



# COSMOS UC San Diego

California State Summer School for Mathematics and Science 

A RESIDENTIAL ACADEMIC EXPERIENCE FOR TALENTED HIGH SCHOOL STUDENTS AT UC SAN DIEGO

## Week 1 Newsletter

### COSMOS 2015 has begun!

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**C**osmos is here and what a week it has been! The students are settling in, making new friends and becoming familiar with the campus. This newsletter, the first of our weekly newsletters, will provide you with a glimpse into your students' lives over this past week.

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# RECAP of OPENING DAY

One hundred and eighty five students arrived on the UCSD campus for the greatly awaited COSMOS 2015 program to begin. Families and staff were found dispersed throughout the Eleanor Roosevelt College (ERC) as students moved into their suites, their home for the next month. The joyful music and friendly environment was very welcoming. All people present then walked to Peterson Hall for the Introduction presentation and Welcoming remarks. Students then split into their clusters and took a tour around campus led by the Residential Advisors. They then returned to ERC



and said their good-byes to their families. The clusters had ice-breakers for the students to begin meeting each other, for they will be working and learning closely together throughout the program. Dinner was well-enjoyed at the college dining hall, Cafe Ventanas. After dinner, the rules and boundaries for the program were clearly explained. There were still plenty of activities left to do for the day. More ice-breakers were played by everyone together and others that involved friendly competition between the clusters. Eventually, everybody headed to their suites, where they finished moving in and met with the group of people with whom they will be living. Lights were out by 11:00pm, to ensure enough energy for the next day. This was only the beginning...



## RESIDENTIAL LIFE

Your minds will be at ease to know that your student is alive and kicking. As a matter of fact, students have been kicking soccer balls, kicking and screaming when we make them go to sleep at 11pm, and kickin it with their neighbors, cluster mates, and the staff. Activities have included Laundry 101, basketball, chalkboard design, Mason Jar Sundae, ice breakers galore and more. And that was just the first four days. They have also been hard at work preparing their cheers and choreographing their dances/skits for the famous COSMOlympics competition between clusters for Friday afternoon. We are thrilled to report that we have had no major injuries so far despite housing 185 teenagers. In fact, there has been some significant hand strength building from activities like high fives from Akhil and detailed lanyard making by William. Other types of learning have been happening outside of the classroom as Shannon has assisted Phillip in learning his right head turn from his left and Maggie demonstrated details of the Grand Canyon. Kalpana and Lisa are working at hard at making dance turns a step of ease for everyone while Ann-Katherin became seaweed for a little while so Noah could have a chance at being a shark. Though safety has been our number one priority, the students have been successful in creating a chatty and energetic community in a short period of time. All in all COSMOS has been off to a great start in and out of the classroom. We hope to continue developing the community next week as we go to the zoo; we try out the beach; make it over to the natatorium; and continue to kick it!



# DISCOVERY LECTURE SERIES

## “Coordinated Robotics: From Ideation, to Prototype, to IP, to Market.”

Chancellor Pradeep Khosla gave a brief introduction to kick off this year’s Discovery Lecture series on Tuesday morning. Chancellor Khosla informed the students how lucky they are to get exposure from the leading experts in the fields they are studying and that this was an opportunity to see how different learning will be in college. Chancellor Khosla reminded students that while STEM fields are extremely important, they shouldn’t ignore the Arts and Humanities. It is extremely important for people to become holistic in both sides of the brain. Finally, Chancellor Khosla urged students to take everything they could out of the COSMOS experience and he hopes to see them one day come to UCSD to continue their education. Following Chancellor Khosla’s speech, Professor Thomas Bewley lectured on “Coordinated Robotics: From Ideation, to Prototype, to IP, to Market.” Professor Bewley displayed some great robots, including the MiP (Mobile Inverted Pendulums) and discussed how a simple idea in a classroom turned into a multi-million dollar industry. MiP can balance itself and drive around on two wheels. Professor Bewley showed them how you can engage with MiP in a variety of ways such as using hand gestures to making it dance and making it carry items across the room. He told the



students how important their ideas were and that they shouldn’t ever let technology stifle their creativity. Technology should only fuel their creativity. Professor Bewley informed them of the many different educational programs and opportunities available to students that don’t require formal education. He also encouraged them to consider cross-disciplinary subjects. He echoed Chancellor Khosla by saying that the Arts and Humanities are also important subjects to learn in addition to Science, Engineering, and Mathematics. Both Chancellor Khosla and Professor Bewley’s lectures gave students a glimpse into the future of engineering, the necessity of engineering, and the importance of being cross-disciplined to succeed in today’s environment.

## FAMILY WEEKEND REMINDER

Family Weekend is July 17th through July 19th. Students must be checked out by an adult specified on the Family Weekend Form between **6-9pm on Friday and must return between 2-5pm on Sunday.** Optionally, students can be checked out at 6pm on Friday and returned by 9pm that same evening or alternately, 2pm on Sunday, returning by 5pm that day. We do not have the staff to accommodate individual schedules. **All students MUST be back to campus by 5pm on Sunday.** PLEASE speak with your child and let us know *by email* if their choice for the weekend has changed so we can staff appropriately. There are many

students who will be staying on campus during the weekend and the RAs have a full schedule of activities and fun planned for those students. **If you have any questions, please call our office at (858) 822-4361 or email [cosmos@ucsd.edu](mailto:cosmos@ucsd.edu).**



# CLUSTER 1: COMPUTERS IN EVERYDAY LIFE

**Cluster 1:** <http://ucsdcosmoscluster1-2015.blogspot.com/>

On Day 1 of COSMOS, Cluster 1 had not only gotten a glimpse of what was in store for the next four weeks, but created an Android app! During this first week, we began to learn Applinventor. It is a scripting language with a graphical interface which

allowed us to put together our simple app in a matter of hours. Applinventor allows us to develop applications for Android based devices, like cell phones. Some of our

first applications for the Android phone include: PaintPot (drawing and painting application), and A Mole Mash game (similar to Whack-a-Mole). Next we worked on our own unique app with our partner. If we wanted to, we could put our apps up for sale in the Android Market! We were paired up

in teams and made a group app which we will present on Thursday afternoon to the cluster. In about three days, we had created an app and could see what other features we still had to work on.

On Wednesday, we practiced number conversions between different bases.

Then we played "Around the World" where Prof. Kastner showed us a flash card with a binary number on it and

we had to give the hexadecimal equivalent. The "winner" was the one who could go around the room against each person and return to their seat – therefore going around the world. Jesse came out on top and won – with Izabella at a close second behind! During lab, we finished up working on our apps and continued to discov-

er the possibilities and limitations of working on a mobile platform. Thursday we heard a presentation from the Science and Engineering librarian that will help us do our research for our upcoming work. In the afternoon, we'll present our work to our cluster. The presentations will be available on our blog - <http://ucsdcosmoscluster1-2015.blogspot.com/>.

We will also begin working on Scribbler Robots during lab. We can't wait to begin to get our robots to obey our every command!

Friday will be our Robot Dance-Off! Videos of our dancing Scribblers will be posted this weekend on our blog.



# CLUSTER 2: ENGINEERING DESIGN AND CONTROL OF KINETIC SCULPTURES

Monday morning we proved that we take the saying

"safety first" literally by attending a lecture on safety. Students learned about how to conduct themselves safely in the labs, how to behave around common hazards, how to avoid accidents and prevent injury. Then we walked the rest of the way across the campus through Warren engineering quad to our home for the next four weeks, the artfully named EBU-2.

Students filed into a lecture hall and Dr. Delson warmly welcomed students and gave an introduction to cluster 2 as well as the pros and cons of three different fastening mechanisms. Students considered a challenging problem individually at first and then vigorously discussed it in small groups. Informal votes were taken before and after discussion for each of the three fastening methods.

A cluster two tradition followed the morning lecture as we headed out to the engineering quad to examine the mechanical clock built by a team of UC San Diego engineering students. We sat in circles as students introduced themselves and talked about their background and goals for the summer. It is clear to this Teacher Fellow that we have a very talented and bright group of students.

In the afternoon we split into two groups and began the process of making the pendulum clock. Students



were instructed on the proper use of tools and safety in workshop and began to drill, file and tap parts. Chris



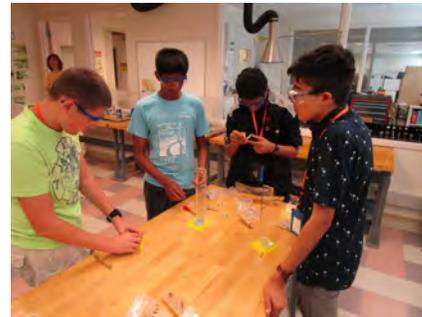
Cassidy led us through the lab and TA Madeline expertly guided students in their clock build. Down in the computer lab, TA Ivan showed students how to master Auto-Desk inventor to create the escape wheel and pendulum for the clock.

Tuesday morning we had the first of our inspirational Discovery Lecture speakers, Mr. Thomas Bewley who regaled us with the tale of the birth of a robot from the seed of an idea in a final exam question, all the way through research and development and bringing the toy to market and selling over a hundred thousand units. This toy, called the "Mip" (short for motorized inverted pendulum) was the star of the show, and much of the theory behind its success related to our cluster. He also gave students advice on project hardware like the Beaglebone Black Linux-based processor and what to expect in college life and beyond.

After the Discovery lecture, we learned about the physics of pendulum motion from Dr. Delson, who used calculus (some students seeing this for the first time!) to derive the equation of pendulum motion. A perfect topic to explain the physics of the robot that had just captured our imaginations and also one we will apply in the analysis of the pendulum clocks students are building this week. Wednesday was a full-on build and design day after students got an introduction to powerful modeling software, Working Model 2D, from Dr. de Callafon. Students in the computer lab clicked away on their unique and creative designs and they clearly dis-

play a diversity of interests and aesthetics values. In the design studio, students completed their clock bases with some countersunk bolt holes, press fitting axels and minor assembly. All of this is motivating them to finish their designs so they can have them cut out by the laser cutter for final assembly in a working clock.

Thursday morning we had a presentation entitled "virtual library tour" in which all COSMOS students were introduced to the myriad of online resources provided to students of UC San Diego. Also discussed were research methods with the school's ROG-



ER database and the deep web. It is clear that students will be able to capitalize on this information this summer and then also during their academic year. Later, students were assigned a clock web page where

they will put their analysis reports, videos and animations. Construction of the clocks continued in the afternoon and we cut out the first pendulums for students who had completed their designs.

Friday we will work on finishing the clocks, working on the clock web pages and talking about the ethics essay which is due next week. The first week has been an intense and immersive engineering experience for the students and they seem excited to continue designing, building and problem solving in the next several weeks.



# CLUSTER 3: LIVING OCEANS AND GLOBAL CLIMATE



Cluster 3 of COSMOS has had an action-packed first week! Dr. Pomeroy has been leading discussions regarding climate change and Dr. Lai has been taking students to examine marine biology. Mr. Matt Ruppel, a former COSMOS graduate student, and current teacher at High Tech High North County, is new as a COSMOS teacher fellow this year. Here are some student thoughts on week one!



“On the first morning, we were driven down to the Scripps Institute of Oceanography for a lecture by Dr. Lai about marine



biology. We then went out onto a research pier where we observed bat rays and guitar fish swimming near the sea floor as well as an artificial tide pool ecosystem created on the pier, serving as a wonderful introduction to this aspect of our cluster topic.” – *Rika Shukla*

“Monday afternoon we headed to the lab and met Dr. Pomeroy. We learned about albe-



do by testing the reflectivity of white paper, black paper, aluminum foil and other surfaces.” – *Tina Fann*

“The discovery lecture by Professor Bewley on coordinated robotics was fascinating and informative! I had a wonderful time learning about the types of projects pursued in the various UCSD robotics labs, and was glad to see that it fostered and encouraged innovation and student-created projects like the MIB toy now on sale. I especially loved the flywheel-powered spherical vehicle. I’d love to learn more about it. In addition to the lab projects, he also covered some valuable



advice about skills to seek out pre-college like familiarity with Linux, 3D CAD (computer-aided design), and basic coding.” – *Barbara Garrison*

“During the Science Communication period, we discussed, in Socratic Seminar format, the pros and cons of the Discovery Lecture we had just heard and then talked about the do’s and don’ts of any lecture or speech... Lastly, we discussed the ways people most efficiently learn (visually,

through lecture, etc.). I personally look forward to learning more about science communication and implementing my new skills during my final project.” – *Camille Rubel*

“On Tuesday afternoon we got to choose our science project groups. There are six project groups with three to four people in each group. ... Three of the groups will work on their project in the lab with

Dr. Pomeroy while the other three groups will work with Dr. Lai at SIO.” – *Carol Tsai*

“On Wednesday we started off at SIO (Scripps Institute of Oceanography) and we got to explore the tide pools and all of its inhabitants, as well as enjoy some fun time in the waves before going back up to a very interesting lecture on ecosystems. In the lab, we experimented with Hooke’s Law and learned how the vibrational frequency of a spring is analogous to that of the vibration of atoms!” – *Thomas Kim*



We are off and running in Cluster 4! Eager minds, smiling faces, and great attitudes abound. The C4 Cosmopolitans are getting acquainted quickly, sharing ideas and helping each other with the fun challenges of their introduction to structural engineering and geophysics. Our group of 24 students has already displayed great enthusiasm and pluck, and seem to be integrating into the regime of their simulated college lifestyle quite well.

Their initial activity and icebreaker was designing and building a K'Nex structure, and then testing it on the 'shake table'. It is a bit more complicated than it initially sounds however. The designing process involves selecting structural members on the basis of their perceived strength as well as cost. A ratio of cost per square foot is calculated, and the students learn about real life considerations of architects and engineers. Lead professor Lelli introduced the terms and elements of



structural design earlier this week.

We saw some ingenuity and thought lead to successful testing that withstood the simulated seismic energy on our shake table, and some equally thoughtful designs fail instead. (Please visit our cluster website to view images and videos of their testing.) They will be using the shake table frequently in the upcoming weeks



to test more sophisticated creations. Yes, they were beginning to think like engineers!

Our C4 group then attacked truss analysis, or did truss analysis attack them? Their math skills, conceptual skills, and patience were greatly tested, but hey, that's sophomore level college information they're digesting. So following some heavy lecture and discussion, they broke into small groups and designed and assem-



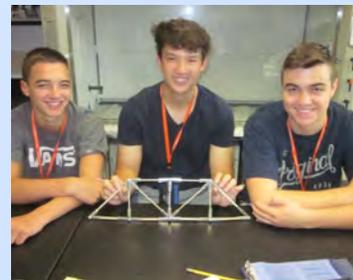
bled wood and aluminum trusses, then tested them after calculating a predicted strength. Thomas Edison wrote that the three keys to great personal achievements were hard work, perseverance, and common sense. By the end of the day, our Cluster 4 students understood his observation well!

Kevin enjoyed introducing and sharing his geophysical knowledge with the students, which led to some basic geology discussions and the adoption of a special rock for each student. Students had to use adjectives and descriptive terms in order to allow another team to quickly match the adjectives to their 'mystery' rock. Similar to the K'Nex activity, observational skills were honed and

tested. Students were also given a primer in plate tectonics, and were assigned some research into historical earthquakes in specific geographic regions. Soon they will understand deeper relationships between earthquake locations and structural design necessities.

The week concluded with the testing of metal 'coupons' for tensile strength and behavior. We crunched numbers and formulas using Excel, quantified the differences between aluminum, steel, and brass, then graphically displayed the data. A Friday tour will give the students a taste of the unique facilities at UCSD, and current engineering research that's underway. Soon they will be placed into one of eight assigned groups of three, and this cadre will design, build, test, redesign, and collect data on a specific structural type or building material. This will be their focus for the remaining three weeks. More about this, their major project, during the next newsletter.

It is our pleasure to work with your terrific students at COSMOS this summer. We sincerely mean that it is a highlight of our year! Cluster 4 rocks!



<https://sites.google.com/a/eng.ucsd.edu/ucsd-cosmos-cluster-4-2015>



# CLUSTER 5: FROM LASERS TO LCDS: LIGHT AT WORK

Cluster 5: “LEDs to Lasers, Lights at Work” hit the ground running with a safety brief on proper use of class 3B, 3R and 4 lasers followed by a lecture by Professor Charles about the electromagnetic spectrum, quantum mechanics, electron levels and more. After lunch at Cafe Ventanas, we returned to the holography lab in the basement of the Jacobs Engineering building to conduct an investigation using red and green lasers to develop a clearer understanding of total internal reflection, Snell's Law and dispersion of light which was led by principal investigator Dr. Peter Ilinykh.

Tuesday morning we were welcomed to the Universi-

ty by Chancellor Khosla followed by our first Discovery Lecture which was delivered by an animated and engaging Professor Thomas Bewley of UC San Diego.

Following the lecture we conducted our first breakout session to develop a better

understanding of the importance of communication in science. In the afternoon, we tackled our first workshop in which we created organic solar cells using blackberry juice, titanium dioxide and graphite. In addition to being a fun and exciting learning challenge, we were able to create working solar cells!

During the rest of the week we continued to deepen our conceptual knowledge of photon-

ics through lecture as we conducted labs to develop a fuller understanding of the structure and function of semiconductors such as LEDs and we created spectrometers that we could affix to the cameras of our cell phones and use to identify compounds based on their spectral signature.

In addition to our in-class time we were able to visit Professor Charles' lab as well as the Falling Star (a Wizard of Oz-like house affixed to the seventh floor of the Jacobs Engineering

building). After such a busy week we are looking forward to a weekend spent relaxing at the world-famous San Diego Zoo and the white sand beaches of Coronado!



# CLUSTER 6: BIODIESEL FROM RENEWABLE SOURCES



In the first week of COSMOS, Cluster 6 has begun exploring the organic chemistry involved in making biodiesel, have made biodiesel from canola oil, and worked on purifying the biodiesel. We've also begun the process of researching ethical issues related to biodiesel and renewable resources.

"Opening day was a blast! We all arrived on campus, checked in, and got to know our suitemates. Then we went to a lecture where we learned more about all the activities that we'll doing in the upcoming month. At last we met our cluster and our cluster RA's, Lizzie and Colin! They took us on a tour of the parts of the campus that we would be using. As we toured, we all realized that we're going to be doing a ton of walking this month!

Next, we headed back to the dorms and said goodbye to parents. After a great first dinner at Café Ventanas, we played some entertaining icebreaker games with everyone in the camp, and then headed to the dorms to play some more icebreakers with our suitemates. With such an exciting and busy day, it was easy to fall asleep as soon as we lay down our heads." - Allison Douglas

"Monday was our first day of class and lab in COSMOS 2015. We met Dr. Pomeroy and Dr. Albizati and received an introductory lecture

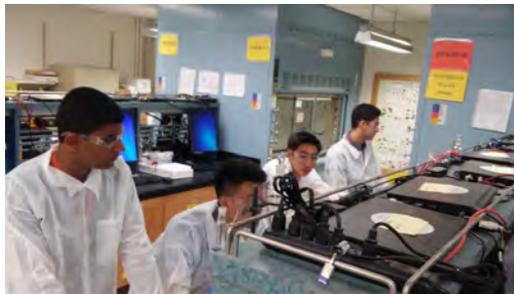
on chemistry concepts and biodiesel's potential to replace fossil fuels and create renewable energy. We proceeded that afternoon to the lab and split into partners. We then began the process of creating biodiesel by causing a reaction in fat molecules. Afterwards, we participated in recreational activities with our cluster and other students." - Amith Lukkoor

"Tuesday, after breakfast, we started the day by attending a lecture given by Professor Thomas Bewley of robotics. All of COSMOS was told by Dr. Bewley about the trials of college, applying your specialties into something new, and how he combined his interests to make a hi-tech toy with his students. After the seminar, we had our first Science Communication class. With our teacher fellow, Mr. Towler, we discussed the value of the speech and the mechanics of a presentation in

general. After lunch, we came back to the labs we started on Monday. We separated the biodiesel from the glycerol and began the process of washing the biodiesel so that we can proceed to the next step of the lab. After many washes, our biodiesel was clean of impurities and the academic day was over. We walked back to Eleanor Roosevelt College to spend the rest of our COSMOS day."

"During lecture, Dr. Pomeroy explained the advantages and disadvantages of biodiesel engines

compared to gasoline. He presented the students with other aspects of the biodiesel industry such as government involvement, foreign policy, and the use of algae to make gasoline and biodiesel.



Next, Dr. Albizati reviewed more organic chemistry concepts pertaining to our biodiesel lab and went over the Valence Bond Theory.

In the lab, we continued to rid our biodiesel of left over water through a drying process. We then chose our project topics and formed groups.

At night, all COSMOS students participated in a variety of activities including time management, chalk art, and sports." - Austin Shakiban

With our first week well underway, we'll next be using an array of equipment to analyze the properties of the biodiesel we've made, begin planning the group projects, and looking into ethical issues surrounding the cluster's focus.



# CLUSTER 7: BIOENGINEERING/MECHANICAL ENGINEERING: THE AMAZING RED BLOOD CELL



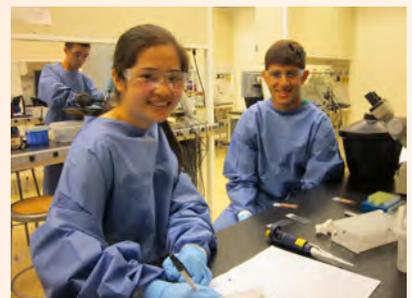
The focus of Cluster 7 in the first two weeks of COSMOS 2015 is “Bioengineering; the Amazing Red Blood Cell”. The first week has been packed with hands-on laboratory work including learning how to use small volume transfer equipment (micropipettors), an indispensable tool commonly used in bioengineering research labs. Students immediately applied their newfound expertise in a lab that analyzed bovine blood cells under different experimental conditions. Blood cell morphology was analyzed using light microscopy to distinguish red blood cells (RBCs, erythrocytes), white blood cells (leukocytes) and platelets. Image J software (from the National Institutes of Health) was then used to quantify the morphology of RBCs under hypertonic, isotonic or hypotonic conditions. First week labs were very closely linked to the highly engaging mini lectures given by Dr. Carlos Vera on the molecular and cell biology of blood cells.

Outside the lab students attended a presentation on the UCSD requirements for lab safety and a second presentation that focused on biosafety and other

safety issues when working in the Bioengineering building. The head of the UCSD library system also presented a very nice summary of the electronic resources available to students to facilitate their COSMOS final projects. All COSMOS students attended the first of a series of Discovery lectures given by Professor Tom Bewley of the Mechanical/Aerospace Engineering Department who presented a highly engaging overview of vari-

ous robots developed and commercialized at UCSD. In the science communication segment of cluster 7, students have begun to analyze the steps involved in generating and effectively ana-

lyzing scientific data. They have also begun to consider their final projects as well as the ethical considerations involved in mechanical or bioengineering research. Finally, students launched a biography presentation series this week in which the lives and contributions of prominent scientists are researched and summarized in an informal presentation made to all of Cluster 7. In summary, Cluster 7 students have shown a very high level of engagement in their first encounter with bioengineering research and are off to a great start in COSMOS UCSD!



# CLUSTER 8: TISSUE ENGINEERING AND REGENERATIVE MEDICINE

**E**arly

Monday morning we began

with safety training to make certain we were properly trained to safely perform our research in the lab. We began learning how tissue engineering has helped patients, either as new models are developed to study tissues, or in the clinical setting such as controlling or enhancing wound healing. We're also learning how to keep a scientific lab notebook and were given an introduction to our tissue engineering labs. That was just the first day and we have not stopped since! In the lab we have all learned how to properly pipette, use serological pipettes, make serial dilutions, use a spectrophotometer, use sterile technique, make media, and use light transmitting microscopes to visualize cells. Tuesday, we were given an overview of how to best utilize the UCSD library, which will be critical for our ethics and research papers. We have had the opportunity to refine our Excel skills, hear about current topics in tissue engineering, and learn more about how cells differentiate into epithelial, connective, nerve or muscle cells and their fate as they may be used for motion, adhesion, or secretion. At this point we definitely have a clearer understanding of tissue engineering. In our scientific communications section the discussions have been focused on how people learn, how to effectively communicate and we had a brief introduction to our ethics project. Overall we have had an amazing start because the brilliant, hard-working, young minds in Cluster 8 are great!



# CLUSTER 9: MUSIC AND TECHNOLOGY



What makes music sound good?

And, how can we make music electronically? Cluster Nine's first week addressed both of these questions. On day one we learned about the physics of notes, and built

electronic wave generators with "Little Bits". We mixed tones to make beat frequencies. We tested our ears by generating tones we thought would be perfect fourths and fifths, and checked to see how close we were. One of us tuned an A by ear to 441 Hz (only missed it by one!)

Tuesday was our first day of Science Communication. The day started off with a very interesting discovery lecture from Thomas Bewley, a professor at UCSD. With a very energetic attitude, he talked to all of us about robotics and some life lessons. He was extremely passionate about everything he said, and he was truly inspiring. After the lecture, the entire cluster went up to another room to talk about the lecture. Before we dove into Professor Bewley's lecture, we got to know each other a little more. We thoroughly learned everyone's names and then began discussing the lecture. About half the cluster



participated in a Socratic Seminar discussion to provide our thoughts about the lecture.

After lunch, the other half of them in a hat. Then each person took a question and talked about it to the cluster for about two minutes. We

wrapped up the day by introducing an essay about ethical issues in the field of music technology and began brainstorming ideas.

Wednesday morning started off with a lecture about embedded electronics, complete with a live demonstration of a motion-controlled music program. This was followed by a presentation on consonance and dissonance, and, using



Audacity, students listened firsthand to the beating sound (called "roughness") generated by playing two slightly different frequencies. Next came classes in the lab, and students installed Canopy onto their computers and began to

learn the syntax of Python, covering the basics of variables, plotting, and for loops. The day ended with an impromptu jamming session, and everybody, even the instructors, pulled out their instruments, Little Bits, or microphones to make some music.

# COSMOS Style

Summer Fun

