

# CLUSTER 2: ENGINEERING DESIGN & CONTROL OF KINETIC SCULPTURES

On day 1, all COSMOS students were introduced to the necessary lab safety guidelines they need through their journey using UCSD labs. Detailed instructions were given on how to handle potentially harmful equipment or chemicals, and what to do in case of emergencies or hazardous incidents. After the training, students met with their cluster professors, Professor Raymond de Callafon, and Professor Veronica Eliasson, who shared the four week schedule and gave an overview of the first week's project; the Clock Project. Students introduced themselves, shared their interests, and the reason they chose cluster 2.



On the second day, COSMOS students attended a "Discovery lecture" by UCSD Nanoengineering professor, Dr. Nicole Steinmetz, who talked about "Nanoengineering Gone Viral". Afterwards, Cluster 2 students worked in the computer lab to develop their own Google sites that will be used as their digital portfolios, and used AutoCAD to start designing their clock parts. They also visited the Design Studio, learned shop fabrication and Lascercamm skills



On the third day, Dr. de Callafon talked to cluster 2 about Computer Simulations and motion. Students were introduced to the Working Model 2D (WM2D) software and had to complete a couple of challenges using it. Students then went to the Design Studio to work on fabricating parts and assembling their clocks.

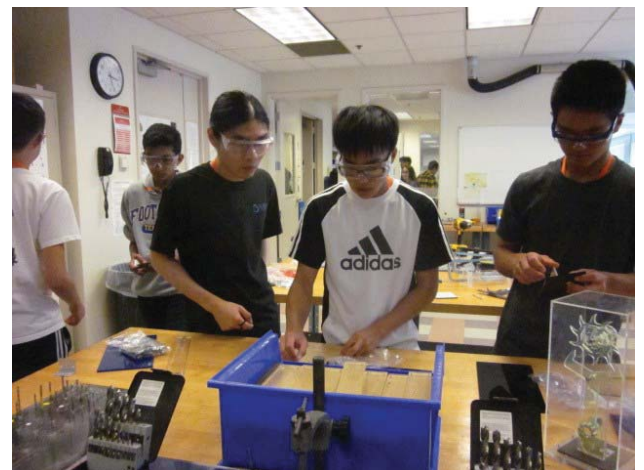


On Thursday, all COSMOS students attended a lecture on how to use the Library resources at UCSD, which they will use throughout their stay at UCSD. Students will research and have access to a huge library of scholarly articles that they will need for their essay write ups and reports.



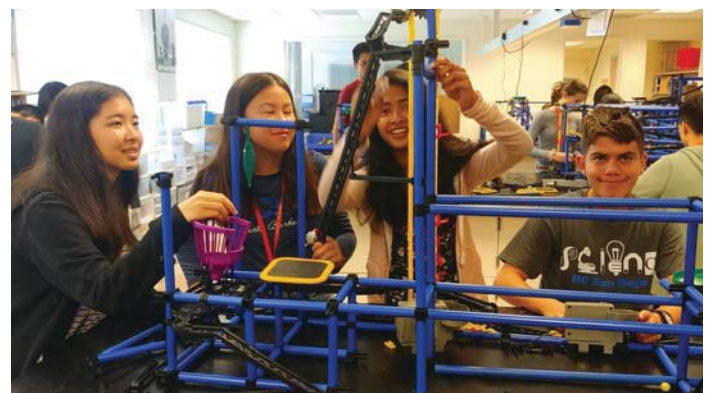
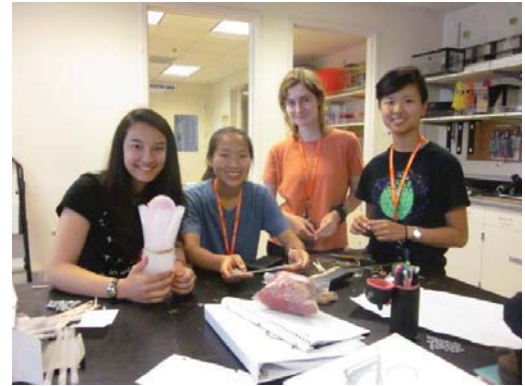
Students continued their work in the lab to create a simulation of their clocks using WM2D. They were

wrapping up their clocks designs and started recording their work on their web pages in preparation to finalize their clock reports.



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After a busy first week where students worked tirelessly on their clock projects, it was time for them to get in teams and start their first team project. Students formed their teams based on different areas of diversity. They considered cultural backgrounds, gender, skills, personality, and artistic vs. technical inclination. Professor Eliasson gave a lecture on Monday morning introducing the water balloon challenge, which is a kinetic sculpture project that provided an opportunity to learn systematic approaches in a design process, and learn how to work in a team. Students then worked in their groups to come up with the best design that will keep a water balloon from breaking after dropping it from various heights towards a bed of nails. They used Pugh charts to analyze the communication between the team members, as well as analyzing the advantages and disadvantages of each of their designs. On Tuesday, all COSMOS students attended a discovery lecture about Microbiomes in Human and Environmental Health by Dr. Rob Knight, who is the founding director of the Center for Microbiome Innovation and Professor of Pediatrics and Computer Science and Engineering at UCSD. Our students went back to the classroom, and each team presented to the rest of the cluster the process they went through as they worked on the balloon challenge. They discussed how they built, tested, documented, and redesigned the structures. Students had their first physics lecture on Wednesday. They learned about Dynamics of moving objects in Kinetic Sculpture, which was an introduction to their next challenge. They had to design and control Mini Sculptures and use at least 1 sensor, 1 actuator, 1 user input, then automate it. On Thursday and Friday, students had programming lectures and had to work on two challenges, the ping pong and the ball catch programming challenges.



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Week 3 was all about mini sculptures. During this week students learned about physics of ball motion, energy, and impact through which they honed their creative, analytical, communication, project management, and teamwork skills.



Cluster 2 teams started the week by sharing the initial sketches of their mini sculptures, discussed uncertainties in their designs, and got feedback from professor de Calafon. Students used their time in the design studio to prototype and test their initial designs; they added motors, forces, sensors, baskets, trampolines and ramps. In the computer lab, students used Working Model 2D to simulate the behavior in their sculptures, and programmed NXT sensors in RobotC. Professor de Calafon gave two lec-



tures this week. The first was an introduction on the dynamics and control of mechanical systems through which he explained the study of the action of forces on bodies and the changes in motion they produce. And the second was about automatic control & microprocessors. He talked about the interdisciplinary

branch of engineering and mathematics that deals with the behavior of dynamical systems, which allows automatic regularization, stabilization, tracking and disturbance attenuation.



The Discovery lecture this week was about solving climate change with Science, Society & Technology by Dr. V. Ram Ramanathan, a professor of Atmospheric and Climate Sciences at the Scripps Institute of Oceanography, UCSD. After the lecture, cluster



2 students learned about the design thinking process and used it as a framework for their mini-sculpture designs. They started developing their team websites to document their learning experience and keep a digital portfolio to archive work and reflect on their growth and learning. Cluster 2 students also toured the Structural and Material Engineering (SME) and Mechanical and Aerospace Engineering (MAE) labs this week and saw large scale experiments that are currently set up there.



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In our last week of COSMOS, our Cluster 2 students were working on evolving their mini sculptures this week to full operating sculptures integrating their design. They started off by performing risk analysis, testing their sensors, motors, and overall dynamics to determine if the design concept was working as planned. The challenges were to identify the highest risk components of a design, and be creative in finding ways to verify if they will work.



Throughout the week, they worked countless hours expanding and improving their designs, and prepared for the culminating presentation and the research expo. They practiced teamwork skills by communicating, negotiating, and advising their teammates throughout the process. Some team members worked on programming sensors and motors, others were documenting the work on their team website, some were laser cutting new pieces for their designs, and some worked on troubleshooting their sculptures.

Students attended an interesting lecture this week by Dr. Margaret Roberts, a Professor of political science at UCSD. Dr. Roberts talked about her book, *Censored*, where she explained her research involving the distraction and diversion inside China's Great Firewall.

After the lecture, cluster 2 visited the Solar Turbines manufacturing facility in Kearny Mesa; a leading provider of energy solutions. They toured the facility and saw the extensive line of gas turbine-powered compressor sets, mechanical drive packages, and generator sets. After the tour, they enjoyed a sunny San Diego day in Belmont park; where they experienced the transformation back and forth between gravitational potential energy and kinetic energy as they enjoyed the roller coaster and the rest of the rides!

Our students overcame various challenges throughout the weeks, they worked really hard and were able to show great commitment and stamina as they approached various tasks. Professor de Callafon awarded our student winners who successfully completed programming challenges, met highest accuracy in designing their clocks, and those who were able to sustain their water balloon from breaking when dropped from 6 feet high with nice giveaways.

