance to the cluster to be 1400 $\pm$ 200 parsecs and constrained its age to 1.2 $\pm$ 0.4 million years. Using our optical data together with the infrared observations from the public 2MASS survey allowed me to determine possible T-Tauri candidates in the cluster. I also analyzed the data for NGC 3532, taken at Cerro Tololo Observatory. Twelve sets of observations, spaced over the three-month period, allowed me to search for periodic variability in the cluster stars in order to determine stellar rotational periods.

Faculty Advisor: *Ann Esin, Physics*

10:45 A.M. **Lia Corrales:** ***Modeling the Rotational History of Young Stars***

Recent observations of young stars have revealed two different distributions for their rotational periods. The periods of stars with masses above 0.25 solar cluster around two and eight days, while lower mass stars do not show an eight-day peak. It has been proposed that the rotation of a star during its formation is governed by the interaction between the star and its accretion disk. When the accretion disk is present, the stellar magnetic field couples the star to the inner edge of the disk, forcing the star to rotate relatively slowly. At later stages, when the disk dissipates, the star spins up due to radial contraction. I investigate the dependence of the rotational period evolution on stellar mass using a Monte Carlo model which incorporates the accepted mass-radius-age relationships for young stars and compare my results to the observed period distribution of 1 million-year-old stars in nearby clusters.

Faculty Advisor: *Ann Esin, Physics*

Physics Presentations Continued

11:00 A.M. **Audrey Sederberg:** ***Interpreting Non-Commutative Open String Theory through Gravitational Holography***

In certain settings of string theory—where the effects of quantum gravity become important—time and space coordinates do not commute, just as position and momentum do not commute in quantum mechanics. Through a toy system within string theory, that of non-commutative open strings, I investigate various aspects of this system using gravitational holography. In particular, I compute the number of degrees of freedom of the non-commutative theory as a function of energy scale.

Faculty Advisor: *Vatche V. Sahakian, Physics*

11:15 A.M. **Karen Shakespear:** ***Interactive Physical Model of the Sine-Gordon Equation***

I have built a museum-style interactive exhibit of a physical system of connected pendulums which gives rise to the Sine-Gordon Equation. Though it arises from relatively simple physical considerations, the Sine-Gordon Model displays many of the hallmarks of a scalar field theory, such as perturbative particles, solitons and anti-solitons, and a bound state known as the "breather." The Sine-Gordon Model is used in many branches of applied physics. As a museum exhibit, this system can be approached successfully from many different levels of scientific sophistication.

Faculty Advisors: *Vatche V. Sahakian and James C. Eckert, Physics*

Biology—Beckman 126

9:15 A.M. **Nicole Bennardo:** ***Characterization of Dynein 2 Light Intermediate Chain (D2LIC) in*** **Tetrahymena thermophila**

Dynein 2 light intermediate chain (D2LIC) is thought to be required for retrograde intraflagellar transport (IFT), the process by which cilia and flagella are established and maintained. To test this hypothesis, I have overexpressed D2LIC in order to interfere with D2LIC binding. I have created several constructs which overexpress varying segments of D2LIC. I have also created two transformed cell lines with these constructs: one overexpresses full length D2LIC, and the other overexpresses the N-terminal half of D2LIC. The transformed cells have reduced ciliary activity, indicating that D2LIC may in fact bind dynein to its IFT cargo.

Faculty Advisor: *David Asai, Biology*

9:30 A.M. **Marguerite Leeds:** ***Modeling, Microscopy and Molecular Biology to Illuminate the Function of a Protein Domain in*** **Arabidopsis thaliana**

The START domain, a putative lipid/sterol binding domain, is predicted to allow biological feedback in protein signaling in the root of the *Arabidopsis* plant. To better understand this possibility, computational models of several possibilities of feedback were created. Protein concentrations were then quantified using Confocal Scanning Laser Microscopy and compared with numerical outputs of model simulations.

Faculty Advisor: *Kathrin Schrick, Keck Graduate Institute of Applied Life Sciences*

9:45 A.M. **Andrew Voorhees:** ***The Evaluation and Redesign of a Bioreactor System to Impart Simulated Intraocular Pressure on Corneal Tissue Engineered Constructs***

Work has been conducted to evaluate the use of a bioreactor system that imparts simulated intraocular pressure on human corneal fibroblasts grown on two-dimensional and three-dimensional cell culture constructs. This evaluation has revealed problems concerning the design and use of the bioreactor. A design for a next-generation bioreactor which addresses these concerns will be presented.

Faculty Advisors: *Elizabeth Orwin '95, Engineering and Biology, and Marta Bechtel, Biology*

10:00 A.M. **Reception, Chemistry and Physics Departments—Galileo Hall Foyer**

Mathematics—Beckman 126

10:30 A.M. **Simon Maccracken Stump:** ***Catastrophes, PDEs and the Grass Paradox***

I studied the behavior of diffusive Lotka-Volterra systems in environments with spatially varying carrying capacities. In particular, I used numeric and analytic techniques to study two similar models for population growth, in order to determine their qualitative differences. Additionally, I investigated competition models in the presence of periodic disasters, in order to determine what factors affect competitive dominance. My goal was a better understanding of the processes of succession and competition in ecological habitats.

Faculty Advisor: *Jon Jacobsen, Mathematics*

11:00 A.M. **Julijana Gjorgjieva:** ***Turing Pattern Dynamics for Spatiotemporal Models with Growth and Curvature***

I considered spatiotemporal patterns, in particular Turing patterns, for reaction-diffusion systems on growing surfaces with curvature. Isotropic growth of the sphere is considered, where growth of the domain occurs in the same proportion in all directions. Performing a modified linear stability analysis and a separation of time scales argument, I derived the necessary and sufficient conditions for diffusion-driven instability of the steady state and for the emergence of spatial patterns. Finally, I explored these results with the help of numerical simulations. Turing theory plays an important role in real biological pattern formation problems, such as solid tumor growth and animal coat patterns, to which these results can be applied.

Faculty Advisor: *Jon Jacobsen, Mathematics*

11:30 A.M. **Joseph Majkut:** ***Foraging Fruit Flies—Lagrangian and Eulerian Descriptions of Insect Swarming***

In this work, I sought to model swarms of fruit flies, *drosophila melanogaster*, whose flights are characterized by straight flight segments interrupted by rapid turns called saccades. These flights are reminiscent of Levy-distributed random walks which are known to lead to efficient search behavior. I built two types of models for swarms of foraging fruit flies, whose behavior depends on swarm density and chemoattractant concentration, using rules inspired by experimentally observed flight patterns. First, I will present a Lagrangian model where the path of each individual fly is tracked. I will also consider an Eulerian model where the fly density evolves as a function of time and space.

Faculty Advisor: *Andrew J. Bernoff, Mathematics*

Computer Science—Galileo Hall-Pryne

10:30 A.M. **Forrest S. Briggs:** ***Migration in Evolutionary Algorithms***

Evolutionary algorithms are biologically inspired optimization algorithms that employ natural selection. In a multi-island evolutionary algorithm, organisms on one island evolve mostly in isolation, but periodically migrate between islands. My research explores the effects of non-constant migration intervals on the convergence rate and population diversity of multi-island evolutionary algorithms.

Faculty Advisor: *Geoffrey H. Kuenning, Computer Science*

10:45 A.M. **Daniel J. Turner:** ***Experiments in Proportional-Share Disk Scheduling***

Hard drives in modern computers represent a shared scarce resource. As a result, it is critical to allocate hard-drive usage in a fair and proportional manner. I will present my results from experiments with an algorithm developed by Matt Ferlo ’03 and Michael Vrable ’04, and discuss their implications.

Faculty Advisor: *Geoffrey H. Kuenning, Computer Science*

11:00 A.M. **Christopher L. Erickson:** ***Garbage Collection for Trailer Arrays***

For some data structures, such as trailer arrays, traditional garbage collection techniques fail. I examined the source of this problem and will present an algorithm that succeeds where traditional techniques do not.

Faculty Advisor: *Melissa E. O’Neill, Computer Science*

Computer Science Presentations Continued

11:15 A.M. **Forrest S. Briggs:** ***Functional Genetic Programming***

A variety of factors influence the success or failure of genetic programming. In this research, I examined the impact of types, library size, and mode of expression on genetic programming. I will show how a point-free style allows theorem-proving techniques to produce an initial population of well-typed programs, and how such techniques provide natural mutation and cross-over operations.

Faculty Advisor: *Melissa E. O'Neill, Computer Science*

12:00 NOON
■ Lunch Break

1:00 P.M.–5:00 P.M.
■ Research Presentations

1:00 P.M. **Chemistry Presentations, please see below**

1:00 P.M. **Engineering Presentations, please see page 12**

1:00 P.M. **Mathematics Presentations, please see page 14**

1:00 P.M. **Physics Presentations, please see page 15**

2:45 P.M. **Humanities and Social Sciences Presentations, please see page 15**

4:00 P.M. **Presentation Days 2006 Keynote Address, please see page 16**

Chemistry—Galileo Hall-Pryne

1:00 P.M. **Christine Kalcic:** ***Adventures in Excess—Excess Thermodynamic Functions of Binary Alkanol + n-alkane Mixtures***

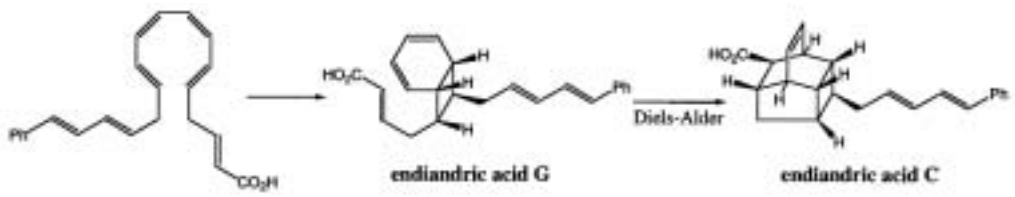
The non-idealities of alkanol + n-alkane mixtures were investigated through densitometry, refractometry, laser light scattering, and viscometry. Excess volumes (V^E), excess Gibbs potentials (G^E), and viscosity deviations (dh) are reported at temperatures ranging from 288 K to 318 K. Systematic trends were identified as a function of alkane chain length, as well as temperature and composition. An explanation for these trends in excess properties is proposed, with a focus on their intermolecular origins.

Faculty Advisor: *Gerald R. Van Hecke '61, Chemistry*

1:15 P.M. **Kaitlyn Gray:** ***A Concise, Biomimetic Route to Natural and Unnatural Endiandric Acids***

The endiandric acids are a class of secondary metabolites isolated from the Australian plant *Endiandra introrsa* (Lauraceae). These cyclic polyketides are of chemical interest due to their novel molecular architecture and their structural interrelationships. I propose a biomimetic synthesis of these compounds through nonenzymatic electrocyclizations of an acyclic polyene precursor. Presented here is the progress I have made toward a concise and convergent synthesis of the acyclic polyene precursor. The synthesis is highlighted by palladium-catalyzed cross-coupling and a Horner-Wadsworth-Emmons reaction.

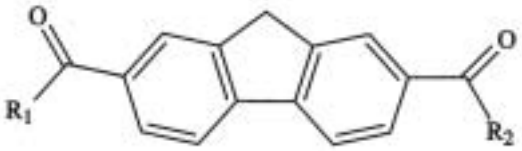
Faculty Advisor: *David A. Vosburg, Chemistry*



Chemistry Presentations Continued

1:30 P.M. **Rachel Harris:** ***A Library of Mesomorphic Materials for the Systematic Study of Structure and Physical Properties—The Smectogenic 2,7 Diacyl Fluorenes***

A library of liquid crystalline materials was studied, each with the same molecular center but with different side chain lengths R_1 and R_2, such that each molecule had the same overall molecular length and weight. These different chain lengths lead to a range from completely symmetric to very asymmetric compounds. Trends due to this asymmetry were found in the liquid crystalline phases formed, phase transition temperatures, and the enthalpies and entropies of these phase transitions. This library was chosen in particular to have a variety of compounds with only one variable—that of asymmetry. I have eliminated other variables present in previous studies of binary mixtures.



Faculty Advisor: *Gerald R. Van Hecke '61, Chemistry*

1:45 P.M. **Megan Yarnall:** ***Chitosan Network Formation Using a Biocompatible Crosslinking Reagent***

Chitosan, the N-deacetylated form of chitin, has many interesting biomedical properties including biocompatibility and bioadhesivity and has been used in a number of biomedical applications. The free amino groups of chitosan make it soluble in dilute acidic solutions and provide active sites for various chemical reactions. Chitosan was functionalized with the natural amino acid cysteine to form a cross-linked network of chitosan polymers via cysteine-cysteine disulfide bonds. These networks were analyzed using NMR and FTIR techniques. The formation of this hydrogel should increase the durability and decrease the solubility of chitosan-based biomedical devices.

Faculty Advisor: *Shenda M. Baker, Chemistry*

2:00 P.M. **Break**

2:15 P.M. **Alice Rusmevichientong:** ***Synthesis and Characterization of Arginine-functionalized Chitosan***

Chitosan, a functional biopolymer derived from the deacetylation of chitin, exhibits interesting biological properties such as biocompatibility and antimicrobial activity. However, its activity is limited by its low solubility at neutral pH. I believe that the functionalization of chitosan with amino acids will increase the cationic character of the polymer by increasing the number of total protonable amine groups, thus enhancing its antimicrobial activity and solubility. The goal of this research is to synthesize and characterize a derivative of chitosan conjugated with arginine.

Faculty Advisor: *Shenda M. Baker, Chemistry*

2:30 P.M. **Sarah Rodenburg: In vitro** ***Protein Expression of Co-cultured Rabbit Stromal Corneal Cells in the Presence of Endothelial Cells for the Construction of a Tissue-Engineered Cornea***

Quiescent keratocytes are the cellular component of normal rabbit corneal stroma but injury induces keratocyte differentiation into the myofibroblast phenotype, resulting in increased α-smooth muscle actin (α-SMA) expression and loss of corneal transparency. Corneal endothelial cells are known to release a variety of cytokines with potential to induce protein expression consistent with the normal keratocyte phenotype. Employing co-culture with endothelial cells, I show that myofibroblasts can be induced to re-differentiate into keratocytes as determined by changes in α-SMA protein expression using western blot and immunofluorescence analysis.

Faculty Advisors: *Marta K. Bechtel, Biology and Elizabeth J. Orwin '95, Engineering and Biology*

Chemistry Presentations Continued

2:45 P.M. **Annie Tan:** ***Effect of Modified Media on the Expression of α-SMA and ALDH3A1 in Human Corneal Stromal Cells***

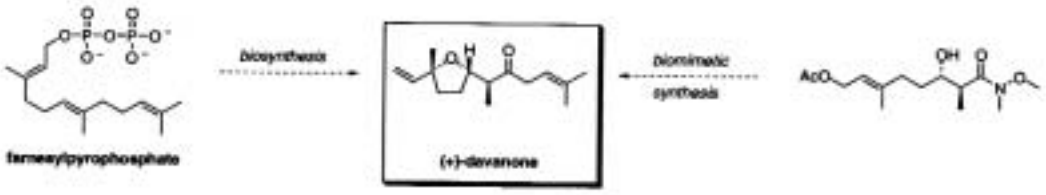
Human corneal stroma contains keratocytes that differentiate into myofibroblasts upon tissue injury, resulting in decreased ALDH3A1 expression, increased α-SMA expression, and loss of corneal transparency. TGF-β can induce α-SMA expression, and serum-free media can restore a dendritic appearance in cells, but the pattern of ALDH3A1 and α-SMA co-expression with these modified medias is unknown. Recent work indicates that TGF-β down-regulates ALDH3A1 while it upregulates α-SMA, and serum-free media upregulates ALDH3A1 while modulating α-SMA expression in a time-dependent manner.

Faculty Advisors: *Marta K. Bechtel, Biology and Elizabeth J. Orwin '95, Engineering and Biology*

3:00 P.M. **Paul Dossa:** ***A Biomimetic Route to the Natural Product (+)−Davanone***

The natural product (+)−davanone is the primary component of davana oil, which is found in the south Indian plant *Artemesia pallens* and is purchased for its fruity fragrance. It has antifungal and spasmolytic properties which can be used for medicinal purposes. (+)−Davanone is a sesquiterpene with three stereocenters and a *cis*-disubstituted tetrahydrofuran ring. The key step of my synthetic strategy is a biomimetic cyclization with a palladium catalyst. My proposed enantioselective route is to be more efficient and more general than previous (lengthy or non-selective) syntheses of davanone.

Faculty Advisor: *David A. Vosburg, Chemistry*



3:15 P.M. **Brianna Lyon-Roberts:** ***Core Histone Recombination and Nucleosome Reconstitution for hOGG1 Assays***

In eukaryotic cells, DNA is wrapped around core histones to form nucleosomes, the core components of chromosomes. hOGG1 is an enzyme which excises oxidized guanine bases. Enzyme activity assays are used to determine how efficiently such enzymes function. My thesis focused on producing recombinant core histones and reconstituting nucleosomes to perform the assay under more natural conditions and thus acquire more physiologically applicable results.

Faculty Advisor: *Karl A. Haushalter, Chemistry and Biology*

Engineering—Galileo Hall-McAlister

1:00 P.M. **Zack Rubin, Scott Kimbrell, Anu Kohli, Eduardo Herrera, Karl Janich:** ***Quadruped Robot with Sensor System***

Remote-controlled pigeon launchers can cost upward of $600, which is 10 times the cost of a manually controlled launcher. It is significantly cheaper, in fact, to modify a manually controlled launcher to be operated by remote control. This presentation will describe how a remote-controlled pigeon launcher was designed and delivered for a fraction of the cost of buying a new remote-controlled launcher.

Faculty Advisors: *Carl J. Baumgaertner and Clive L. Dym, Engineering*

1:15 P.M. **Michael Saldana, Ted Jiang, Chris Woodruff:** ***Wireless Sensor Networks to Assist Drivers in Crowded Parking Lots***

One of the most frustrating things about driving in a busy parking lot is the tedious search for a parking space. Our project goal was to design a wireless solution that will be applicable and deployable at Harvey Mudd College and also scalable to accommodate larger parking structures. In the past year, we have designed the hardware for the wireless sensor 'motes' as well as the software governing mote operation and network architecture.

Faculty Advisor: *Sarah L. Harris, Engineering*

Engineering Presentations Continued

1:30 P.M. **Julien Bost, Hugues Bouvier, Sébastien Ronsse:** ***Closed-Space Environment Exploration Using Reinforcement Learning***

The goal of this research project was to demonstrate the efficiency of reinforcement learning for exploring closed-space non-Markovian environments using a robot navigation system. Genetic algorithms were used in simulation to choose the best actions at given states and this policy was then implemented into a robot and honed using reinforcement learning.

Faculty Advisor: *Sarah L. Harris, Engineering*

1:45 P.M. **Mark Brenneman, Amanda Rainer:** ***Quadruped Robot with Sensor System***

Quadruped locomotion has been studied with the Joinmax Robot Dog. Using three degrees of motion in each leg, a statically stable walking pattern has been established. Additionally, a sensor system with range-sensing has been developed to aid in the autonomous movement of the dog, to help in avoiding obstacles, and to have the dog heel at one's side.

Faculty Advisor: *Sarah L. Harris, Engineering*

2:00 P.M. **Break**

2:15 P.M. **Sarah Thomson:** ***Development of Helix Structures in Tendril-Bearing Plants***

I have studied the structural changes that take place as plant tendrils coil while attached to a support. The process of the development of a helix from an initially straight tendril must be a combination of growth and deformation of tissues. I have modeled the tendril structure using the finite element code ANSYS; with appropriate loads, material properties and boundary conditions, the model qualitatively reproduces the geometry of the actual tendrils.

Faculty Advisor: *Lori C. Bassman, Engineering*

2:30 P.M. **Laurel Fullerton, Rob Chambers:** ***Testing, Modeling, and Refinement of an Electronic Speckle Pattern Interferometer***

Over the past three years HMC students have collaborated with Los Alamos National Laboratory to develop and characterize a novel electronic speckle pattern interferometer (ESPI) that can measure 3-D deformations with a sensitivity approaching 10nm. The system has been developed with the goal of studying mesoscale deformations in polycrystalline surfaces. Recently we have investigated the effects of camera focus on data collection and phase unwrapping on data analysis.

Faculty Advisor: *Lori C. Bassman, Engineering*

2:45 P.M. **Steve Santana, Benson Tsai, Kai Mayeda, Karen Brown:** ***Investigation into Small-Molecule Diffusion in Nanoscale Systems***

Polymer membranes are used commonly in industry and research as a method of gas separation. Some applications include the separation of air into pure oxygen and the removal of high order hydrocarbons from emissions. The purpose of this research is to explore the permeability of polymer films as the volume fraction of added impermeable particles is changed. The Maxwell model correctly predicts that the permeability of polymer films generally decrease as impermeable spheres are added. However nanoparticles, rather than filling in existing cavities, instead increase the volume available for gas transport by interfering with the polymer's chain packing. By altering the nanoparticle size, it may be possible to tune the polymer so as only to permit passage of certain gas molecules through the membrane. The focus of the research is to investigate the nanoparticle diameter needed to increase this available volume. Additional research will explore the affects of further shrinking the nanoparticle diameter in order to tune the polymer to favor one type of gas permeation over another. This will be done by testing polymer

Steve Santana, Benson Tsai, Kai Mayeda, Karen Brown continued to next page

films in the gas cell that has been designed and constructed by the team. The team will observe this phenomenon by measuring the transport of gases across the membrane in the gas cell. This semester's and future research aims to determine the permeability of polymers as a function of the impermeable sphere size. The exploration will yield knowledge that allows for the fine tuning of membrane properties so that they could be manufactured for various industrial applications.

Faculty Advisor: *Nancy K. Lape, Engineering*

3:00 P.M. **Lindsay S. Wray:** ***Designing a Tissue Engineered Corneal Model***

I have developed a model growth system for culture of corneal cells on a collagen matrix, which can be used to study wound-healing mechanisms in the cornea. With this system, I can monitor the impact of growth factors, extracellular matrix interactions, and mechanical signals on cells in an environment which mimics that of the natural cornea. In addition, I have developed a method for optimizing corneal cellular growth by electrospinning an oriented collagen matrix.

Faculty Advisor: *Elizabeth J. Orwin '95, Engineering and Biology*

Mathematics—Beckman 126

1:00 P.M. **John Hearn:** ***Kolmogorov Complexity and Graphs***

Kolmogorov Complexity is the theory that the complexity of a string of symbols, say over the set {0,1}, can be measured by its compressibility. Effectively, the complexity of a string is the length of the shortest binary encoded algorithm able to completely reproduce it. My thesis explores ways that this complexity measure can be used to prove various properties of graphs.

Faculty Advisor: *Ran Libeskind-Hadas, Computer Science*

1:30 P.M. **Tristan Brand:** ***A Fast Fourier Transform for the Symmetric Group***

A discrete Fourier transform, or a DFT, is an isomorphism from a group algebra to a direct sum of matrix rings. An algorithm that efficiently applies a DFT is called a fast Fourier transform or FFT. In this talk, the concept of a DFT will be introduced, along with some of its basic applications. Then a specific FFT for the symmetric group will be examined and its running time analyzed.

Faculty Advisor: *Michael Orrison, Mathematics*

2:00 P.M. **Break**

2:15 P.M. **Kenneth Maples:** ***Optimal Control of a Building During an Earthquake***

Earthquakes are a serious problem for structural engineers around the world, destroying the lives, occupations and property of countless people. This thesis presents a technique for alleviating the effect of an earthquake on a multistory building using an active controller. The controller is determined to optimally satisfy certain system constraints. Generalizations to different buildings and control configurations are presented, as well as further results.

Faculty Advisor: *Weiqing Gu, Mathematics*

2:45 P.M. **Tyler Seacrest:** ***Applications of Linear Algebra and Lie Groups to Image Processing***

I explored several interesting applications of linear algebra, Lie groups and Lie algebras to image processing. I employed covariance matrices to determine the best axes to use when representing an image, both in pixel space and color space. I examined the implications of the Perron-Frobenius theorem in modeling color variety. Finally, I used parameter subgroups of certain Lie groups to identify invariants in color image processing.

Faculty Advisor: *Weiqing Gu, Mathematics*

Physics—Galileo Hall-Edwards

1:00 P.M. **Jason Leonard:** ***Experimental Measurement of Thermoelectric Power***

Thermoelectric power is a voltage gradient across a material induced by a thermal gradient. Measurement of Thermoelectric power provides insight into the underlying transport properties of a material. Experimental design and control of thermoelectric power measurement apparatus will be discussed. Thermoelectric power data of several cerium based compounds will be presented. These compounds commonly exhibit unusual properties due to the presence of a valance f-shell electron. The structurally equivalent, f-electron free, lanthanum analogues of these compounds are also examined to isolate the effect of the f-shell electron.

Faculty Advisors: *Patricia D. Sparks, James C. Eckert and Chih-Yung Chen, Physics*

1:15 P.M. **Paul Arpin:** ***An Experimental Study of Non-Equilibrium Electron Distributions and Ultrafast Scattering Dynamics in Gold***

Using a pump-probe geometry, time resolved data for the second-harmonic generated at the surface of a thin gold film has been obtained. The second-harmonic generation is used to study the equilibration and thermalization of the photoexcited electron distribution. An ultrafast laser with a 50 fs pulsewidth was used to resolve the picosecond thermalization process. The experimental results were compared with a numerical model developed by previous students.

Faculty Advisor: *Thomas D. Donnelly, Physics*

1:30 P.M. **S. Henry Feldman:** ***Second Harmonic Generation as a Probe of Electron Dynamics on a Femtosecond Timescale***

In equilibrium, electrons in a metal will have energies described by a Fermi-Dirac distribution at the well defined temperature of the surroundings. When this system is excited by an ultrafast laser pulse, the resulting distribution is nonthermal. The distribution subsequently thermalizes through elastic scattering back to a Fermi-Dirac distribution, on a timescale of a few hundred femto-seconds, and then relaxes back to the equilibrium temperature through electron-phonon scatterings on a timescale of picoseconds. This work details improvements made to the experimental procedure in hope of obtaining results which better conform to a numerical simulation which modeled these dynamics.

Faculty Advisor: *Thomas D. Donnelly, Physics*

1:45 P.M. **Will Gannett:** ***Effect of Grain Size on Exchange Anisotropy in Spin Valves***

Spin valves, thin layered magnetic structures, are commonly used as magnetic sensors in electronic devices. I have extended work done by Stephanie Moyerman '06 and others on spin valve structures by examining two sets of spin valve samples that differ only in the grain size of the sputtered layers. This has allowed us to examine the effect of grain size on the magnetoresistive properties of the spin valves.

Faculty Advisor: *James C. Eckert, Physics*

2:00 P.M. **Break**

Humanities and Social Sciences—Galileo Hall-Edwards

2:45 P.M. **Humanities 2: Student Perspectives on the Value of Service-Learning**

Leah Anderson, Claire O'Hanlon, Autumn Petros-Good, Adrian Sampson, Lolly Simoni

Students in the Hum2 Building Community course each completed a substantial service-learning project. These projects included rebuilding homes in the Gulf Coast, building a church in a small Mexican village, tutoring children in Pomona, and working collaboratively with Pilgrim Place residents. By serving our community, we learned firsthand how communities are built and the rewards and challenges of being an active agent in the process. This presentation will highlight the ways in which the service component of this course amplified our classroom learning.

Course Instructor: *Debra Mashek, Humanities and Social Sciences*

3:30 P.M. All Campus Reception—Galileo Hall Foyer

4:00 P.M.

■ **Presentation Days Address**

Galileo-McAlister

Introduction: Daniel L. Goroff, Vice President for Academic Affairs and Dean of the Faculty

Keynote Speaker: Sally Blower, Professor, Department of Biomathematics and UCLA AIDS Institute, David Geffen School of Medicine, University of California Los Angeles

"Predicting the Unpredictable: The Evolution of Drug-resistant HIV in the U.S. and Africa"

The U.S. Government has pledged to spend $15 billion in Africa and the Caribbean on AIDS prevention and care. A central focus of this plan is to provide antiretroviral treatment to millions of HIV-infected individuals. A major concern that has been raised regarding the plan to rollout antiretroviral therapies (ART) in Africa is that it may potentially generate an epidemic of drug-resistant strains of HIV. Here we review what has occurred as a result of high levels of use of these therapies in the United States in terms of (i) changes in risky behavior, and (ii) the emergence and transmission of drug-resistant HIV. We discuss how we have used mathematical models as health policy tools both (i) for understanding the dynamics and (ii) for predicting the likely evolutionary trajectories of drug-resistant HIV epidemics. We then show how the theoretical models can be used to predict the likely impact of the antiretroviral rollout on the evolution of the epidemic of drug resistant HIV-1 in Africa. At currently planned levels of treatment coverage, we predict that over the next decade in Africa: (i) the impact of ART on reducing HIV transmission (and prevalence) is likely to be undetectable (unless accompanied by substantial changes in behavior), (ii) the transmission rate of drug-resistant HIV will be below the surveillance threshold of 5% set by the World Health Organization, and (ii) the majority of cases of drug-resistant HIV that will occur will be the result of acquired resistance rather than transmitted resistance. We conclude that (for the next decade) large-scale surveillance for detecting and monitoring drug-resistant HIV in Africa will be unnecessary. Instead, we recommend that (i) acquired resistance in treated individuals should be monitored, and (iii) that sentinel surveillance (in a few urban centers) should be used to monitor transmitted resistance. We also make specific predictions for the evolution of transmitted resistance in Botswana, and we determine when the WHO threshold will be exceeded in this country. We show that the WHO threshold will be exceeded in Botswana if drug-resistant strains evolve that are as fit/transmissible as the drug-sensitive strains; under these conditions, transmitted resistance in Botswana will rise to ~10% by 2009. Finally we discuss how operations research techniques can be used to determine equitable and ethical strategies for the distribution of antiretrovirals in Africa.

Sally Blower, Ph.D., a professor of biomathematics at the University of California at Los Angeles, is a mathematical and evolutionary biologist whose research focuses on developing models of transmission dynamics. She uses these models as health policy tools: to design epidemic control strategies for a variety of infectious diseases, to understand and predict the emergence of antibiotic and antiviral drug resistance, and to develop vaccination strategies. The main focus of her research is to develop the study of infectious diseases into a predictive science. Recently, her work has focused on HIV, tuberculosis and genital herpes. She has also pioneered the application of innovative uncertainty and sensitivity techniques (based upon Monte Carlo methods and Latin Hypercube Sampling) to the analysis of transmission models. These techniques enable transmission models to be used to predict the future with a degree of uncertainty and to identify which parameters are critical in determining which future outcome will actually occur.

Dr. Blower is a member of the Advisory Board for the Program in Infectious Disease & Social Change at Harvard Medical School. She is active on many editorial/advisory boards, including the Journal of Molecular Epidemiology & Evolutionary Genetics, and has served as a consultant to the CDC, WHO, RAND, EPA, Burroughs Wellcome, Glaxo Smith Kline, Aventis Pasteur, the Frankel Group, the Global HIV Prevention Working Group and the International Partnership for Microbicides. Dr. Blower recently served as a member of the IOM Committee on Examining the Probable Consequences of Alternative Patterns of Widespread Antiretroviral Drug Use in Resource-Constrained Settings and contributed to the publication of Scaling Up Treatment for the Global AIDS Pandemic: Challenges and Opportunities, an IOM 2004 Report. Dr. Blower and her lab members also act as consultants regarding infectious disease modeling for TV/film crews. They most recently shared their expertise on tuberculosis epidemic modeling for Arcwelder Films' production of the miniseries "Microkillers" for National Geographic and helped with the art direction and influenza epidemic modeling for CBS crime investigation drama, "NUMB3RS."

Tuesday, May 2, 2006

PROJECTS DAY

HMC Computer Science, Engineering, Mathematics and Physics Clinics

Please see Projects Day Program for further details or visit http://www.hmc.edu/acad/clinic/

10:30 A.M.

- **Registration and Poster Sessions**
  Ronald and Maxine Linde Activities Center

1:00 P.M.

- **General Session:**
  Galileo-McAlister
  Welcome: President Jon C. Strauss
  Remarks: Patrick Little, Director, Engineering Clinic
  Milestone Awards: Daniel L. Goroff, Vice President for Academic Affairs and Dean of the Faculty

1:30 P.M.-5:00 P.M.

- **Clinic Presentations:**
  Classrooms, Galileo Halls and Labs

Wednesday, May 3, 2005

9:00 A.M.–12:00 P.M.

- **Research Presentations**

All Day **Humanities and Social Sciences Photography Exhibit, please see below**

9:00 A.M. **Chemistry Presentations, please see below**

9:00 A.M. **Engineering Presentations, please page 18**

9:00 A.M. **Mathematics Presentations, please see page 19**

9:30 A.M. **Physics Presentations, please see page 20**

10:30 A.M. **Biology Presentations, please see page 22**

Humanities and Social Sciences Art Exhibit—Galileo Hall Foyer

All Day **Art 50: Beginning Black and White Photography—Final Art Show**

Sarah Mei Estrada, Anu Kohli, Westin Kurlancheek, David Mar, Peter Mawhorter, Vanessa McClure, Adam Skalenkis, Josh Slater, Mutiara Sondjaja

Each student will present a poster presentation of his/her portfolio.

Course Instructor: *Phil Marquez, Humanities and Social Sciences*

Chemistry—Galileo Hall-Pryne

9:00 A.M. **Sarah Hummel:** ***Sequence Specificity of Human 8-oxoguanine DNA glycosylase***

Reactive oxidative species in cells covalently modify the genome and this DNA damage is linked to cancer and aging. One lesion, 8-oxoguanine (oxoG), leads to G:C to T:A mutations if left unrepaired. The body prevents this mutation with human 8-oxoguanine glycosylase (hOGG1), an enzyme that excises oxoG from DNA. Recombinant hOGG1 was overexpressed in bacteria and purified using chromatography. The activity of hOGG1 was analyzed by treating synthetic DNA oligomers with the enzyme. The use of multiple DNA oligomers of varying sequence will allow the determination of how sequence context around the oxoG affects the rate of repair by hOGG1.

Faculty Advisor: *Karl A. Haushalter, Chemistry and Biology*

Chemistry Presentations Continued

9:15 A.M. **Westin Kurlancheek:** ***Theoretical Investigation of Through-bond, Through-space and Hydrogen-bond Mediated Electronic Coupling Using* Ab initio *Methods***

The Pathways Model has been used to investigate electron tunneling in a wide variety of biological or biologically-related systems. In order to investigate the underlying assumptions of this theory, model systems were formulated and the electronic coupling constant was calculated using self-consistent field and correlated wavefunctions. Further investigations probed donor/acceptor energetic effects as a function of bridge orientation. Qualitative models were developed in order to explain the orientation dependence of the electronic coupling constant in hydrogen-bond and through-space mediated systems.

Faculty Advisor: *Robert J. Cave, Chemistry*

9:30 A.M. **Elaine K. Hart:** ***Peptide Bridge-Mediated Electron Transfer Between DMPD and Pyrene-Sulfonyl***

Recent experimental studies on photoinitiated electron transfer in systems of the form DMPD-AAn-Pyr (AA=alanine, glycine, or proline, DMPD = dimethyl-1,4-benzenediamine, Pyr = pyrene-sulfonyl, n < 4) suggest significant dependence of electron transfer rates on the nature of the amino acid linker connecting the donor and acceptor. I will present the results of theoretical studies of the electronic coupling element for electron transfer based on INDO S/CI wavefunctions. I investigated the coupling elements for forward and reverse electron transfer as a function of n and AA, as well as the variation of the coupling with geometry.

Faculty Advisor: *Robert J. Cave, Chemistry*

9:45 A.M. **Stephen Edwards:** ***One-electron Approximations to Electron Transfer—Implementation and Testing of the KT-GMH method***

The Generalized Mulliken-Hush (GMH) approach has proven to be a robust method for calculating the electronic coupling element for electron transfer and has been applied to a wide variety of systems of interest to experimentalists. In its many-electron form, GMH requires results from correlated electronic structure methods as input, and this limits the size of the system to which GMH can be applied; correlated methods scale poorly with system size. We present results here from a one-electron version of the GMH method, based on use of Hartree-Fock orbitals (KT-GMH) as a one-electron basis, obtaining effective one-electron approximations to electronic coupling elements. Results are compared with many-electron results for model systems and the new methods are applied to donor-bridge-acceptor systems that have been studied experimentally.

Faculty Advisor: *Robert J. Cave, Chemistry*

Engineering—Galileo Hall-McAlister

E168A: An Introduction to Fiber Optic Communication Systems
Course Instructor: *Qimin Yang, Engineering*

9:00 A.M. **Chris Acon, Karen Shi, Jessica Riley:** ***Optical MEMS for Optical Switching***

Microelectromechanical systems (MEMS) are microscopic mechanical devices fabricated from semiconductors using photolithographic techniques. MEMS are used in optical switches by redirecting optical rays via a matrix of micro-mirrors. They are currently used in computer networking and projection systems, and are expected to replace optical-electrical-optical switches.

9:15 A.M. **Jim Castelaz, Laura Moyer:** ***Unique Mode Guiding via Photonic Crystal Fibers***

Photonic Crystal Fibers (PCFs) use defects in 2-D nanoscale air/glass patterns to guide light along a fiber. This technique allows for mode guiding with unique and useful properties such as large mode areas or high-bandwidth zero dispersion. Other novel applications of PCF's include polarization-based manipulation and sensor applications.

Engineering Presentations Continued

9:30 A.M. **Cassie Chou, Wayne Tanaka, Keane Kaneakua Kawaipunahele:** ***Creating a Wavelength Converter for a Fiber-optics Communication Using SOA***

Semiconductor Optical Amplifiers (SOAs) provide different functionalities due to their broad gain bandwidth and subnanosecond response time. In this project, we will create a wavelength converter that couples an existing signal onto a new wavelength using the non-linear gain saturation properties of SOAs.

9:45 A.M. **Karl Janich, Michael Pugh:** ***Arrayed Waveguide Gratings for WDM Applications***

Wavelength-Division Multiplexing (WDM) technologies allow the transmission of multiple signals through a single optical fiber. Arrayed Waveguide Gratings (AWG's) are planar lightwave circuits commonly used to perform the multiplexing and demultiplexing of separate wavelength channels in WDM systems. In this presentation, the workings of AWG's are explored and recent research into increasing the capabilities of AWG's is considered.

10:00 A.M. **Reception, Biology and Mathematics Departments—Galileo Hall Foyer**

10:30 A.M. **Dane Lindblad:** ***3-D Holographic Data Storage***

CDs, DVDs, and other methods of two-dimensional optical data storage utilize only 0.01% of the volume of the disk. For over thirty years, scientists have been trying to perfect three-dimensional (holographic) data storage. This presentation will focus on the methods of holographic data storage that companies are currently developing.

10:45 A.M. **Justin Kim:** ***Photonic Crystal Fibers for Sensor Applications***

Photonic crystal fibers (PCF) stand as an emerging technology for the fiber-optics industry. Combining fiber optics theory with unique geometry in design, the PCF can be altered to efficiently take on a multitude of tasks including various sensor applications. Specifically, PCF can be implemented in a myriad of ways to sense anything from biological species, minerals, to trace amounts of gases.

Mathematics—Beckman 126

9:00 A.M. **Alex Eustis:** ***Continued Fraction Tilings—Regs and Negs***

Continued fractions may be represented combinatorially, using square-and-domino tilings, as well as algebraically. My research has been focused on finding combinatorial interpretations for new kinds of continued fractions, particularly the *negative* continued fractions which we introduce. These results shed light on the theory of negative continued fractions, and enable us to find new combinatorial proofs of continued fraction identities.

Faculty Advisor: *Arthur T. Benjamin, Mathematics*

9:30 A.M. **Tracy Powell:** ***The Eigenvalues of the Symmetrized Exponentiated Adjacency Matrices of Broom-Tree Graphs***

A collection of web pages about a given topic is a directed graph whose nodes are web pages and whose edges are hyperlinks. A certain symmetric matrix derived from the adjacency matrix of the graph is used in a variant of the Internet search algorithm HITS. The leading eigenvalue of this matrix is simple. However, numerical experiments suggest that as the number of nodes in a particular family of so-called "broom-tree" graphs increases, the second and first eigenvalues of the matrix become close together. Among other results, we show that in fact the ratio of the second to first eigenvalues is bounded by a constant that is less than one. This guarantees that the modified HITS algorithm returns a unique ordering of the web pages, and gives a lower bound on the speed of convergence of the algorithm.

Faculty Advisor: *Lesley A. Ward, Mathematics*

10:00 A.M. **Reception, Biology and Mathematics Departments—Galileo Hall Foyer**

Mathematics Presentations Continued

10:30 A.M. **Jessica May:** ***Matrix Representations of the Alexander Polynomial of a Link***

In the 1960s, a French mathematician, George de Rham, proved that representations of the fundamental group of knots into 2x2 complex upper right triangular matrices with determinant one are determined exactly by the roots of the Alexander polynomial. I have extended this result to demonstrate that representations of the fundamental group of links are determined by the roots of the multivariable Alexander polynomial.

Faculty Advisor: *Jim Hoste, Mathematics, Pitzer College*

11:00 A.M. **Nick Rauh:** ***Explorations in Subtropical Algebra***

With the growing number of applications of tropical algebra to the study of biology and various fields of mathematics, my thesis turns its attention to the more degenerate structure that Francis Su and I fondly call "subtropical algebra." I will present a variety of tools I have developed in exploring subtropical objects, including the mathematical and philosophical ambiguities of building a coherent subtropical geometry, and a few pretty results concerning lattice maps and induced topologies on subtropical space.

Faculty Advisor: *Francis E. Su, Mathematics*

11:30 A.M. **Elan Segarra:** ***An Exploration of Riemann's Zeta Function and His Corresponding Hypothesis***

Identified as one of the 7 Millennium Problems, the Riemann Zeta Hypothesis has successfully evaded mathematicians for over 100 years. Simply stated, Riemann conjectured that all of the nontrivial zeroes of his zeta function have real part equal to $1/2$. In this presentation, I will provide an overview of the problem and show how a diverse set of mathematical disciplines has come together to help crack it.

Faculty Advisor: *Darryl H. Yong '96, Mathematics*

Physics—Galileo Hall-Edwards

9:00 A.M. **Travis McQueen:** ***Experimental Confirmation of the Quantum Nature of Light***

A candidate single photon light source was constructed utilizing the phenomenon of spontaneous parametric down-conversion (SPDC) in a β-barium borate (BBO) crystal. Experimental measurement of the degree of second order coherence yielded a raw $g^{(2)}(0) = 0.011 \pm 0.003$, indicating the source emits single photons in direct contradiction of classical theory. A series of control experiments were performed that provide confirmation of the validity of the technique for measuring $g^{(2)}(0)$.

Faculty Advisor: *Richard C. Haskell, Physics*

9:15 A.M. **Meghan Driscoll:** ***The Magneto-Optical Kerr Effect***

The magneto-optical Kerr effect is the rotation in polarization that occurs when polarized light is reflected off of a magnetized material. We use this effect to measure the hysteresis loops of thin film samples by applying a sweeping magnetic field to the sample and then measuring the rotation in polarization of a laser beam that is reflected off the sample. MOKE hysteresis loops of spin-valve structures were compared to results from vibrating sample magnetometry. By adding time resolution to our experimental set-up, we will be able to study the fundamental time scale of magnetization changes in coupled ferromagnetic-antiferromagnetic thin-film samples.

Faculty Advisor: *Peter N. Saeta, Physics*

9:30 A.M. **Colin Parker:** ***Time-Resolved MOKE Measurements of Spin-valve Structures***

An open question in the theory of magnetism is how the kinetic energy of the electrons couples to the spin degrees of freedom. The magneto-optical Kerr effect (MOKE) is an optical technique for measuring the magnetization in thin-film structures. Using femtosecond pulses from a Ti:sapphire laser, I was able to measure the magnetization dynamics on very short time scales. By using two pulses with a variable temporal delay, I can measure the time scale on which optically deposited energy is coupled into spins in the form of reduced magnetization.

Faculty Advisor: *Peter N. Saeta, Physics*

Physics Presentations Continued

9:45 A.M. **Stephanie Feldman:** ***Fundamental Principles of OCM and Applications to* Xenopus laevis *Embryonic Development***

Two motion-sensitive optical coherence microscopes (OCMs), operating at 850 and 1300 nm, were used to image frog embryonic development and to extract tissue optical properties. In order to interpret my images rigorously, I also performed calibration studies with various concentrations of polystyrene nanospheres executing Brownian motion in water. I then applied our OCM motion sensitivity capabilities to detecting possible Brownian motion of organelles within living embryonic cells. Finally, we created 3-D time-lapse movies of frog neurulation, real-time and in-vivo.

Faculty Advisor: *Richard C. Haskell, Physics*

10:00 A.M. **Reception, Biology and Mathematics Departments—Galileo Hall Foyer**

10:30 A.M. **Octavi Semonin:** ***Generation of a Submicron Aerosol Produced Through Ultrasonic Atomization***

High frequency piezoelectric transducers have been used for decades to produce liquid droplet aerosols in a variety of applications. A well-defined fluid dynamic theory exists, predicting the droplet radius produced based on the fluid's properties and the driving frequency of the piezotransducer. In my research, I have extended both the range of droplet sizes produced, and tested this fluid dynamical theory. One important application of this research is to produce an improved deuterium target for laser fusion by reducing the droplet radius to the order of 0.1 microns, which I will test this coming summer at the University of Texas at Austin.

Faculty Advisor: *Thomas D. Donnelly, Physics*

10:45 A.M. **Aaron Bernard:** ***Motion Sensitivity in Optical Coherence Microscopy (OCM)***

The Harvey Mudd College 1300 nm OCM measures velocities of scatterers through changes in phase of the interferometer fringe signal. I have focused on improving instrument phase precision. Through MATLAB simulation, an expected phase noise ($\Delta\phi_{RMS}$) is compared to potential noise sources of galvo fluctuations, electronics, and the phase relation between fringe signal digitization and piezo-phase modulation of the interferometer. In the process of improving precision, I have discovered a powerful technique for distinguishing true diffusive motion from phase noise.

Faculty Advisor: *Richard C. Haskell, Physics*

11:00 A.M. **Adam Skalenakis:** ***Estimation of Geological Uplift Rates in the San Gabriel Mountains Using GPS Geodetic Measurements***

Bounded by four fault zones, the San Gabriel Mountains are one of the fastest rising mountain ranges in the world. GPS geodetic measurements conducted since 1994 at sites throughout the San Gabriel Mountains have marked each site at specific three-dimensional coordinates with uncertainties of a few millimeters. Previous studies have measured horizontal movements on the order of tens of millimeters per year. This study is the first to detect vertical uplift rates greater than two sigma above zero. This data allows for new models of fault activity in the San Gabriels and can be compared against geological inferences of the rate of mountain uplift.

Faculty Advisor: *Gregory A. Lyzenga '75, Physics*

11:15 A.M. **Alexander I. Himmel:** ***A New Search for the Higgs Particle at Low Mass***

Numerical simulations of Higgs production at low Higgs mass (below 135 GeV) in the Compact Muon Solenoid experiment are performed in preparation for the upcoming Large Hadron Collider run at CERN. Studies are performed of the associated production of the Higgs particle with a top-antitop quark pair, a channel plagued by high background. A new analysis method is examined which improves the signal-to-noise ratio in this challenging channel: less processed hadronic data is used in conjunction with neural network techniques. Thus, the data itself guides the analysis, rather than assumptions about the data.

Faculty Advisor: *Richard C. Haskell, Physics*

Biology—Galileo Hall-Pryne

10:30 A.M **Libby Beckman:** ***The Hard Stuff of Soft Corals—Determining the Phylogenetic Significance of Sclerite Form in*** **Sinularia**

Sclerites are small structural components of calcium carbonate embedded in the tissue of soft corals. They are often used for taxonomic identification, but it is unclear how they reflect evolutionary relationships among soft corals. Within the genus *Sinularia*, two different surface sclerite forms are observed: *leptoclados* and *nonleptoclados* clubs. This distinction may indicate an evolutionary divergence among species within the genus. To investigate this hypothesis, I sequenced MSH, a mitochondrial gene, and constructed a phylogenetic tree based on sequence similarity to see if the *leptoclados* species formed a branch independent of the rest of the genus.

Faculty Advisor: *Catherine S. McFadden, Biology*

10:45 A.M **Sean Fogarty:** ***Linking Visibility and Patrol Behavior in Territorial Male Eastern Collared Lizards,*** **Crotaphytus collari**

Animals that hold breeding territories should patrol in a way that affords them better views of their territories, enabling them to monitor potential mates and respond to the advances of rivals. Thus, male Eastern Collared Lizards should increase their territorial visibility by selecting particular movement patterns, favoring certain areas or time budgeting. I use network analysis and optimization techniques to investigate these patterns in territorial data I collected this summer. The evidence suggests that although the male lizards' movements appear random, they tend to concentrate their effort in better than average areas, and linger in higher visibility areas once found.

Faculty Advisor: *Susan E. Martonosi, Mathematics*

11:00 A.M **Alejandro Enriquez:** ***Comparative Energetics of Bipedal and Quadrupedal Locomotion in*** **Dipsosaurus dorsalis**

Why do Desert Iguanas sometimes run on only their hind limbs? I measured the metabolic energy of *Dipsosaurus dorsalis* lizards while they ran on a treadmill. I then statistically compared the metabolic rates between the trials when the lizards ran bipedally and when they ran quadrupedally. The results of this analysis indicate whether one form of running is more energetically expensive than the other. The relative costs of different forms of running may explain why animals use multiple, distinct types of locomotion for different situations.

Faculty Advisor: *Anna N. Ahn, Biology*

11:15 A.M **Trisha Staab: In vivo** ***Activity of the Femorotibialis Muscle During Two-legged and Four-legged Running in the Desert Iguana*** **Dipsosaurus dorsalis**

Muscle function changes depending on environment and behavior. During high speed locomotion, desert iguanas, which generally locomote quadrupedally, occasionally rise up on their hind limbs and run bipedally. The activity of the hind limb muscles involved in locomotion will likely change from quadrupedal to bipedal running. In the current study, I investigate *in vivo* muscle activation and muscle length changes of the femorotibialis muscle in *Dipsosaurus dorsalis* lizards during high speed quadrupedal and bipedal running. By understanding how muscle activity changes, we can better understand how animals generate different modes of locomotion.

Faculty Advisor: *Anna N. Ahn, Biology*

12:00 NOON

■ **Lunch Break**

1:15 P.M.–10:00 P.M.
■ Research Presentations

1:15 P.M. **Engineering 4: Introduction to Engineering Design Presentations, please see below**

1:45 P.M. **Computer Science Presentations, please see page 25**

1:45 P.M. **Mathematics Presentations, please see page 25**

7:00 P.M. **Humanities and Social Sciences Presentations, please see page 26**

Engineering—Galileo Hall-Edwards and Galileo Hall-Pryne

Engineering 4: Introduction to Engineering Design

1:15 P.M.
Galileo-Pryne

New Design for Student Desks
Client: Teach for America
Liaisons: Steve Santana, Chris Kaleel and Lewis Leiboh
Faculty Advisors: *Clive Dym, Nancy Lape, Erik Spjut, Ruye Wang*

Initial Problem Statement: Schools across the country typically have one of two standard designs for desks. One desk design has minimal storage space, typically a basket, and includes an attached chair; the other design features a large desktop and storage space, either immediately below the desktop or to the side of the desk; this design is typically bulky and does not have an attached chair. It is commonplace for teachers to constantly change the desk configuration in the classroom to facilitate working in groups or facing the front to hear a lecture. Both designs present problems as neither function well in the group configuration. Additionally, attached-chair design is often difficult for larger students to use and the bulky design is cumbersome to move. Teach for America requests a new desk design that is easy to move, useable by students of all sizes, workable in a group configuration and that includes storage space.

1:15 P.M.. **Team A:** Michael Braly, Whitney Hsiong, Daniel Nishball, Vicky Wu
1:30 P.M.. **Team B:** Natalie Durgin, Philip Liao, Rachel Nishimura, Graham Orr
1:45 P.M. **Team C:** J.J. Boyles, Jane Chen, Steve Huntzicker, Andy Wong
2:00 P.M. **Team D:** Tim Fielder, Matt Garber, Arjun Kalyanpur, Kevin Samrick

1:30 P.M.
Galileo-Edwards

Collapsible Staging System for HMC Dorm Parties
Client: HMC Social Committee
Liaison: Gordon Hoople and Laura Moyer
Faculty Advisors: *Clive Dym, Nancy Lape, Erik Spjut, Ruye Wang*

Initial Problem Statement: Many of the parties thrown at Harvey Mudd College include some kind of entertainment, be it a DJ or a live band. Usually, the entertainment is in the middle of the party, up on a raised platform. Currently six wooden stages are used for this purpose. The drawback to this system is that the stages are large and there is nowhere to store them. They are also heavy and awkward to move because they cannot be taken apart. The HMC Social Committee would like a new set of stages that could be taken apart between uses for storage and that are also sturdy enough to support a DJ or a band. The total area of the stage should be variable to accommodate use in different dorms and settings.

1:30 P.M.. **Team A:** Lauren Allen, Michael Martin, Autumn Petros-Good, Nathan Roones
1:45 P.M.. **Team B:** Lauryn Baranowski, Joshua Peraza, Christine McGrinn, Andrew Hunter
2:00 P.M.. **Team C:** Trevor McQueen, Rebecca Noyes, Max Myers, Sam Gordon
2:15 P.M.. **Team D:** Jon Lake, Daniel Rodriguez, Ibrahim Shaikh, David Stachnik

Engineering 4 Presentations Continued

2:15 P.M. Galileo-Pryne

Classroom Media Center
Client: Teach for America
Liaison: Steve Santana, Chris Kaleel and Lewis Leiboh
Faculty Advisors: *Nancy Lape, Ruye Wang*

Initial Problem Statement: Computer usage in elementary school classrooms is continually becoming more widespread. Many school districts see the incorporation of computer-based learning as essential to the education process. While this presents few problems to schools that are able to afford newer, smaller computers and the larger facilities that are required to store such hardware, schools in economically-disadvantaged areas typically have bulkier computers and limited space. In order to remedy this situation, Teach for America desires a design for a computer workstation which would be included in a typical classroom. This workstation must be easy to maintain, usable by young students, compact, and allow for groups of approximately five students to work at a time.

2:15 P.M. **Team A:** Chelsea Hodge, Rachael Martin, David Su, Diana Vargas

2:45 P.M. **Reception, Computer Science and Engineering Departments—Galileo Foyer**

3:00 P.M. Galileo-Pryne

Crowd Control System for HMC Dorm Parties
Client: HMC Social Committee
Liaison: Zachary Lupei and Laura Moyer
Faculty Advisors: *Clive Dym, Nancy Lape, Erik Spjut, Ruye Wang*

Initial Problem Statement: Every semester there are around 10 large parties thrown by Harvey Mudd College dorms. These parties have attendance in the range of 500–600 people. The requirements to get into the party are either a 5-C ID or a 5-C host. In order to maintain control over this attendance requirement, a single entrance and exit for the party is necessary with guards checking each person who enters. The current system to contain the party in such a manner is difficult to set up and adjust. This project is focused on creating a new crowd control system for parties thrown at Harvey Mudd College. The system must work for all eight dorms on campus, should be easy to move, should be easy to assemble and disassemble, and should be sturdy enough to keep people out of the party.

3:00 P.M. **Team A:** Kevin Festini, Ryan Quarfoth, Tim Sweda, Brad Witkowski
3:15 P.M. **Team B:** Matt Bladek, Tony Evans, Eduardo Herrera, Eric Young
3:30 P.M. **Team C:** Vicki Chen, Robert Egan, Claire O'Hanlon, Tony Wimer-Maniago
3:45 P.M. **Team D:** Hannah Hoersting, Shannon McKenna, Kacy McKibben, Michael Van Antwerp
4:00 P.M. **Team E:** Hayden Gomes, Janet Komatsu, Trevin Murakami
4:15 P.M. **Team F:** Katie Hall, Ben Taborsky, Ian Wright

3:00 P.M. Galileo-Edwards

Electrical Face Plate for the Blind
Client: Christian Record Services
Liaison: Ronald Bowes
Faculty Advisors: *Clive Dym, Nancy Lape, Erik Spjut, Ruye Wang*

Initial Problem Statement: Design a face plate for an electrical outlet that will make the process of plugging in a conventional two-prong and/or three-prong (ground) plug into wall outlets easier for the blind. The blind and visually impaired have a difficult time lining up the plug with the outlet. Because they can't see where the holes are, they must feel with their fingers and then remove their fingers and hope they have lined up the plug and the outlet sufficiently to make a match.

3:00 P.M. **Team A:** Lucia Cheung, Zack Rubin, Andrew Sabater
3:15 P.M. **Team B:** Andrew Lawrence, Daniel Scinto, Michael Ross, Kevin Hoberman
3:30 P.M. **Team C:** Lolly Simoni, Jinsun Yoo, Anna Lei, Adam Richter
3:45 P.M. **Team D:** Greg Herschler, Edwin Lei, Scott Smith, Justin White
4:00 P.M. **Team E:** Leah Anderson, Alex Bajaj, Kelley Hodges, April Hui, Bruce Yan
4:15 P.M. **Team F:** Hector Cuevas, Liz Flannery, Alicyn Henkhaus, Rudy Resch

Computer Science—Galileo Hall-McAlister

1:45 P.M.–2:45 P.M. **CS 157: Computer Animation**

Jason Arold, David Coyne, Faith Dang, Janna DeVries, Jon Dodge, Stephanie Grush, Joe Ishikura, Jeremy Lennert, Stephen Smith, Brad Tennis, Brian Young

Students will present their final projects.

Faculty Advisor: *Elizabeth A. Sweedyk, Computer Science*

2:45 P.M. **Reception, Computer Science and Engineering Departments—Galileo Hall Foyer**

Computer Science—Galileo Hall Foyer

3:15 P.M.–5:00 P.M. **CS 121: Software Development**

Eric Berglund, James Egan, Andy Glass, Eita Hatayama, Martin Hunt, Eric Johnson, Stephen Jones, Topper Kain, Kyle Roberts, Russell Rutledge, Ben Sibelman, Michael Tauraso, George Tucker, Danny Turner, Josh Utter-Leyton, Craig Weidert, Evan Yazawa

Students will demo games built as software engineering projects.

Faculty Advisor: *Elizabeth A. Sweedyk, Computer Science*

Mathematics and Interdisciplinary Contest in Modeling (ICM/MCM)—Beckman 126

1:45 P.M. **Cris Cecka, Michael Martin, Tristan Sharp:** ***Modeling a Global Crisis (and Australia)***

Today's HIV epidemic is an intimidating situation to model. The progression of the disease occurs on a large time scale and involves the whole globe. The dynamics are unique because only people of certain ages play a role; no one recovers from HIV, but treatments can extend lives tremendously; resistant strains can appear easily; the disease may reduce the population of the most affected countries, affecting the epidemic dynamics; and an HIV vaccine may soon appear. In 96 hours, we developed a model that incorporates these considerations and found that it was rich in behavior. We report the predictions of this model for the most critical country on each continent.

Faculty Advisor: *Jon Jacobsen, Mathematics*

2:00 P.M. **Elisa Celis, Julijana Gjorgjieva, Kenneth Maples:** ***Placing Pipes and Sprinklers—A Macedonian Dilemma***

A cute Macedonian farm girl, Vesna, needed help designing an efficient pipe-sprinkler system to water her father's cabbage patch. We helped Vesna analyze the flow of water through the pipe-sprinkler system. To help her improve this system, we developed an algorithm for optimizing the placement of the watering pipes and sprinklers, to ensure even coverage and minimal flooding in the field. The algorithm provides a general method for optimizing the irrigation system for an arbitrary plot of land, not just for the specified cabbage patch. Our analysis of the system gave Vesna a quick and efficient way to tend her father's cabbages.

Faculty Advisor: *Jon Jacobsen, Mathematics*

Mathematics—Beckman 126

2:15 P.M. **David Gross:** ***Spectral Methods in PDE***

In this talk, I considered certain systems of reaction-diffusion equations on growing domains that arise from our interest in modeling biological and ecological situations. Although they espouse some of the simplest non-linearities, the equations are impossible to solve analytically, and standard methods to compute accurate numerical solutions can be computationally taxing and take an inordinate amount of time. I have found significant improvements by using spectral methods and the Fast Fourier Transform.

Faculty Advisor: *Jon Jacobsen, Mathematics*

2:45 P.M. **Reception, Computer Science and Engineering Departments—Galileo Hall Foyer**

3:15 P.M.–4:15 P.M. **Mathematics 55:** ***Discrete Mathematics—Graph Complexity***

Representatives from the Spring 2006 Math 55 (Discrete Mathematics) course will present a sampling of key insights and new results generated by the course's nearly 50 students during their one-week research adventure into measuring the complexity of a graph.

Faculty Advisor: *Michael Orrison, Mathematics*

Humanities and Social Sciences—Joseph B. Platt Campus Center Living Room

7:00 P.M.–8:00 P.M. **Music 49: American Gamelan**

Bill Alves (HMC Faculty), Kristin Hunt (Scripps), Martin Hunt (HMC), Darryl Yong '96 (HMC Faculty), Julie Simon (Scripps Faculty), Mutiara Sondjaja (HMC), John Pham (Chaffey College), Ansel Schmidt (Pitzer), Gena Urowsky (HMC), Kiat Tanapan (Pitzer)

The Harvey Mudd College American Gamelan is a musical ensemble playing new works on Javanese metallophones and gongs custom built and tuned for this group. We will be performing works by Bill Alves, Kristin Hunt and Lou Harrison.

Course Instructor: *William Alves, Humanities and Social Sciences*

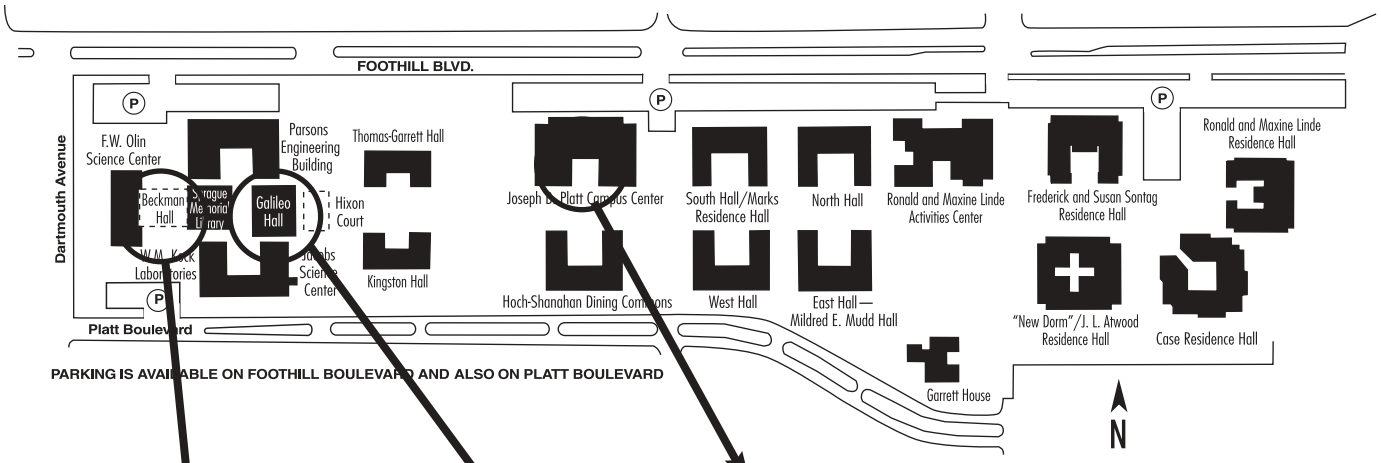
Humanities and Social Sciences—Galileo Hall-McAlister

8:30 P.M.–10:00 P.M. **MS 127s:** ***The Harmony of Sound and Light***

Nick Aase (Pomona), Mario Balibrera (Pomona), Forrest Briggs, Cris Cecka, Chris Erickson, Alex Eustis, Tiffany Head, Alex Himmel, George Korir, Johnny Lu, Kawika Maunupau, Christoph Rau, Sarah Scott, Elan Segarra, Wyatt Toolson, Chris Woodruff, Steve Wyckoff, Nancy Yu

In this course, students study the arts of form and color in motion, especially in connection to music. For their final projects, students create abstract computer animations with music that will be screened for the first time at this show.

Course Instructor: *William Alves, Humanities and Social Sciences*



Joseph B. Platt Campus Center Living Room

Beckman Hall B126

Galileo Hall-Pryne
Galileo Hall-McAlister
Galileo Hall-Edwards
Galileo Hall Foyer

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