A Celebration of Student Research

Presentation Days
May 5 and 7, 2014

HARVEY MUDD COLLEGE

A Celebration of Student Research

Student research is an integral part of the Harvey Mudd College experience, and during Presentation Days each spring, the entire College community is invited to celebrate students' original projects in design or research.

Our students grapple with real-world problems through individual and group research projects across all disciplines. Our professors use research as a powerful teaching tool that promotes learning well beyond the classroom and the laboratory. For many Harvey Mudd students, these intense research opportunities spark a lifelong love for a previously unconsidered field, help them lead diverse teams from many varied disciplines and provide them with the flexibility to change careers over time.

Each year, more than 200 students participate in Presentation Days, and every department at the College is well represented. From groundbreaking individual research done by graduating seniors to engaging and eye-opening design projects done by first-year students, the emphasis throughout Presentation Days is on student achievement.

You'll find the presentations listed by room and then by time. The 2014 Presentation Days Committee members are Elizabeth Glater, Kash Gokli, Lelia Hawkins, Colleen Lewis, Rachel Mayeri, Michael Orrison, Nicholas Pippenger and Patricia Sparks. Special thanks go to Stephanie Graham, Eric Ditwiler and the Office of the Dean of Faculty.

Index of Presenters

Monday, May 5

	Recital Hall	Shanahan 1430	Shanahan B460	Shanahan 2421	Shanahan 2425
10–10:30 a.m.	REFRESHMENTS AT THOMAS-GARRETT PLAZA				
10:30 a.m.	Shah	Arnold-Roksandich	An	DeRose, Nichols, Song, Xie	Bagaria, Chasnov, Sharma, Piersall
10:45 a.m.	Jahl	Chaturapruek	Ruiz		
11:00 a.m.	Patterson	Fischer	Weisberg	Anderson, Elminyawi, Farfan, Villa	Barry, Morgan-Witts, Robertson, Szejer, Zeeb
11:15 a.m.	Allen	Gutekunst	Spierings van der Wolk		
11:30 a.m.	Fielder	Lingenbrink	Mastalli-Kelly	McKiernan, Menon, Paek, Waugaman	Lee, Lertvilai, Nguyen, Yang, Zhao
11:45 a.m.	J. Lee	McDermott	Patel		
Noon–1:30 p.m.	LUNCH				
1:30 p.m.	Hazelton	Serrato	Vick	Kim, Mehall, Nielsen, Rabasca	Caldwell, Fikes, Iwamoto, Liu, Schiller
1:45 p.m.	Bo Lee	Shi	Sharma		
2:00 p.m.	Winkler	Sugarman	Yandow	Ng, Ngai, Perez, Rosen	Krupa, Sebastian, Lam, Lau, Rich
2:15 p.m.	Musselman-Brown	Usatine	Zesch		
2:30–3 p.m.	REFRESHMENTS AT THOMAS-GARRETT PLAZA				
3 p.m.	Haynes	Turner	Donti	Alves, Barina, Govindaraj, Hannan	Aguilera, Gonzales, Johnson, Martin
3:15 p.m.	Amorosi	Kent-Dobias			
3:30 p.m.	Hussain	Kumar	Putman	Liu, Kimberling, Hansen, Nguyen	Chang, Higle-Ralbovsky, Jolly, Menda
3:45 p.m.	Plassmeyer	Megson			
4 p.m.	Parikh	ICM/MCM	Culhane	Thaker, Subler, Xue, Teng, Perdomo	Chen, Huang, Kyle, Schein
4:15 p.m.					
4:30 p.m.			Bhattacharyya, Dominguez, Fa-Kaji, Schlesinger		
4:45 p.m.					

Biology

Chemistry

Computer Science

Engineering

Humanities, Social Sciences, and the Arts

Mathematics

Physics

Wednesday, May 7

	Recital Hall	Shanahan B442	Shanahan 1430	Shanahan 2450	Shanahan 2454	Parsons 1287
8:30 a.m.	Stevens					
8:45 a.m.	Low					
9 a.m.	Zazueta					
9:15 a.m.	Gao		HSA10		Astronomy 62	Fredrick, Johnson
9:30 a.m.	Parks					Thompson, Bodell
9:45 a.m.						Lui, McConnaughey, Dobke
10–10:30 a.m.	REFRESHMENTS AT THOMAS-GARRETT PLAZA					
10:30 a.m.	Yeh					Apple, Liu
10:45 a.m.	Wong					Chang, Su
11 a.m.	Shull		HSA10		Astronomy 62	Nishizaki, Shah
11:15 a.m.	Plassmeyer					Ayoz, Bulut
11:30 a.m.	Gai					Owens, Cheney
11:45 a.m.						Shaw, Beall, Liao
Noon–1:30 p.m.	REFRESHMENTS AT THOMAS-GARRETT PLAZA					
1:30 p.m.	Muller			Bourland, Miller, Ozdemir, Wang	Ramirez, Shaw, Stringer-Usdan, Wyld	
1:45 p.m.	Warren			Tucker, Slaats, Bodenbender, Dietrich	Yu, McCabe, Le, Jones	
2 p.m.	Tweedy			Chapko, Kaye, Miller, Zimmerman	Bodell, Diaz, Friend	
2:15 p.m.	Luckey			Kager, Nguyen, Smallwood	Brown, Martinez, Chaffee	
2:30–3 p.m.	BREAK					
3 p.m.	Donelick			Anderson, Fanlo, McConnell, Zhao	Leung, Rinnert, Zhang	
3:15 p.m.				Marcus, Chow, Pepper, Lum	Batachari, Hu, Jahn, Song	
3:30 p.m				Gott, Gupta, Lim, Zuniga	Maeda, Huerta, Wong, Pednekar	
3:45 p.m.				Burgess, Cyprus, Nguyen, Picciano	Ho, Lam, Parikh, Schooley	
4 p.m.		HIV/AIDS		Kim, Matonis, Sinopoli, Zosman	Joseph, O'Neill, Scharff	
4:15 p.m.				Robinson, Nguyen, Yasanayke, Chao	Beese, Chan, Keinan, Pennington	
4:30 p.m.				Capron, Chapman, Ho, Li		
4:45 p.m.						
5 p.m.						
5:15 p.m.						
6–8 p.m.	Art Show in Art Gallery					
8–10 p.m.	Jazz Concert in Recital Hall *Music of Bud Powell*					

Monday, May 5 | Morning

10 a.m. Refreshments at Thomas-Garrett Plaza

Drinkward Recital Hall

Chemistry

10:30 a.m. Sejal V. Shah: **A Homologous Series of Porphyrin Dyes for Dye-Sensitized Solar Cells**
Advisor: Hal Van Ryswyk, professor of chemistry and Chair, Department of Chemistry

Dye-sensitized solar cells (DSSCs) are a promising alternative to silicon solar cells. DSSCs, made of an inexpensive semiconductor, a dye and an electrolyte, are cheaper to manufacture, but they need to be more efficient to effectively compete with silicon solar cells. A series of fluorinated zinc porphyrins were synthesized for use as potential dyes. The efficiency and surface chemistry of these dyes were investigated.

10:45 a.m. Lydia G. Jahl: **Chemical Composition and Light Absorption Properties of Claremont Ambient Air and Po Valley Fog Water**

Advisor: Lelia Hawkins, Barbara Stokes Dewey Assistant Professor of Chemistry
The chemical composition and solar radiation absorption properties of aerosols and fog water are important because of the effects these properties can have on the climate. Atmospheric samples contain compounds that absorb light, and this radiative forcing may be significant. Absorption spectra of Claremont ambient air and Po Valley fog water were taken in a Liquid Waveguide Capillary Cell with a UV-Visible spectrophotometer. Ion chromatography and a Total Organic Carbon analyzer were used to find concentrations of various chemical species. Characteristic absorptivities at 365 nm were calculated from Beer's law with regard to the organic carbon content. Data analysis reveals diurnal trends in air pollution and possible sources of light-absorbing compounds.

11 a.m. Anastasia L. Patterson: **Zinc Oxide Nanorod and Nanotube Photoanodes for Dye-Sensitized Solar Cells**

Advisor: Hal Van Ryswyk, professor of chemistry and chair, Department of Chemistry
Dye-sensitized solar cells (DSSCs) have the potential for being a low-cost, scalable commercial energy resource, and offer an alternative to single-crystal silicon photovoltaics. This project focused on the production and characterization of the photoanode component of a DSSC. Zinc oxide nanorods and nanotubes were grown via an electrochemical process and tested to investigate the feasibility of inexpensive, solution-processed nanostructures and their performance.

11:15 a.m. Elizabeth L. Allen: **Dehalogenation of Groundwater Pollutants by Cobaloximes**
Advisor: Katherine Van Heuvelen, assistant professor of chemistry

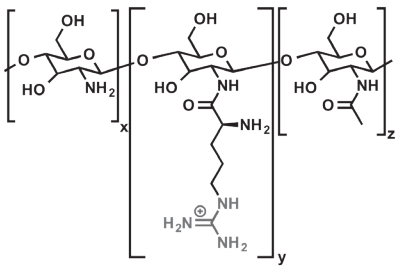
This project explored the dechlorination of carcinogenics found in groundwater throughout the United States. Vitamin B12 (cyanocobalamin) naturally dehalogenates chlorinated alkenes in certain anaerobic bacteria. In hopes of elucidating its mechanism, we have synthesized a series of cobalt-containing molecules called cobaloximes that model B12. Exposure of these models to a reducing agent and a proton donor is known to release less-chlorinated organic products, a phenomenon that Van Heuvelen summer researchers confirmed in 2013. I aimed to study the roles of the different reagents involved and explore how adjustments in their reactivity and stoichiometry alter product formation. Most of my work focused on the development of a reaction procedure that results in systematically detectable products.

11:30 a.m. Brian C. Fielder: **Synthesis of Novel Chitosan-Antioxidant Conjugates**
Advisors: Shenda Baker, professor of chemistry; Andrew P. Duncan, Synedgen Inc.

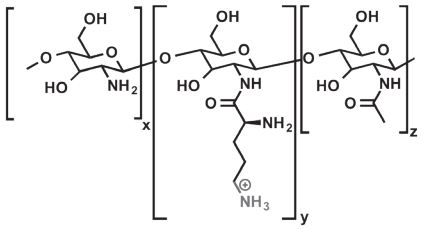
Chitosan is an abundant polysaccharide derived from shrimp shells. It is soluble in water at low pH and has a variety of interesting biological properties. The chitosan derivative poly(acetyl, arginyl)glucosamine (PAAG) is a conjugate of the amino acid arginine and chitosan. It is water-soluble at physiological pH, opening up many possibilities for its use as a therapeutic. Deferoxamine is a bacterial iron chelator and antioxidant. We are synthesizing the novel chitosan-deferoxamine and PAAG-deferoxamine conjugates as a means of selectively delivering the antioxidant to cell surfaces. We hope to use these conjugates to treat or prevent free radical damage to cells.

11:45 a.m. Julia S. Lee: **Synthesis and Characterization of a Chitosan Derivative**
Advisor: Shenda Baker, professor of chemistry; Andrew P. Duncan, Synedgen, Inc.

Chitosan, a copolymer of glucosamine and N-acetylglucosamine, has been shown to have antimicrobial activity at low pH. However, chitosan is insoluble at physiological pH, reducing its utility as an antimicrobial agent. A water-soluble chitosan derivative was developed previously by functionalizing chitosan with the positively charged amino acid arginine, and that conjugate was observed to have antibacterial properties similar to chitosan. In order to explore the effects of positive charge on chitosan conjugates' solubility and activity, we have synthesized an ornithine-chitosan conjugate and investigated its antimicrobial activity. We present a synthetic route toward the ornithine-chitosan conjugate and data characterizing the conjugate's bioactivity.



PAAG
poly (acetyl, arginyl) glucosamine
antimicrobial, anti-biofilm



PAOG
poly (acetyl, ornithinyl) glucosamine
bioactivity?

Noon–1:30 p.m. **Lunch**

Shanahan 1430 | Morning

Mathematics

10:30 a.m. Allison F. Arnold-Roksandich: **L-Functions and Arithmetic Functions**
Advisor: Christopher Towse, associate professor of mathematics, Scripps College

L-functions are an interesting area of number theory because of their ability to encode information. L-functions can even be used to encode arithmetic functions. In fact, several arithmetic functions can be related to the Riemann Zeta-function through L-functions. This talk will discuss the encoding of arithmetic functions and their relation to the Riemann Zeta-function.

10:45 a.m. Sorathan Chaturapruek: **A Mathematical Framework for Unmanned Aerial Vehicle Obstacle Avoidance**
Advisors: Weiqing Gu, professor of mathematics; Zachary Dodds, Leonhard-Johnson-Rae Professor of Computer Science

The obstacle avoidance navigation problem for Unmanned Aerial Vehicles (UAVs) is a very challenging problem. It lies at the intersection of many fields such as probability, differential geometry, optimal control and robotics. We build a mathematical framework to solve this problem for quadrotors using both a theoretical approach through a Hamiltonian system and a machine-learning approach that learns from human sub-experts' multiple demonstrations in obstacle avoidance. Prior research on the machine-learning approach uses an algorithm that does not incorporate geometry. We have developed tools to solve and test the obstacle avoidance problem through mathematics.

11 a.m. Emily M. Fischer: **Infinitely Many Rotationally Symmetric Solutions to the Semilinear Laplace-Beltrami Equation on the Unit Sphere**
Advisor: Alfonso Castro, professor of mathematics

We show that on the unit sphere, the semilinear Laplace-Beltrami Equation has infinitely many solutions that are rotationally symmetric about some axis. This equation corresponds to a singular ordinary differential equation, which we solve using energy analysis and phase plane analysis. We obtain a Pohozaev-type identity to prove that the energy is continuously increasing with the initial condition and then use phase plane analysis to prove the existence of infinitely many solutions.

11:15 a.m. Samuel C. Gutekunst: **Characterizing Forced Communication in Networks**
Advisor: Susan Martonosi, associate professor of mathematics

Research into the load maximization problem has been proposed as a novel way to disrupt communication networks. Inherent to this method is the concept of load, representing the amount of communication forced through a vertex in such networks. We will begin by defining and motivating load as a property of graphs. We will then summarize combinatorial, spectral and structural approaches we have pursued, emphasizing research that begins to combinatorially characterize load as a graph property.

11:30 a.m. David Lingenbrink: **New Subgroups of the Finite Affine Group**
Advisor: Michael Orrison, Avery Professor of Mathematics

The finite affine group is a matrix group whose entries come from a finite field. A natural subgroup consists of those matrices whose entries all come from a subfield instead. I will introduce intermediate subgroups with entries from both the field and a subfield. I will also examine the representations of these intermediate subgroups as well as the resulting branching diagram for the subgroup chain.

11:45 a.m. Matthew McDermott: **Fast Algorithms for Analyzing Partially Ranked Data**
Advisors: Michael Orrison, Avery Professor of Mathematics

Imagine your local creamery administers a survey asking their patrons to choose their five favorite ice cream flavors. Any data collected would be an example of partially ranked data, as the set of all possible flavors is only ranked into groups of the chosen flavors and the not-chosen flavors. If your creamery asks you to help analyze this data, what approaches could you take? One approach is to use the natural symmetries of the underlying data space to break down any data set into smaller parts that can be more easily understood. I will describe how to use permutation representations of the symmetric group to create and study efficient algorithms that yield such decompositions.

Noon–1:30 p.m. **Lunch**

Shanahan B460 | Morning

Physics

10:30 a.m. Fangzhao A. An: **Experimental Realization of Slowly Rotating Light**
Advisor: Theresa Lynn, associate professor of physics

A light beam and its constituent photons can carry spin angular momentum (from a rotating electric field vector) or orbital angular momentum (from a rotating field amplitude pattern). Angular momentum of visible light can be crucial in determining light-matter interactions, but the rotations occur at hundreds of terahertz and are observed only indirectly. In contrast, slowly rotating light can be generated by superposing modes of light with slightly detuned frequencies; some of these superpositions have been predicted to carry angular momentum with sign opposing their direction of slow rotation. I show experimental realization of slowly rotating spin superpositions, present continuing theoretical questions and outline future experiments with orbital angular momentum superpositions.

10:45 a.m. Alberto J. Ruiz: **Simultaneous Collection of Resonance Raman and Fluorescent Signatures Using a 405 nm Excitation Source**
Advisors: Gregory Lyzenga ’75, professor of physics; Michael Storrie-Lombardi P13, visiting professor, University of Florida Astrobiology

Raman scattering (RS) is the result of inelastic collisions between photons and the electronic shell of a molecule. The shift in photon energy is information rich, but RS occurs less frequently than Rayleigh scattering and fluorescence. Exciting a molecule within its maximum absorption band can increase RS by three orders of magnitude if the Raman signal can be separated from co-existent fluorescence. The resulting technique, Resonance Raman Spectroscopy (RRS), can chemically characterize organic targets without sample preparation. High-resolution RRS has been achieved for fluorescing targets using Shifted Excitation Raman Spectroscopy (SERDS) for lasers operating at 783, 671, and 488 nm. Noting the λ^4 wavelength dependence of RS efficiency, this work extends SERDS to 405 nm laser diodes.

11 a.m. Alanna L. Weisberg: **Physical Attributes and Assembly of PEG-linked Immuno-labeled Gold Nanoparticles for OCM Image Contrast in Tissue Engineering and Developmental Biology**
Advisors: Richard Haskell, Burton G. Bettingen Professor of Physics; Elizabeth Orwin '95, professor of engineering

In developing an artificial human cornea replacement, we are immuno-labeling human corneal fibroblasts with gold nanoparticles to visualize the cells and their phenotypes. We see excessive nonspecific binding when labeling cells with PEG-linked immuno-labeled gold nanoparticles (IgG-AuNPs). We have investigated the physical properties of IgG-AuNPs assembled with three different protocols in an attempt to understand and eliminate this nonspecific binding. Two of these protocols bind the antibody with a PEG-linker. We monitor the hydrodynamic radius and surface plasmon resonance (SPR) at each stage of assembly. SPR measurements indicate a different structure near the gold surface when the PEG-linker is bound to gold first and then bound to the antibody second rather than vice versa.

11:15 a.m. David C. Spierings van der Wolk: **Manipulating the Orbital Angular Momentum of Entangled Photons from Spontaneous Parametric Down-Conversion**
Advisor: Theresa Lynn, associate professor of physics

Quantum entanglement is an important resource in numerous quantum communication protocols, and the orbital angular momentum (OAM) of light offers a means of encoding more information per photon than established schemes based solely on two-state variables, such as polarization. However, precise measurement and manipulation of OAM-entangled photon pairs remains a challenge. Using a combination of phase holograms and single-mode optical fibers, our research group measures correlations between the OAM of photon pairs produced by spontaneous parametric down-conversion (SPDC). I present efforts to improve OAM entanglement measurements by addressing the complicated spatial mode structure inherent to the use of SPDC as a source for entangled photons.

11:30 a.m. Lucas G. Mastalli-Kelly: **Maximizing Optical Path Length in a Thin Multilayer Solar Cell**
Advisor: Peter Saeta, professor of physics and chair, Department of Physics

We model the absorption enhancement in thin multilayer solar cells caused by scattering from embedded dipole scatterers. By re-examining the coupling between the dipole and field orientations used in prior work, we find new limits on the enhancement possible in a variety of thin-film solar cell geometries using realistic dipole properties.

11:45 a.m. Sheena K.K. Patel: **Anomalous Hall Measurements of Co/Tb Multilayers That Exhibit All-optical Switching**
Advisor: James Eckert, professor of physics

All-optical switching has been observed in rare earth-transition metal (RE-TM) alloys. The RE and TM sublattices couple to each other antiferromagnetically and have a characteristic magnetic compensation temperature where the net magnetization is zero. Measurements of the Anomalous Hall effect were used to track the magnetic reversal of Co/Tb multilayers with structure [Ta(4 nm)/[Co(t)/Tb(t)]xN/Ta(4 nm)] with constant Co:Tb ratio and total thickness of 25 nm. Divergence of the coercive field near the magnetic compensation temperature was observed for these samples at temperatures that decreased from 390 K for the sample with the thinnest layers to 247 K for the sample with thickest layers, indicating that the polarized moment in the Tb layer is reduced as the layer thickness increases.

Noon–1:30 p.m. **Lunch**

Engineering

E80 Experimental Engineering
Advisors: Chris Clark, associate professor of engineering; Jon Roberts ’93, adjunct professor of engineering; Erik Spjut, professor of engineering and Union Oil Company Engineering Design Fellow; Qimin Yang, associate professor of engineering

Sophomores in the Experimental Engineering course engage in hands-on laboratory work to fly instrumented model rockets as a team and then analyze and report on their data—all with the goal of learning fundamental principles applicable to multiple engineering disciplines. The students will report on their design process, their modeling and how the data from their flights compared with their expectations.

Room 2421

10:30–11 a.m.	Samuel DeRose, Sarah Nichols, In Sung Song, Daniel Xie
11–11:30 a.m.	Spenser Anderson, Ramy Elminyawi, Matias Farfan, Ana Villa
11:30–Noon	Jožefa McKiernan, Nithya Menon, Sarah Paek, Maxwell Waugaman

Room 2425

10:30–11 a.m.	Akhil Bagaria, Ben Chasnov, Apoorva Sharma, Richard Piersall
11–11:30 a.m.	Allison Barry, Thomas Morgan-Witts, Kelly Robertson, Jessica Szejer, Christina Zeeb
11:30–Noon	Daniel Lee, Pichaya Lertvilai, Triet Nguyen, Tiancheng Yang, Mo Zhao

Monday, May 5 | Afternoon

Drinkward Recital Hall

Biology

1:30 p.m. Lisa Hazelton: **Modeling the Growth of the Barnacle *Balanus glandula***
Advisors: Sarah Gilman, W.M. Keck Science Department; Catherine McFadden, Vivian and D. Kenneth Baker Professor in the Life Sciences and chair, Department of Biology

Increases in average air and water temperatures due to global climate change will especially affect intertidal organisms such as the barnacle *Balanus glandula*, which inhabits both aquatic and terrestrial environments. Dynamic energy budget (DEB) models have been used to successfully model the growth of other marine invertebrates. A DEB model predicts an organism's energy use and intake from its body size, food supply and temperature. I developed a DEB model for *B. glandula* grown in completely submerged experimental conditions. This model can then be extended to predict growth in response to global climate change for *B. glandula* living in an intertidal environment.

1:45 p.m. Alex B. Lee: **Circumnutation in Wild Cucumbers**
Advisors: Stephen Adolph, Stuart Mudd Professor of Biology; Anna Ahn, associate professor of biology; Sharon Gerbode, assistant professor of physics

Since the time of Darwin, biologists have been interested in plants that climb surrounding structures to gain access to the sun. *Echinocystis lobata*, a wild cucumber, uses tendrils to climb. *E. lobata* finds these structures to climb through circumnutation, a circular motion common in growing plants. While past studies simply track the tip of the plant in 2-D space during circumnutation, we hope to understand the mechanisms of circumnutation by creating quantitative 3-D reconstructions of the entire tendril. Our mechanical model, which approximates the tendril as a rod bent by gravity, is made to mimic circumnutation by altering the rod's intrinsic curvature. This model is compared to the reconstructions to understand the nature of the motor that drives circumnutation.

2 p.m. Lauren N. Winkler: **Stationary Phase Degradation of ß-Galactosidase in *Escherichia coli***
Advisor: Daniel Stoebel, assistant professor of biology

The ß-galactosidase assay has long been regarded as an easy and reliable method for assessing the output of lacZ transcriptional fusions in Escherichia coli genetic studies. As the rate of lacZ transcriptional initiation increases or decreases, intracellular levels of ß-galactosidase should follow suit. ß-galactosidase activity should therefore serve as a faithful proxy for lacZ expression. In order for this relationship to hold, however, ß-galactosidase degradation must occur more rapidly than any fluctuations in the rate of lacZ transcriptional initiation. My data indicate that stationary phase ß-galactosidase persists in excess of five hours, suggesting that ß-galactosidase assays may not be suitable for measuring levels of transcriptional initiation during stationary phase.

2:15 p.m. Audrey Musselman-Brown: **Cophylogenetic Reconciliation of Mutualistic Species**
Advisors: Ran Libeskind-Hadas, R. Michael Shanahan Professor of Computer Science and chair, Computer Science Department; Catherine McFadden, Vivian and D. Kenneth Baker Professor in the Life Sciences and chair, Department of Biology

Phylogenetic tree reconciliation is an important problem in biology because it allows biologists to infer the evolutionary histories of pairs of interacting species. Many algorithms currently exist for finding reconciliations between groups of parasite species and their hosts. These algorithms are often used to reconcile groups of mutualistic species, but the assumptions made by host-parasite algorithms may not be valid for trees of mutualists. I have developed an algorithm specifically designed for use with mutualistic species that produces simpler, more biologically plausible reconciliations than the available algorithm for host-parasite species.

2:30–3 p.m. **Break**

3 p.m. Lillian E. Haynes: **Exploring the Neuronal and Genetic Basis of Food Choice in *Caenorhabditis elegans* for Bacteria Found in its Natural Habitat**
Advisor: Elizabeth Glater, assistant professor of biology

Understanding food choice behavior is key to understanding human obesity and eating-related disorders. We used the nematode *Caenorhabditis elegans* to understand the neuronal and genetic basis of food choice. To determine the neurons involved in choosing among bacteria from the natural habitat of *C. elegans*, we used mutant worm strains defective in specific neurons and rescue strains (mutant strains with normal function restored in one neuron). To visualize how sensory neurons drive food-choice decisions, the activity of the sensory neuron AWC was measured in in freely moving worms using fluorescent indicator GCaMP3.0. Finally genetically different strains of *C. elegans* were screened for differences in food preference to understand how natural genetic differences affect food choice.

3:15 p.m. Clara Amorosi: **The Metabolic Niche of RpoS in *Escherichia coli***
Advisor: Daniel Stoebel, assistant professor of biology

Bacteria are remarkably adept at responding to different stressors. In particular, sigma factors, which allow bacteria to regulate gene expression, are highly relevant to bacterial stress protection. RpoS is an alternative sigma factor in *Escherichia coli* that controls the general stress response by regulating up to 10 percent of the genome. It has been proposed that RpoS is involved in a tradeoff between bacterial self-preservation and nutritional competency. To further test this, I developed a procedure to measure the impact of RpoS levels in a strain of *E. coli* on the metabolism of a number of energy sources. This investigation provides a more complete picture of the role of RpoS in bacterial regulation of stress and metabolism.

3:30 p.m. Sidra Hussain: **Modeling the Evolution of Genetic Trade-offs**
Advisor: Stephen Adolph, Stuart Mudd Professor of Biology

An evolutionary trade-off refers to a situation in which an allele or trait increases fitness in one way and decreases it in another. Computational population simulations were used to model quantitative traits and explore genetic trade-offs. Simulations of the trajectory of a population undergoing evolution were created to explore how various directions and strengths of selection could give rise to or affect the equilibrium of trade-offs. For example, simultaneous selection on two traits controlled by a single trade-off locus led to a negative correlation between the traits under certain conditions.

3:45 p.m. Brennan C. Plassmeyer: **Bio 198 Independent Study in Experimental Ecology**
Advisor: Catherine McFadden, Vivian and D. Kenneth Baker Professor in the Life Sciences and chair, Department of Biology

In my independent study Experimental Ecology laboratory course, I designed and carried out experiments to test hypotheses about the complex ecological interactions underlying species diversity, habitat associations and effects of abiotic and biotic factors on growth rates of organisms. I will present the results of one of the experiments that I completed during this semester, focusing on its experimental design, implementation and analysis.

4 p.m. Natasha A. Parikh: **Visual Selective Attention to Pleasant Foods: A Neurological Study**
Advisors: Elizabeth Glater, assistant professor of biology; Catherine L. Reed, professor of psychology, Claremont McKenna College

Food is advertised everywhere, but Americans struggle with obesity and eating disorders. The mixed media creates a conflict: Should we pay attention to food or avoid it for health's sake? Using high-density electroencephalography, I investigated the neural substrates of selective visual attention to food cues and whether these neural markers were modulated by people's eating behaviors and body satisfaction. Hungry participants performed a dot-probe attention task that cues a food and a non food. After eating one food, they were tested again to determine if their attention to specific food cues changed as a result of satiety. Satiety and differences in eating and body image may affect automatic attention orienting. This study could have implications for understanding eating disorders.

Shanahan 1430 | Afternoon

Mathematics

1:30 p.m. Alexa Serrato: **Reed's Conjecture and Cycle-Power Graphs**
Advisor: Nicholas Pippenger, professor of mathematics

Reed's conjecture is a proposed upper bound for the chromatic number of a graph. Reed's conjecture has already been proven for several families of graphs. I show how one of those families of graphs can be extended to include additional graphs and also show that Reed's conjecture holds for a family of graphs known as cycle-power graphs, and also for their complements.

1:45 p.m. Tongjia Shi: **Random Permutations**
Advisor: Nicholas Pippenger, professor of mathematics

Random permutations are among the most natural mathematical structures, but we still don't know everything about them. Here, we will focus on the ordered cycle lengths of a random permutation and ask questions like, "What's the expected length of the shortest cycle in a very large random permutation?" Historical research has given partial and complicated results, which are unsatisfactory considering the simplicity of the problem. We will complete the missing results and provide a unified description for the ordered cycle lengths of these random permutations.

2 p.m. Carling Sugarman: **Using Topology to Explore Mathematics Education Reform**
Advisor: Jon Jacobsen, associate professor of mathematics

Mathematics education is a constant topic of conversation in the United States. Many attempts have been made historically to reform teaching methods and improve student results. Particularly, past ideas have emphasized problem-solving to make math feel more applicable and enjoyable. Many have additionally tackled the widespread problem of "math anxiety" by creating lessons that are more discussion-based than drill-based to shift focus from speed and accuracy. In my project, I explored past reform goals and some added goals concerning students' perceptions of mathematics. To do so, I created and tested a pilot workshop in topology, a creative and intuitive field, for use in fourth- through sixth-grade classrooms. Preliminary results suggest some success in altering student views on mathematics.

2:15 p.m. Jeremy B. Usatine: **Arithmetical Graphs and the Frobenius Number**
Advisors: Dagan Karp, assistant professor of mathematics; Melody Chan, National Science Foundation postdoctoral fellow and lecturer, Harvard University

If R is a list of positive integers with greatest common divisor equal to 1, calculating the Frobenius number of R is in general NP-hard. Dino Lorenzini defines the arithmetical graph, which naturally arises in arithmetic geometry. He also defines a notion of arithmetical graph genus, the g-number, that in specific cases coincides with the Frobenius number of R. Using a formulation of chip-firing on the vertices of an arithmetical graph, I will discuss this connection and how in specific cases, this connection can be leveraged to quickly find upper bounds for the Frobenius number of R.

2:30–3 p.m. **Break**

Shanahan 1430 | Afternoon

Physics

3 p.m. Andrew P. Turner: **Distinguishability of Qudit Hyperentangled States by Linear Evolution and Local Measurement**
Advisor: Theresa Lynn, associate professor of physics

Entanglement is a property of quantum systems that is central to many applications such as quantum teleportation, quantum secret sharing and quantum cryptography. All of these applications require measurement of entangled particles in the "Bell-state basis." The goal of this kind of measurement is to distinguish qudit hyperentangled states, or states of two particles simultaneously entangled in multiple variables, where each variable takes an arbitrary number d of distinct values. Such measurements are difficult in general, and so measurements that use only linear evolution and local measurement (LELM) are of particular interest. We show a theoretical bound on qudit hyperentangled Bell-state measurements using LELM devices, setting limitations on various quantum information protocols.

Shanahan 1430 | Afternoon

Mathematics

3:15 p.m. Jaron P. Kent-Dobias: **Planar Dipole Driven Pattern Formation**
Advisor: Andrew Bernoff, Kenneth A. and Diana G. Jonsson Professor of Mathematics and chair, Department of Mathematics

Many two-dimensional fluid-like systems are mediated by a dipole-like interaction. We show that the microscopic details of any such system are irrelevant in the macroscopic limit and contribute only a constant offset to the system's energy. A numeric model is developed, and all stable domain morphologies are characterized. By applying a random energy background in the numerics, we recover a smörgåsbord of diverse morphologies that were previously unstable and that show strong similarities to physical systems. Finally, we develop a method for recovering information about the microscopic parameters of any system from only simple aspects of their shape.

3:30 p.m. Shreyas Kumar: **Simulations of Surfactant Driven Thin-Film Flow**
Advisors: Rachel Levy, associate professor of mathematics; Darryl Yong '96, associate professor of mathematics

Surfactant-driven thin film flow has been a rich area of study with important industrial and biological applications. The accepted model, created by Gaver and Grotberg in the 1990s, is a coupled system of nonlinear partial differential equations for the height of the thin fluid film and the concentration of surfactant, which lowers the surface tension of the fluid. Comparisons of simulations of the model to the experimental results suggest significant time scale differences. This talk explores the impact of the equation of state (relating surface tension to surfactant concentration) on the results of the simulations and considers ways to reconcile the model with experiment.

3:45 p.m. Peter Megson: **Experiments with Surfactants on Thin Fluid Films**
Advisors: Rachel Levy, associate professor of mathematics; Jon Jacobsen, associate professor of mathematics

Surfactants on thin fluid films appear in many biological and industrial contexts, notably in the human lung. Spatial concentration gradients in surfactant give rise to surface forces which lead to perturbations in the fluid height profile and cause the surfactant to move on the fluid surface. Since the 1990s, models have existed which predict the fluid height profile and surfactant concentration in such problems, although experiments which measure both simultaneously are a relatively recent development. We present an experimental setup which can be used to study both height profile and surfactant concentration simultaneously in order to facilitate comparison with the models. This talk will also present preliminary results with this apparatus on Newtonian and non-Newtonian fluid layers.

4 p.m. **Mathematical and Interdisciplinary Contests in Modeling**
Advisor: Susan Martonosi, associate professor of mathematics

This year's Mathematical and Interdisciplinary Contests in Modeling (MCM/ICM) took place Thursday, Feb. 6–Monday, Feb. 10. During this competition that typically attracts a few thousand teams from around the world, four teams from Harvey Mudd worked around the clock to solve one of three modeling problems: the keep-right-except-to-pass driving rule; modeling what makes an athletic coaching legend; and using networks to measure influence and impact. The problems are generally open ended and will not have a unique solution. Teams are judged on their mathematical content, creativity, appropriateness and written style. In this session, participating students will present their problem and proposed solution.

Physics

1:30 p.m. Michelle L. Vick: **Determining Binary Orbital Periods via Timing Analysis of Microlensing Events**
Advisor: Ann Esin, associate professor of physics

Many stars in the galactic disk are gravitationally bound in binary systems. Better understanding of star formation requires accurate statistics of these systems. However, acquiring information about dim and distant binaries is difficult. Gravitational microlensing (magnification) of background stars by such systems can prove useful by providing information about the systems' orbital properties. Lensing events show distinctive patterns of brightness variability when a binary system acts as a lens. When the system is rapidly rotating these patterns appear periodically. With careful timing analysis, the orbital period of the binary can be calculated from the microlensing signal. I will present results on the effectiveness of this timing analysis technique in extracting orbital periods.

1:45 p.m. Jennifer Sharma: **Magneto-transport Properties of CoIr Thin Films**
Advisors: James Eckert, professor of physics; Patricia Sparks, professor of physics

Several applications of magnetic materials require that the preferential easy axis of the magnetic moment lies perpendicular to the plane of the material, a result known as perpendicular magnetic anisotropy (PMA). We investigated multilayers of cobalt and iridium, which have previously exhibited strong PMA and can produce both antiferromagnetic and ferromagnetic coupling between the magnetic layers. Five samples with varying Ir and Co thickness were sputtered, then measured to determine their magneto-transport properties, characterized in three ways: measuring the magnetization of the sample with respect to applied field, and measuring the changes in the extraordinary Hall effect (EHE) and orientation-dependent anisotropic magnetoresistance (AMR) with respect to temperature.

2 p.m. Andrew J. Yandow: **Characterizing the Laser Ejection of Polystyrene Nanosphere Targets from a Silicon Surface**
Advisor: Tom Donnelly, professor of physics

Simulations predict that when a high-intensity laser pulse interacts with a wavelength-scale particle energy is transferred to electrons by a process known as multi-pass stochastic heating. To study this mechanism, we developed a technique to place polystyrene nanosphere targets in the focal volume of a high-intensity laser pulse. We deposit targets on a silicon substrate and then remove them using an ablating laser pulse just prior to the arrival of a high-intensity pulse. We observed the targets leaving the substrate in real time by measuring the light they scatter from a continuous-wave laser beam running parallel to the substrate surface, yielding a timing profile and a partial velocity distribution. Our technique will be used this summer at the University of Texas' GHOST laser.

2:15 p.m. Jordan D. Zesch: **Optimization of Time-of-Flight Mass Spectrometers Using Simion**
Advisors: Peter Saeta, professor of physics and chair, Department of Physics; Greg Miller, Space Science, Southwest Research Institute

Multibounce time-of-flight (MBTOF) mass spectrometers have high resolution and small mass, making them suitable for space exploration. Southwest Research Institute's goal for this project is to develop an efficient approach to optimize the design of a MBTOF to minimize the high voltage required to achieve the greatest possible mass resolution, which should be sufficient to distinguish isotopologues of very similar mass, such as DH16O and H217O. Our approach combines the simulation of ion trajectories using Simion with scripting from Mathematica to search for a global optimum for given instrument length.

Computer Science

3 p.m. Priya L. Donti: **A Holistic Approach to Productivity and Wellness**
Advisors: James Boerkoel, visiting assistant professor of computer science; Qutayba Abdullatif, associate dean, student health and wellness

We've all been in that situation where what we want to do supersedes what we should do, and in the opposite situation where we end up completing obligatory tasks rather than pursuing our own interests. This project aims to help students achieve flow and work-life balance by means of a smart phone app that acts as a friendly, motivating, personalized study buddy. This past semester, we collected data on Harvey Mudd student productivity and wellness through both an in-depth email survey and an experiential study conducted using PACO. We then used this data to begin developing the artificial intelligence models that will be the basis of our app. By the end of summer, we hope to have an Android app prototype ready for user tests in fall 2014.

3:30 p.m. Alex Putman: **Transformational Grammar for Jazz Idioms**
Advisor: Robert Keller, professor of computer science

Shelton Berg's Goal Note Method asserts that effective jazz improvisations can be built from common idioms in the context of basic chord progressions. I will present a transformational grammar that defines these and other jazz idioms and that controls their placement within melodies generated by a grammar within Impro-Visor. Applying such transformations dynamically provides for automatic creation of melodies that support a particular improvisational style.

4 p.m. Michael Culhane: **Co-Evolution of Programs and Their Proofs**
Advisor: Robert Keller, professor of computer science

Evolutionary algorithms can develop creative solutions to problems, but those solutions could often be more reliable with proofs of their correctness. Similarly, formal methods such as Hoare Logic provide a toolset for proving programs but often require creative input to construct those proofs. We investigate blending evolutionary algorithms and formal methods in order to generate provably correct software. We co-evolve programs along with their proofs, using formal methods to guide program evolution and using evolutionary methods to assist in proof construction.

4:30 p.m. Arielle Schlesinger, Noelle Fa-Kaji, Neftali Dominguez, Victor Bhattacharyya: **Perceptions of What Counts as a Programming Language**
Advisor: Colleen Lewis, assistant professor of computer science

An educational programming language may be more accessible, less frustrating and more rewarding for young students. However, if a student thinks that the educational language does not constitute actual computer programming, it is hard to build interest in the subject and confidence in their programming skills. We interviewed sixth-grade students about their perception of various programming environments to understand students' tacit assumptions about computer programming. Within a summer enrichment program, we attempted to build students' confidence in their programming ability by showing how the educational programming language they used related to Java, C++ and Python, but there were no statistically significant differences between students who did and did not receive the intervention.

Engineering

E80 Experimental Engineering
Advisors: Chris Clark, associate professor of engineering; Jon Roberts ’93, adjunct professor of engineering; Erik Spjut, professor of engineering and Union Oil Company Engineering Design Fellow; Qimin Yang, associate professor of engineering

Sophomores in the Experimental Engineering course engage in hands-on laboratory work to fly instrumented model rockets as a team and then analyze and report on their data—all with the goal of learning fundamental principles applicable to multiple engineering disciplines. The students will be reporting on their design process, their modeling and how the data from their flights compared with their expectations.

Room 2421

1:30 p.m.	Sooyeol (Suzy) Kim, Bryan Mehall, Caroline Nielsen, Maggie Rabasca
2 p.m.	Angela Ng, Amy Ngai, Jonathan Perez, Aaron Rosen
2:30–3 p.m.	Break
3 p.m.	Alexander Alves, Tito Barina, Thendral Govindaraj, Fabiha Hannan
3:30 p.m.	Jeanette Liu, Kaitlin Kimberling, Kaitlin Hansen, Huy Nguyen
4 p.m.	Avi Thaker, Nicole Subler, Ashuka Xue, Ben Teng, Joana Perdomo

Room 2425

1:30 p.m.	Eric Caldwell, Austin Fikes, Jessica Iwamoto, Maggie Liu, Adam Schiller
2 p.m.	Sebastian Krupa, Sherman Lam, Kirklann Lau, Alex Rich
2:30–3 p.m.	Break
3 p.m.	Ryder Aguilera, Eddie Gonzales, Cory Johnson, Rose Martin
3:30 p.m.	Julie Chang, Jacob Higle-Ralbovsky, Paul Jolly, Kunal Menda
4 p.m.	Josephine Chen, Xin Huang, Nicole Kyle, Stephen Schein

Wednesday, May 7 | Morning

Drinkward Recital Hall

Chemistry and Biology

8:30 a.m. Christian Stevens: **Using RNA-based Gene Therapies to Inhibit HIV-1: A Tunable tRNA-nucleolar Localizing Trans-activation Response Element (TAR) Decoy-U5 Short Hairpin RNA (shRNA) Triple Chimera**
Advisor: Karl Haushalter, associate professor of chemistry and biology

A TAR decoy is a short RNA oligomer that inhibits HIV-1 transcription by binding to the trans-activator of transcription (Tat) protein, thereby competitively inhibiting the TAR-Tat interaction required for efficient HIV-1 transcription. The U5 shRNA is a small piece of RNA that specifically targets HIV-1 transcripts and prevents them from being translated through RNA interference. In this work, the TAR decoy and the U5 shRNA are used in a variety of tRNA chimeras. Using a dual-luciferase reporter assay with firefly luciferase under the control of the HIV-1 long terminal repeat (LTR) promoter, we show that expression of the variable tRNA chimeras result in differential inhibition of HIV-1. Chimeras with multiple therapies show the greatest inhibition and all chimeras have tunable inhibition.

8:45 a.m. Robyn Low: **Effect of Electromagnetic Stimulation on Rabbit Corneal Fibroblasts Gene Expression**
Advisor: Elizabeth Orwin ’95, professor of engineering

A viable tissue-engineered (TE) cornea offers a promising alternative to using human donor tissues in treating corneal diseases. Corneal fibroblasts cultured in the lab undergo a wound-healing response that alters protein expression and results in a cloudy cornea. In order to reverse the wound-healing response, we are investigating the effect of electromagnetic stimulation on protein expression in rabbit corneal fibroblasts. Cells are exposed to varying wavelengths and intensities of light and then analyzed for changes in protein levels that are characteristic of the wound-healing phenotype. Corneal cells alter their protein expression in response to different wavelengths and intensities of light.

9 a.m. Christopher J. Zazueta: **Gene Control Using tRNA-shRNA Chimeras: Knockdown by shRNA and Degradation of tRNA**
Advisor: Karl Haushalter, associate professor of chemistry and biology

Gene therapy using RNA interference (RNAi) mediated by short hairpin RNAs (shRNAs) targeted against HIV-1 is a promising alternative to antiretroviral therapy. Fusing shRNA to carrier tRNA to produce a tRNA-shRNA chimera can provide a tunable level of shRNA delivery that is dependent on the action of the enzyme tRNaseZ to separate the shRNA and tRNA components of the chimera. We have introduced changes in the sequence of the acceptor stem of the tRNA portion of the tRNA-shRNA chimera to produce the next-generation of tRNA-shRNA chimeras. Our targeted mutations are designed to result in an isomerization that triggers rapid tRNA decay after release of the shRNA by tRNaseZ. The knockdown efficiency of the resulting constructs can be assayed by a dual-luciferase assay.

9:15 a.m. Eva Gao: **Inhibiting HIV-1 with Chimeric tRNA-miRNA Mimics**
Advisors: Karl Haushalter, associate professor of chemistry and biology

Gene therapy utilizing RNA interference (RNAi) has the potential to repress HIV-1 replication in patients living with HIV. This study investigates the effectiveness of microRNA (miRNA) mimics fused to tRNA in inhibiting the synthesis of proteins important to HIV-1's lifecycle. Expression vectors coding for chimeric RNA molecules consisting of tRNA(Arg) or tRNA(Ser) fused to miRNA mimics directed against either Gag-Pol or CCR5, respectively, were designed and constructed. Using a dual-luciferase assay in cultured cells, the effectiveness of these tRNA-miRNA mimic constructs will be compared with the effectiveness of analogous tRNA-short hairpin (shRNA) constructs.

9:30 a.m. Sophie Parks: **Effect of Electromagnetic Stimulation on Cell Viability of Rabbit Corneal Fibroblasts**
Advisor: Elizabeth Orwin '95, professor of engineering

Production of a tissue-engineered cornea would alleviate the global shortage of donor corneas, allowing millions of visually impaired people to receive treatment. The most important quality of a viable cornea is transparency, which is influenced by protein expression. Corneal fibroblasts undergo a wound-healing response that results in protein expression corresponding to a cloudy cornea. Electromagnetic stimulation shows promise in reversing this response to get the desired protein expression. However, electromagnetic radiation can also reduce cell survival. This project looks at the effect of varying wavelengths and intensities of light on viability of corneal fibroblasts with the goal of developing ideal growing conditions to maximize viability and minimize the wound-healing response.

10–10:30 a.m. **Break**

Drinkward Recital Hall | Morning

Biology

10:30 a.m. Beverly O. Yeh: **Food Choice Preference and its Correlation With Immune Response in *Caenorhabditis elegans***
Advisor: Elizabeth Glater, assistant professor of biology

The nematode worm *C. elegans* consumes bacteria that grow on rotting fruit. Some of these bacteria are pathogenic and cause an immune response in *C. elegans*. Using bacteria found in *C. elegans* natural environment, we worked to determine if C. elegans prefer or avoid bacteria that induce an immune response. We found that *C. elegans* exhibited preferences between different species of bacteria as well as different strains of the same species of bacteria. *C. elegans* detects volatile odors that bacteria release with chemosensory neurons. The neuronal basis of food choice preference was determined by using mutant strains where specific neuron functions are destroyed. Preliminary data have shown that the AWC chemosensory neuron is a key component in food choice preference of *C. elegans*.

10:45 a.m. Garrett T. Wong: **The Effect of RpoS Levels on the RpoS Regulon in *Escherichia coli***
Advisor: Daniel Stoebel, assistant professor of biology

In *E. coli*, RpoS is a transcriptional regulator for a large number of genes (its "regulon"). We know that the amount of RpoS present varies widely across environmental conditions. However, assays of the RpoS regulon have treated the RpoS signal as binary: It's either there, or it's not. Instead, I examined transcription across a range of RpoS levels to begin to build functional relationships between RpoS levels and transcription in its regulon. I showed that the transcriptional response to increasing RpoS is monotonic, but often nonlinear. Unlike previous examinations of the RpoS regulon, I employed RNA-seq; the greater sensitivity of this assay reveals many more genes affected by RpoS than previously identified.

11 a.m. Lauren Shull: **The Effect of DNA Supercoiling on Expression of osmY in *Escherichia coli* During Late Stationary Phase**
Advisor: Daniel Stoebel, assistant professor of biology

DNA supercoiling can act as a regulator for gene transcription and has been implicated as a signal of environmental stressors. The *E. coli* sigma factor RpoS is responsible for transcribing the general stress response genes under stressful conditions including cold shock, high osmolarity, acidity, and entry into stationary phase. The gene osmY, induced during hyperosmotic stress, is both RpoS dependent and induced by DNA relaxation during exponential growth. However, little is understood about RpoS-driven transcription or the interaction between RpoS and supercoiling during late stationary phase. Identifying appropriate control genes and using a combination of quantitative PCR and supercoiling assays have helped elucidate the role of supercoiling in this previously unstudied condition.

11:15 a.m. Brennan C. Plassmeyer: **A Mathematical Model of Optimal Perch Height for Arboreal Lizards**
Advisor: Stephen Adolph, Stuart Mudd Professor of Biology

Arboreal lizards utilize a "sit and wait" foraging pattern: perching in trees until prey items appear on the ground. I created a quantitative model to determine the optimal perch height for such foragers—the perch height that maximizes net energy gain. As the lizard perches higher, it can see more ground area, but is unable to see smaller prey items and expends more energy climbing and running. The model yielded two general results: (1) The optimal perch height for lizards ranging from 5 to 20g is between 1 and 2m and (2) Larger lizards should perch higher if they have better visual acuity. Both of these model results are commonly observed in arboreal lizard species.

11:30 a.m. Lisa Gai: **Convergent Evolution in Vocal Learning Birds**
Advisors: Daniel Stoebel, assistant professor of biology; Erich Jarvis, associate professor of neurobiology, Duke University Medical Center

Humans are not unique in their capacity for vocal learning, the ability to acquire new vocalizations through imitation. Four mammalian groups and three avian groups also share this trait, with the avian groups in particular used as model organisms. Vocal learning ability is thought to have evolved independently in each group, that is through convergent evolution. In addition to acting on outward traits, convergent evolution can be a powerful force at the gene sequence level. By identifying convergent genes, we may better understand the genetic basis of this trait. Here we present preliminary work on a pipeline to identify such genes in vocal learning birds.

Shanahan 2454 | Morning

Physics

8:30–Noon

Astronomy 62 Introduction to Astrophysics
Advisor: Gregory Lyzenga ’75, professor of physics

Students in Introduction to Astrophysics present reviews and research on various topics in modern astrophysical research. Abstract of talks can be accessed at https://dl.dropbox-usercontent.com/u/3991845/A62_abstracts.pdf and will be available in hard copy at the talks.

Scheduled presenters: Ferrel Atkins (PO), Caitlyn Bonilla, Phillip Diffley, Caleb Eades, Christian Guerrero, Ryan Jones, David Khatami (PO), Tatsu Monkman (PO), Sheena Patel (by video), Ralitsa Racheva (PO), Jennifer Sharma, Holly Strickland, Miranda Thompson

Shanahan 1430 | Morning

Humanities, Social Sciences, and the Arts

8:30 a.m.–Noon

HSA10 Critical Inquiry, Representative Student Presentations
Faculty: Bill Alves, Isabel Balseiro, Hal Barron, Ambereen Dadabhoy, Marianne de Laet, Erika Dyson, Gary Evans, Kenneth Fandell, Vivien Hamilton, Rachel Mayeri, Paul Steinberg, Lisa Sullivan, Chang Tan

Critical Inquiry is a topical seminar in the humanities, social sciences and the arts required of all second-semester students. As part of a research project undertaken in the second half of the semester, all students give formal research presentations. The participants in each of the 13 sections then choose one of those presentations to represent their section during Presentation Days. The presentations in this session cover a wide range of topics, from the economics of oil and energy to religious experiences.

Engineering

Special Topics in Engineering
Advisor: Gordon Krauss, Fletcher Jones Professor of Engineering

9:15 a.m. Emma Fredrick and Maya Johnson: **Walkers**

Walkers help users maintain balance while moving. However, many models do not have safe, convenient methods for holding items users may wish to carry with them. The team designed, prototyped and tested a universal walker accessory dock that users can attach to their walkers and then easily add, remove or rearrange walker accessories, such as trays or cup holders, to the accessory dock.

9:30 a.m. Emma Bodell and Margaret Thompson: **Drowsy Driving Device**

The new product development process for a device to prevent drowsy driving accidents will be presented. The device is designed to sense when a driver is falling asleep and subsequently alert them. The device originated with a need area, a business case was researched and outlined, customer needs were investigated through surveys and focus groups, and prototypes were developed from a list of specifications and tested using a model of drowsy driving events.

9:45 a.m. Alistair Dobke, Frank Lui, James McConnaughey: **E190S New Product Development**
Advisor: Gordon Krauss, Fletcher Jones Professor of Engineering

Washing glassware is a time-consuming, repetitive task that hinders scientists and research. There is a need for a small, affordable, automated glassware washer. This project involved the development of three laboratory glassware cleaner prototypes. Ultrasonic agitation was selected as the cleaning method in the final prototype, and the final prototype is a modular, programmable intake/outtake pump system and glassware racks that can turn any commercially available ultrasonic cleaner into a cyclical laboratory glassware washer.

10:30 a.m. **E190N Transformation of a Manufacturing Company**
Advisor: Kash Gokli, professor of manufacturing practice

The Manufacturing Planning and Execution course teaches tools and techniques in shop floor, quality and supply chain management. By using these tools and techniques students will transform an unprofitable manufacturing company in to a successful, profitable company. Students will present their findings and plan of action for this transformation.

10:30 a.m.	Chris Apple, Maggie Liu
10:45 a.m.	Chanel Chang, Frances Su
11 a.m.	Lauren Nishizaki, Sejal Shah
11:15 a.m.	Sila Ayoz, Berkay Bulut
11:30 a.m.	Cierra Owens, Brian Cheney
11:45 a.m.	Ivan Shaw, Lawrence Beall, Angelo Liao

Wednesday, May 7 | Afternoon

Drinkward Recital Hall

Chemistry

1:30 p.m. Katherine Muller: **Mass Spectrometry and Absorptivity of Atmospheric Nitro-aromatics**
Advisor: Lelia Hawkins, Barbara Stokes Dewey Assistant Professor of Chemistry

The contribution of fog to the radiative forcing of the atmosphere is not well-quantified. Fog water, which reflects light and cools that atmosphere, also may contain suspended light-absorbing brown carbon. Recent research has shown that less than a dozen nitro-aromatic compounds may account for a statistically significant portion of this fog water absorptivity, particularly at the longer wavelengths observed in fog water from urban areas. Mass spectrometry and UV-visible analysis of fog water samples show that measurable quantities of these nitro-aromatics are present and have a measurable impact on the absorptivity of atmospheric samples.

1:45 p.m. Olivia Warren*: **Evaluation of the Extraction of Chemical Species from Desalination Brine**
Advisor: Mary Cardenas, LaFetra Associate Professor of Environmental Engineering

Dave Larky is a career engineer and scientist with a number of patents in color television, radar tracking and heat transmission. He is currently interested in the extraction of chemical species from the brine of desalination plants. Given current attention to desalination, this chemistry capstone project (also a Clinic project) aims to identify the various chemical species that are obtainable from brine and to minimize the cost of extracting those species. Our team designed a system to extract targeted chemical species from desalination brine. The system was simulated through computer modeling and characterized using economic analysis. **Members of the Clinic team also include Anthony Chung (spring team leader), Angela Medina, Abe Cass and Patrick Loftus.*

2:15 p.m. Morgan Luckey: **Characterization of Thorium-bearing Minerals in Highly Radioactive Rare-Earth-rich Rocks at Mountain Pass, California**
Advisor: Jade Star Lackey, associate professor of geology, Pomona College

The occurrence of thorium in lanthanide-rich rocks at Mountain Pass, California was studied to determine the origin of actinide enrichment and the effects of decay on surrounding minerals. Mountain Pass is mined for Ga,Y, Zr, Nb, In, Ta, Re and all of the naturally occurring lanthanides except thulium. The area's 0.3–0.4 mr/hr background is primarily generated by decay of thorium rather than uranium. Elemental analysis was done by XRF, WDS-EMP and EDS-BSE; mineral analysis was done by XRD, SEM and petrographic microscopy; and a Geiger-Muller counter and gamma spectrometer were used to estimate relative decay rates. Thorium occurs as thorium silicates with uranium phosphate cores in micron scale grains along paths of hydrothermally altered carbonatite.

Drinkward Recital Hall | Afternoon

Physics

3 p.m. Andrew Donelick, Christopher Hirlinger, Yeahmoon Hong: **Shanahan Grant Project–Experimental Hybrid Propulsion System**
Advisor: Greg Lyzenga ’75, professor of physics

A hybrid rocket motor is a rocket propulsion system that burns a solid fuel and a liquid oxidizer to achieve thrust. The Experimental Hybrid Propulsion System is a student-driven research project that aims to design, develop, build and test a throttleable hybrid rocket motor. The ultimate goal is to control the thrust of the motor at any point in time, so that it can be programmed to follow variable thrust curves. This year, we focused on designing and constructing the motor and its test bed. Team members worked on understanding the theory of rocket motor design, constructed and tested a small demonstration motor, designed and constructed a reusable combustion chamber, nozzle, oxidizer plumbing system, static test stand and data collection system.

Shanahan B442 | Afternoon

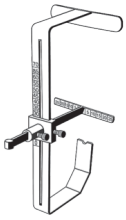
Chemistry and Biology

3–5:30 p.m. **HIV-AIDS: Science, Society and Service**
Advisor: Karl Haushalter, associate professor of chemistry and biology

Students from Bio187, Chem187 and STS187 will make their final summary presentations of their community engagement projects. Each team of students worked together with a community-based organization on a semester-long project related to HIV-AIDS.

3:00–3:15 p.m.	Introduction and overview
3:15–3:45 p.m.	Crossroads Team: Miranda Parker, Sophie Parks, Zoe Brown (PZ)
3:45-4:15	Bienestar Team: India Richter (PZ), Christian Gomez (POM), Danie Diamond (SCR), Monique Nguyen (CMC)
4:15-4:30 p.m.	Break
4:30-5 p.m.	Youth Above the Influence Team: Molly Horgan (POM), Lauren Kecskes (CMC), Alex Washburn (SCR)
5-5:30 p.m.	Promotoras Team: Christopher Zazueta, Jacqueline Tran (POM), Karen Hou (POM), Marta Bean (SCR), Sherry Zhang

Engineering



1:30–
2:15 p.m.

E4: Introduction to Design and Manufacturing
(break 2:30-3 p.m.)

Device to Measure Nose Shape During Surgery
Client: Dr. Brian Wong, Beckman Laser Institute, Irvine, Calif.

I am looking for a device that is autoclavable and can measure changes in nose shape during surgery. There is an existing solution (a projectometer, see image) but it is difficult to use, not very accurate, and prone to movement. This device gives you two measurement points on the nasal tip—one north-south and one front-back. Ideally, I would like to know the shape of the nose in a more robust way—for example, how far the nose sticks out and how far it rotates and changes along its profile, all measured during a surgical procedure. We need to achieve sub-millimeter accuracy with the device.

1:30 p.m.	Team 1: Kimi Bourland, Zach Miller, Alex Ozdemir, Kangni Wang
1:45 p.m.	Team 3: Zoe Tucker, Paul Slaats, Zane Bodenbender, Sam Dietrich
2 p.m.	Team 2A: Alana Chapko, Lucy Kaye, Nathan Miller, Anna Zimmerman
2:15 p.m.	Team 2B: Marisa Kager, Nga Nguyen, Tyler Smallwood

Design of Improved Shoulder Sling for Patients After Rotator Cuff Surgery
Client: Dr. Jeff Fairley, Western University of Medicine and the Body Center

After rotator cuff surgery, the shoulder must be immobilized for an extended period of time. During that time, the arm is supported and held away from the patients body by a sling. This sling is supported substantially by the muscles of the patient's neck, causing discomfort and fatigue. The client would like an inexpensive and safe means to redistribute the load off the neck of the patient, while not incurring any new risk to the patient.

3 p.m.	Team 2: Sarah Anderson, Conor Fanlo, Kelly McConnell, Carmel Zhao
3:15 p.m.	Team 3: Noah Marcus, Scott Chow, Scout Pepper, Jonathan Lum
3:30 p.m.	Team 1: Nick Gott, Deval Gupta, Jeremy Lim, Willie Zuniga

Design of Improved Post Harvest Food Preservation Technology for Developing Countries
Client: Tom Little and Patrick Little, Harvey Mudd College
Moderators: Liz Orwin '95, Kash Gokli

Food spoilage after harvest is an important problem in developing countries. Cooling and then sustaining the lowered temperatures has the potential to dramatically improve shelf life of produce, thus increasing access to markets in the developing world. There are, however, significant challenges, including limited capital resources, scarce energy, lack of technological awareness and other problems typically associated with severe poverty. The clients would like to explore techniques and approaches that could be developed into a system for target country Cambodia.

3:45 p.m.	Team 1A: Cassie Burgess, Robert Cyprus, Phuong Nguyen, Paul Picciano
4 p.m.	Team 2: Solhee Kim, Camille Matonis, Joe Sinopoli, Hannah Zosman
4:15 p.m.	Team 3: Charlotte Robinson, Daniel Nguyen, Chanud Yasanayke, Jedrik Chao
4:30 p.m.	Team 1B: Andrew Capron, Owen Chapman, Joanna Ho, Sabrina Li

Shanahan 2454 | Afternoon

Engineering

1:30–4:30 p.m.

E4 Introduction to Design and Manufacturing

Laptop Checkout System
Client: Joseph Vaughan, CIO/vice-president for computing, Harvey Mudd College

Computing and Information Services (CIS) would like to have a cabinet that can hold laptops and can charge them. It would allow students/faculty/staff to check out laptops using their ID card and would record information about who checked what out, when, to a spreadsheet or database (preferably either a Google spreadsheet or our asset database). The solution could be expanded for other devices such as cables and projectors.

1:30 p.m.	Team 1: Juan Ramirez, Ivan Shaw, Aaron Stringer-Usdan, Kira Wyld
1:45 p.m.	Team 3A: Lucy Yu, Dan McCabe, Alexa Le, Kathryn Jones
2 p.m.	Team 2: Evan Bodell, Mario Diaz, Aaron Friend
2:15 p.m.	Team 3B: Amy Brown, Jerry Martinez, Mike Chaffee
2:30-3 p.m.	Break

Miniature XYZ Translation Stage for Smartphone Camera
Client: Joon You, Praxis BioSciences, Irvine, Calif.

Praxis BioSciences is working on a miniature spectrometer technology that will be compatible with a smartphone. Current method relies on CCD arrays about a size of 1cm x 1cm. We would like to extend this technology to be compatible with a smartphone camera sensor (which is tiny [2um x 2um]). The challenge lies in positioning the spectrometer in precise location with tight precision on the order of micrometers. The key technical requirements are size (relative to the phone) cost (under $50) and material selection (not too heavy) as the portability and affordability are the key advantage of this technology over the conventional spectrometers.

3 p.m.	Stage 1: Calvin Leung, Paige Rinnert, Shiyu Zhang
3:15 p.m.	Stage 2: Lakshmi Batachari, Siyi Hu, Jerome Jahn, Ian Song
3:30 p.m.	Stage 3: Kazuho Maeda, Leonardo Huerta, Wai Sing Wong, Raunak Pednekar

A Safer Baby Bath Seat
Client: Kids in Danger, Chicago, Ill.

Baby bath seats are devices designed to aid a parent in washing a baby that cannot fully support itself, typically between 4–10 months. Unfortunately, injury and death are a result of the failure modes of these devices. This is mainly due to parents leaving the baby unattended after being lulled into a false sense of security concerning the safety of the bath device. Since 1983, there have been more than 130 known deaths associated with bath seats. Lawsuits and ethical obligations associated with these deaths have forced all but one manufacturer to cease production of baby bath seats. These obvious safety concerns have left KID (a non-profit organization that assesses the safety of baby products on the market) with no safe baby bath seats to recommend to parents. Our mission was to develop a safe solution to effectively wash a baby without allowing the caregiver to leave the baby.

3:45 p.m.	Team 1: Cherie Ho, Joshua Ryan Lam, Natasha Parikh, Emily Schooley
4 p.m.	Team 3: Jesse Joseph, Rachel O'Neill, Lydia Scharff
4:15 p.m.	Team 2: Emily Beese, Cherilyn Chan, Eliana Keinan, Elyse Pennington

Wednesday, May 7 | Evening

Caryll Mudd and Norman F. Sprague, Jr. Gallery

Humanities, Social Sciences, and the Arts

6–8 p.m.

Art 033: Photography Art and 179C: Undisciplined Art
Advisor: Ken Fandell, associate professor of art and Michael G. and C. Jane Wilson Professor in Arts and the Humanities

Artworks produced in Harvey Mudd art classes.

Artists
Jacob Tracy Bandes-Storch, Benjamin Junhua Chasnov, Alejandro Jose Frias, Lisa Gai, Abhishek Goenka, Jane Elizabeth Hoffswell, Cecily Beatrice Hunt, Minji Lee, Jack Yunung Ma, Christian Taylor Mason, Bryan Roman Monroy, Natasha Aseem Parikh, Miranda Chantelle Parker, Frances Yenan Su, Rebecca Ann Thomas, Felicia Marie Agrelius, Tyler C. Cohen, Madeline Rose Goldkamp, Leah Rose Hughes, Chandler Phillip Jennings, Meghan C. Jimenez, Peter W. Megson, Samantha Elizabeth Munoz, Azubuike Isaiah Ndefo-Dahl, Alexander Merrifield Putman, Brittani A. Serna, Katherine Rose Shepherd, Brianna Leilani Thielen, Joshua Austin Vasquez, Bruce YH Yan

MS182 Introduction to Video Art
Selections from videos produced in Video Art class will show in this looping video projection. Project assignments ranged from (1) formal experiments about video's capacity to represent time, space or light to (2) subjective portrayals of thoughts, feelings or dreams to (3) reflections on the ubiquitous uses of video today.

Video Artists
Gillian Chen, Marley Cohen, Mary Elise Elam, Samantha Englert, Emma Frederick, Alejandro Frias, Mitch Horning, Tyler Hoyle, Samantha Munoz, Angad Ohri, Weerapat Pittayakanchit, Michelle Schultz, Nicholas Smith, Aarthi Sridhar, Tyler West, "Laura" Xin Zhang

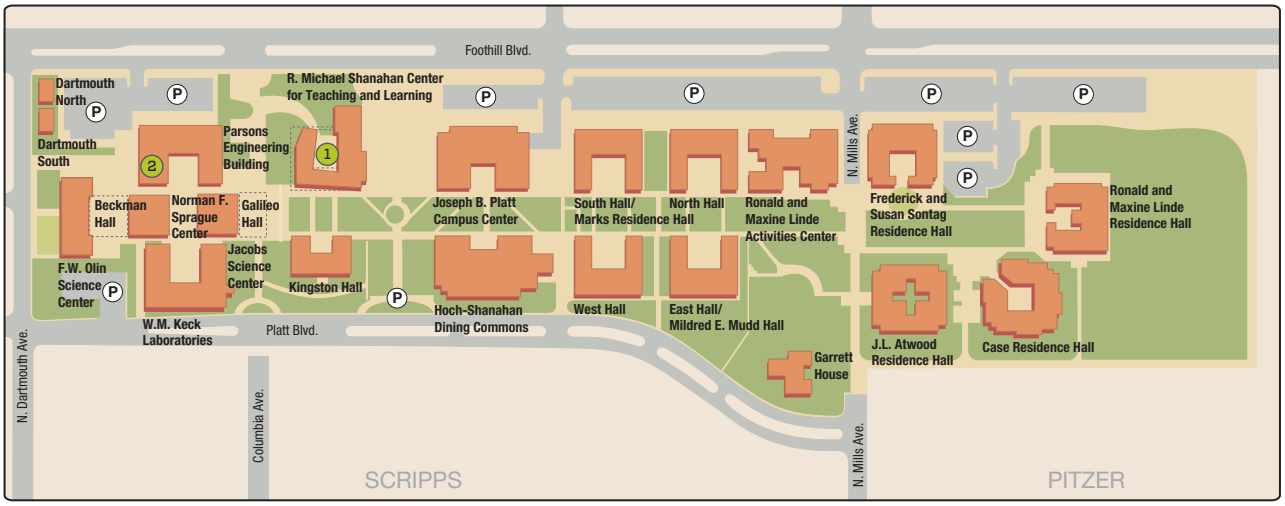
Drinkward Recital Hall | Evening

8–10 p.m. **Jazz Concert, Music of Bud Powell**
Advisor: Robert Keller, professor of computer science

Students will perform, in a mixture of trios and small combos, music of celebrated jazz composer and pianist Earl (Bud) Powell (1924–1966). Bud Powell was one of the legendary musicians who led the development of the bebop genre. His legacy includes hundreds of recordings as both leader and sideman, in which can be heard a then-innovative style of left-hand comping while the right-hand played lines similar to those of bebop horn players such as Charlie Parker.

Players
Sun Hwi Bang, drums
Eric Benjamins (PZ), alto sax
Brett Berger, piano
Hayden Blauzvern, alto sax
Aric Hunter, guitar
Andrew Jevsevar (PZ), electric bass
Robert Keller, instructor, piano, trumpet
Kelly Lee, piano, vocal
Brennan Plassmeyer, drums
Xiaoyin Qu (POM), piano
Tim Rotolo (CMC), piano
Victor Shang, piano
Sid Srinivasan, drums
Ankit Sud (CMC), drums
Jack Tyndall (PZ), tenor sax
Mitul Verma, Indian flutes
Matt Wilber, piano

Tunes
Bouncing with Bud
Buster Rides Again
Celia
Elogie
Hallucinations
I'll Keep Loving You
Oblivion
Parisian Thoroughfare
So Sorry Please
Un Poco Loco



1 R. Michael Shanahan Center for Teaching and Learning
Drinkward Recital Hall
Caryll Mudd and Norman F. Sprague, Jr. Gallery

2 Parsons 1287

Ⓟ HMC community parking only. Public parking available on Platt Blvd. and Foothill Blvd.

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