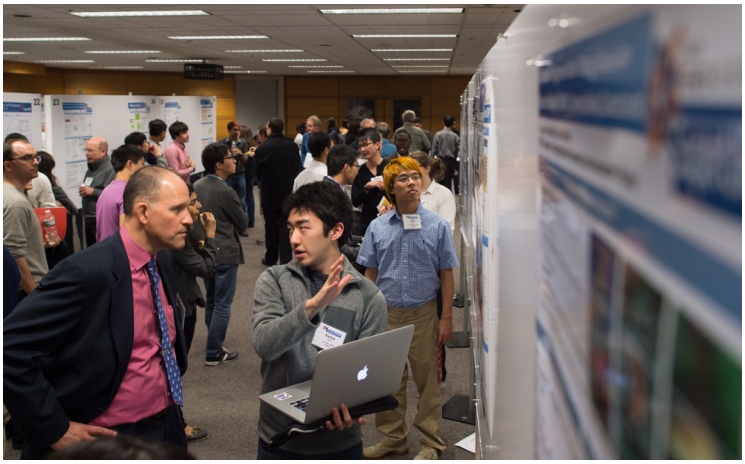
Building a Research Community: SuperUROP in its third year

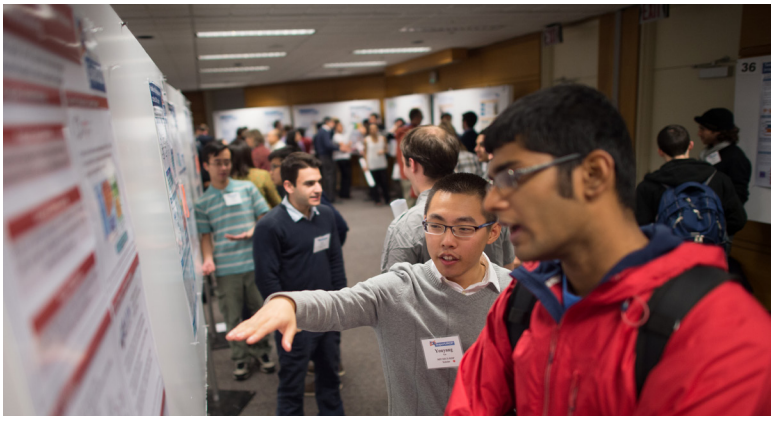
Getting to do serious, year-long research projects in electrical engineering and computer science is in! This year, 104 Course VI juniors and seniors elected to immerse themselves in a year-long research experience in SuperUROP, the three year old program in EECS modeled after MIT's Undergraduate Research Opportunities Program (UROP). Students are seeking the benefits and opportunities that SuperUROP provides – including working closely with a faculty advisor and his/her research group, working in high tech laboratory facilities, publishing a scientific paper or producing a prototype, and building a network with peers and industry sponsors.

"We are creating a community of scholars," notes SuperUROP creator and EECS Department Head Anantha Chandrakasan. "As they are exposed to the breadth of research in EECS, their excitement and enthusiasm to engage in research and innovation is contagious." While UROPs also enable students to conduct research, the SuperUROP includes a two–term course on undergraduate research (6.UAR), which focuses on topics such as choosing and developing a research topic, industry best practices, and presentation skills. The class — taught by Chandrakasan and Dean for Undergraduate Education and EECS faculty member Dennis Freeman — engages a wide range of experts from inside and outside MIT to broaden the approach to research, entrepreneurship and funding.

Support for the SuperUROP comes from industry and private sponsors through the Research and Innovation Scholars Program (RISP). Industries such as Cisco, Texas Instruments, VMWare, and Analog Devices are interested in not only building the next generation of top level researchers but also exposure to new directions in technology innovation. The RISP students also have a chance to present their work to their supporting company as well as to the annual undergraduate research conference started in 2013 called EECScon.



Two sessions were held back-to-back to accommodate the 104 SuperUROP students who presented their research work at the SuperUROP Research Review. Pictured left foreground : Ted Equi, SuperUROP Industry Liaison.



104 SuperUROP students presented their research work at the SuperUROP Research Review in early December 2014, attended by many Industry sponsors, MIT faculty and guests.

In an email to The Tech, in May 2012, Ray S. Stata '57, founder of Analog Devices, said, "As an industrial sponsor, Analog Devices will look for opportunities to collaborate with students and faculty on research topics of continual interest and provide insights into the relevance of research to real world applications. Analog Devices is excited about exploring new possibilities to strengthen our relationship with MIT students and faculty through the SuperUROP program."

"You get to meet a lot of people in different fields — from industry, graduate school and academia," says Lyne Tchapmi Petse '14, who joined SuperUROP in 2013 at the urging of her advisor, Charles Sodini, the Clarence J. LeBel Professor of Electrical Engineering. She saw the program as a way to dive deeper into her project — developing an earpiece that monitors and sends vital signs to a smartphone for doctors to analyze. "The project has given me a lot of insight into my future career choices." (Read more about Lyne and other SuperUROP grads and current students, pages 15-16.)

In addition to the students and company sponsors and mentors, the other key component group in the SuperUROP is the faculty advisor. This group has also been growing with 58 faculty building a working research mentorship with one or more SuperUROP students this academic year 2014-15. EECS faculty members have posted well over 100 research project ideas for which students can apply to work on, beginning in the coming academic year. In the spring, EECS Principal Investigators aggressively recruit undergraduates into their groups through SuperUROP. Each participating SuperUROP faculty member also benefits through the RISP with a stipend — something which George Verghese, the Henry Ellis Warren Professor and MacVicar Fellow notes is not only generous but reflects the enthusiasm of the sponsors in their sustained support of the program.

SuperUROP in its third year, *continued*

Photos taken at the SuperUROP Research Review and Community Dinner where 104 SuperUROP research students presented their work and joined industry sponsors for a Research Community dinner following. [Gretchen Ertl, photography]

"There are so many things to like about SuperUROP!" Verghese, says. "I particularly like the way it gets students to really settle into a research project over the academic year, and to take serious ownership from the beginning. Doing the project in a cohort, with joint classes, activities, milestones, and presentations to the wider community, also changes the dynamics — and not just for the students, but also for the mentors (graduate students and faculty)."

By the end of their full year, SuperUROP students earn a certificate in advanced undergraduate research, which is offered in a variety of fields, including artificial intelligence, computer systems, nanotechnology and synthetic biology to name a few. In many cases, this work becomes the basis for earning an MEng degree and applying to graduate school.

One of the final preparations each SuperUROP student makes is to distill his or her year of research into a 90 second pitch for an audience of 6.UAR peers, course instructors and industry sponsors. Francis Chen about to go on in his MEng in artificial intelligence, at the time, had done his SuperUROP research in synthetic biology, specifically designing and implementing a microfluidic DNA assembly system. "The 90 second pitch was my chance to practice all I'd learned from 6.UAR in a setting with feedback from the entire class," Chen said. "It was an excellent opportunity to distill my work down to its essentials, polish an impactful pitch and experience broad, unfiltered feedback." (Read more about Francis and other SuperUROP grads and current students, pages 15-16.)

Growing the SuperUROP

As SuperUROP moves into its 4th year, MIT's Aero/Astro Department is joining EECS in offering SuperUROP to its upcoming juniors and seniors. Students will learn about the program at two info sessions in early March with applications due by April 1.

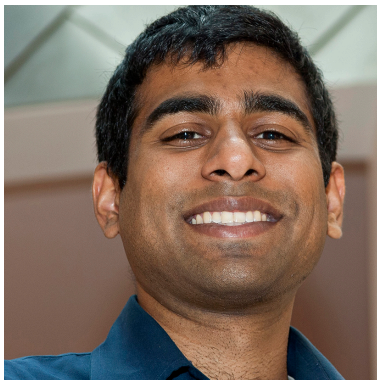
MIT President L. Rafael Reif noted in the fall 2014 about SuperUROP: "In just two years, SuperUROP has developed into a tremendous opportunity for Course VI students to gain meaningful research experience in world-class labs. The impact we are already seeing is enormous; I am enthusiastic about the program's potential to help shape how our students think about the role research plays in addressing important challenges."

See the brief features on several SuperUROPs from the inauguaral class through the current 2014-15 class (pages 15 and 16). Three USAGE students who helped shape the SuperUROP as it was being formed are featured in the section on USAGE, page 18.

http://eecs-superurop.mit.edu

Current and Alumni SuperUROPs: part of a growing community

Class of 2012-13



After completing his SuperUROP in 2013, **Arun Saigal**, then a senior, fulfilled his MEng, and by July (still in 2013), joined Quizlet, an education technology startup. *"I had UROP'd in the Media Lab my freshman year and in CSAIL my sophomore and junior years. While I felt like the UROPs allowed me to do some interesting work, they didn't give me a really in-depth research experience. I was hoping to do research at a level that I could publish."*

Not finding that in his UROPs, Saigal was able to reach that level in the SuperUROP in his senior year. He worked on MIT App Inventor, a blocks-based programming language that allows people to build Android applications. His MEng focused on information accountability for mobile applications — a fitting preparation for his work at Quizlet, where he is lead Android developer.

"The SuperUROP is a great opportunity to do meaningful work outside of the classroom during the school year. Take advantage of this time to build relationships with your mentors and people in the lab you are in, and produce high quality research that you are proud of."

Lyne Tchapmi-Petsi worked under Prof. Charles Sodini and his students David He and Eric Winokur, for her SuperUROP, followed by earning her VI-A MEng at Maxim Integrated. Now she is pursuing her PhD in Electrical Engineering at Stanford.

"I worked on developing a wireless communication system for an earpiece that monitors and sends vital signs to a smartphone for display and analysis. The project was extremely comprehensive and allowed me to further my skills in embedded programming and circuit design. I learned to do research in topics I initially had little experience in — encouraging me to try new projects and topics of research. The class portion of the SuperUROP was mind opening. It gave me a glimpse into the different possibilities for careers in industry, graduate school and academia."

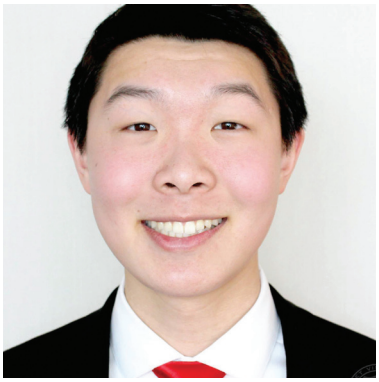
Tchapmi-Petsi wants to use all the skills she has acquired to create Software, Electronics, and Robotics systems that will help enhance the lives of people throughout the world.

Class of 2013-14

Ishwarya Ananthabhotla completed her SuperUROP in 2014 as a junior working under Professor Daniela Rus in the Distributed Robotics Lab. She said about the experience:

"The concept of the research entailed design, development, and fabrication of miniature robots and robotic components that were capable of assembling themselves by self-folding upon the application of heat. I enjoyed being on the forefront of a novel investigation, learning from the creative approaches of my mentors and fellow students, and simply being able to work on technical challenges in a space of robotics that I found fascinating. The experience I gained from the SuperUROP program solidified my future plans — it showed me that I truly am passionate about research, and I see myself being in academia in the years down the road. I'm beginning to do my Master's research this year in an area that's closely tied to hardware and robotics, under Prof. Chandrakasan, and I hope to join a PhD program after my MEng is complete. Overall, the SuperUROP program really gave me a sense of direction and a valuable set of skills as I work towards achieving my future career goals."

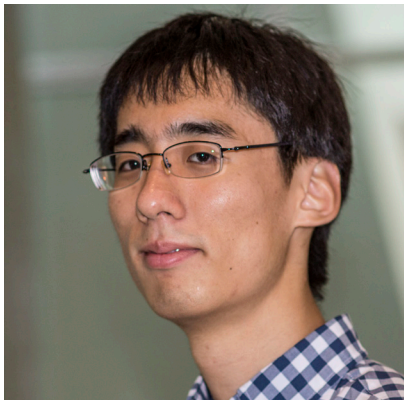
As a SuperUROP, **Francis Chen**, worked under Prof. Ron Weiss designing and implementing a microfluidic DNA assembly system. The idea was to be able to automatically synthesize custom sequences of DNA for experimentation in the field of synthetic biology. His work involved three foci: a microfluidic chip (design and fabrication), a controller (hardware), and a compiler (software). "Though I was not able to produce a working end-to-end system as a SuperUROP, I made a great deal of progress in terms of designing/building the sub-systems."



"I've learned a lot about engineering research on the cutting edge and will be gaining more experience in this area in the MEng program in the MIT EECS Department (concentrating in artificial intelligence). I chose not to continue my research last fall, because I wished to focus on software engineering instead of a highly multidisciplinary project for now."

SuperUROP Alumni and Current, *continued*

Class of 2013-14, *continued*



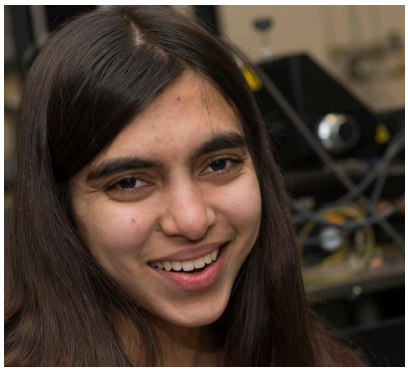
Through SuperUROP, **Daniel Kang** was able to work with Prof. David Gifford on applying state-of-the-art machine learning techniques to understand large biological data-sets in the context of epigenetics. This work both implemented a distributed, approximate inference algorithm to process billions of examples on the hours time-scale and has lead to novel discoveries regarding the accessibility of DNA. Currently this work is under review for publication in the journal *Science*.

Kang was selected recently for the Churchill Scholarship — only the 12th MIT student ever to be selected for this honor for which he will study math at Cambridge University. He will then study for his PhD at Stanford.

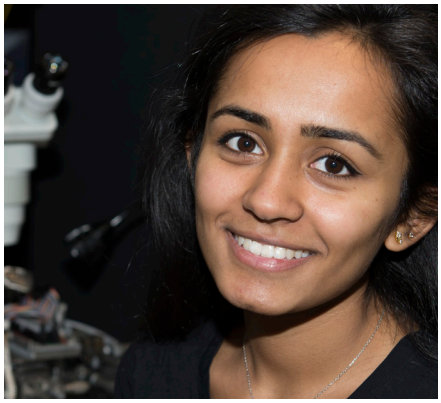
Since high school, Kang has gained perspective by working in industry, such as open source projects x264 and FFmeg/Libav, work on Google's then experimental video codec and later on Google Search followed by an externship at Apple's Applied Machine Learning Group.

Class of 2014-15

SuperUROP and EECS senior **Elaine McVay** is working in Prof. Tomas Palacios' lab to develop large area electronics out of conductive and semi-conductive two-dimensional materials including graphene, graphene oxide, and Molybdenum Disulfide (MoS_2). I am approaching this challenge by developing inks out of these 2D materials that a 3D printer can print into not just a large area, but a large volume. I am also developing an organic LED display that is powered by MoS_2 transistors. This application is first being fabricated by conventional methods, but components of the display can also be printed with our 3D printer once it and the inks are fully developed.



McVay says about her experience, *"This project has helped me decide that I want to continue on to graduate school."* She wants to pursue her MEng followed by a PhD program.



Mihika Prabhu is working as a SuperUROP in the Quantum Photonics Laboratory under Prof. Dirk Englund, Jamieson Career Development Professor. The work involves developing a quantum photonic processor that will be able to carry out a wide range of quantum and classical algorithms. *"We seek to advance the state-of-the-art by creating a quantum Photonic Integrated Circuit (PIC) that boasts complete reprogrammability, as well as a decrease in chip size by using the silicon-on-insulator fabrication process,"* she says. Prabhu is thrilled to work in a research group where she is exposed to many aspects of an exciting field.

"It was incredibly exciting seeing light propagating through the quantum photonic processor for the first time. Seeing the system finally functioning has been one of the most satisfying moments of my research thus far." Prabhu has discovered through this work a fascination with creating quantum technlogies using photonics and plans to pursue her PhD in the field.

"Working at the cutting edge of synthetic biology—and working largely independently—has been extremely exciting!" says EECS senior and SuperUROP **Ava Soleimany**. *"Being able to point to something completely novel and say 'I created that' is extremely cool."* As a 6-7 major, Soleimany is working in the lab of Prof. Tim Lu, where she says the aim is to expand the scope of biological computation by constructing higher-order cellular state machines in *Escherichia coli*. Using DNA recombinases as a basis for circuits, cells can be engineered to execute sequential logic and differentiate in a controlled, predictable manner. She is amazed at the potential from this work to use these logic systems to enable biotechnology applications such as microbes engineered to produce a large number of pharmaceuticals based on only a few inputs. She wants to continue towards a PhD in either Computational Systems Biology or Bioengineering. *"I've realized [through SuperUROP] that intellectual discovery, leadership and mentorship are really my core motivators,"* she says.