



# Foundations Of Resilient CybEr-physical Systems (FORCES)

Aimée Tabor

Director of Education & Outreach  
University of California, Berkeley



# Education & Outreach

- \* **Overview** – Education and Outreach Goals and Objectives.
- \* **Teaching** - Overview of teaching material developed.
- \* **Outreach** – Broader Impacts.
  - \* **Girls in Engineering** – Update and highlights of last summer’s program and plan for this summer’s program.
  - \* **CYBEAR** - Update and highlights of last summer’s program and plan for this summer’s program.
  - \* **SUCCESS** - Update and highlights of last summer’s program and plan for this summer’s program.
- \* **Going Forward** - Education/outreach in the coming 6-12 months.

# FORCES Education & Outreach Goals

## \* Curriculum Development

- Address the gaps in the EE, CS, and Systems curricula in the area of economic incentives for large-scale cyber physical systems: our focus on EI for EE & CS applications.
- Updates on IPAM – Saurabh & Azu

## \* Outreach to Community & Broadening Participation

- Girls In Engineering – Elizabeth Hagar Bernard
- CYBEAR & SUCCESS
- Development of k-12 Module on CPS

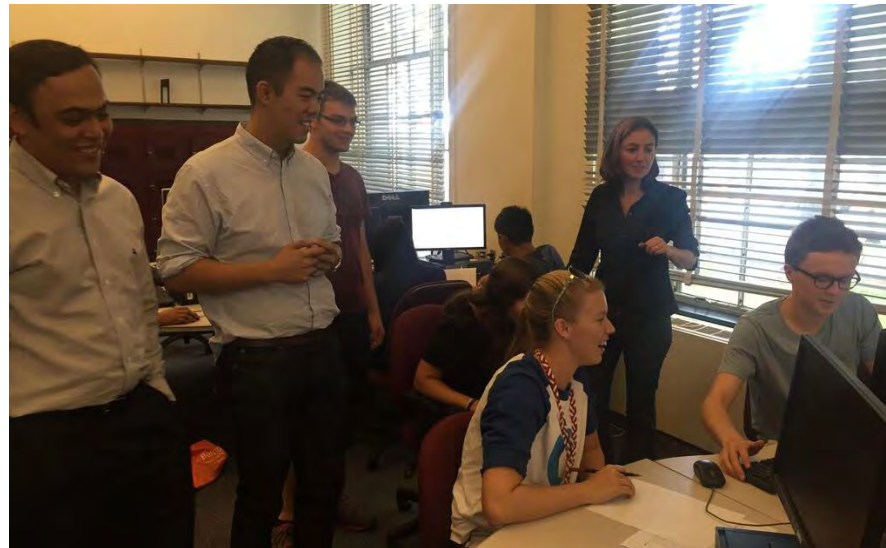
# Curriculum Development

## Game Theory Models for Infrastructure Networks

- \* Offered: Fall 2015
- \* Incoming MIT Freshman
- \* No prior knowledge of game theory or infrastructure operations

“Listening to Professor Amin’s research was very interesting – it mostly struck me because of how applicable it is in a real-world scenario using strategies such math, graph and game theory. It helps to have a greater understanding of everyday instances and everyday networks.”

Bridget Bassi '17



“My favorite part of the module was getting super radical at the end. By the end of it, I learned that you have to go all out to win. I put all of my chips in one basket, and I was leading the charge with my group members. It was a revolution.”

Alexander Lynch '19

# Curriculum Development

- \* Results (Dr. Saurabh Amin)
- \* Next Steps



# IPAM Summer School

## Institute for Pure & Applied Mathematics

- \* Games and Contracts for Cyber-Physical Security, July 7-23
- \* *Organizing Committee: Saurabh Amin, Asuman Ozdaglar, Galina Schwartz*

- \* **Enrollees: 96**

- \* 27 Faculty
- \* 60 Graduate Students
- \* 7 Post Docs
- \* 2 Industry

- \* **Topics:**

- \* *Networked Markets: Intermediaries & Market Power*
- \* *Effect of Information in Congestion Games*
- \* *Adversarial Classification Games*
- \* *An Introduction to Mean Field Models of Dynamic Games*
- \* *Theoretic tools for distributed sensing in the presence of strategic sensors*
- \* *Learning, Predictability and Stability in Big Games*
- \* *Cyber-Insurance for Large Scale Interdependent Network*





# IPAM Summer School



## \* Speakers:

Saurabh Amin (MIT)

Itai Ashlagi (MIT)

Hamsa Balakrishnan (MIT)

Tamer Basar (UIUC)

Kostas Bimpikis (Stanford )

George Cybenko (Dartmouth)

Ian Hiskens (Michigan)

Ramesh Johari (Stanford)

Ehud Kalai (Northwestern)

Cedric Langbort (UIUC)

Patrick Loiseau (Institut Eurécom)

Bud Mishra (NYU)

John Musacchio (UC Santa Cruz)

Michael Ostrovsky (Stanford)

Galina Schwartz (UC Berkeley)

Michael Schwarz (Google Inc.)

Srinivas Shakkottai (Texas A & M)

Jeff Shamma (Georgia Institute of Technology)

Eran Shmaya (Northwestern)

R. Srikant (UIUC)

Milind Tambe (USC)

Hamidou Tembine (New York University Abu Dhabi)

Alexander Teytelboym (University of Oxford)

Mihaela van der Schaar (UCLA)

Rakesh Vohra (University of Pennsylvania)

Adam Wierman (California Institute of Technology)

Stephen Wright (University of Wisconsin-Madison)

Muhamet Yildiz (MIT)

William Zame (UCLA)

**Schedule:** <http://www.ipam.ucla.edu/programs/summer-schools/graduate-summer-school-games-and-contracts-for-cyber-physical-security/?tab=schedule>

# IPAM Long Program

## Institute for Pure & Applied Mathematics

- \* New Directions in Mathematical Approaches for Traffic Flow Management
- \* Ongoing: September 8th – December 11th
- \* Co-Chair: *Alexandre Bayen*
- \* Topics:
  - \* *Traffic estimation toolbox based on MILP*
  - \* *Two-dimensional traffic flow modelling for large-scale network*
  - \* *Two-class traffic control to reduce congestion and emissions in freeway systems*
  - \* *Conservation laws with local flux constraints to model toll-gates and moving bottlenecks*
  - \* *Entropy-like Lyapunov functions for the stability analysis of adaptive traffic signal controls*





# Berkeley Girls in Engineering



“It teaches individuals about different types of Engineering and how it is a positive influence on the world. It also works with amazing ladies!”  
[2015 camper]

# Berkeley GiE: Program Structure

- \* 2, 1-week sessions at UC Berkeley
- \* 62 middle school girls
- \* Female Berkeley faculty and students led hands-on workshops
- \* Camp also included modules on teamwork, public speaking
- \* Girls worked on team projects throughout the week
- \* Field trips to Twitter (programming workshops, Q&A sessions)





# Berkeley GiE: Program Structure

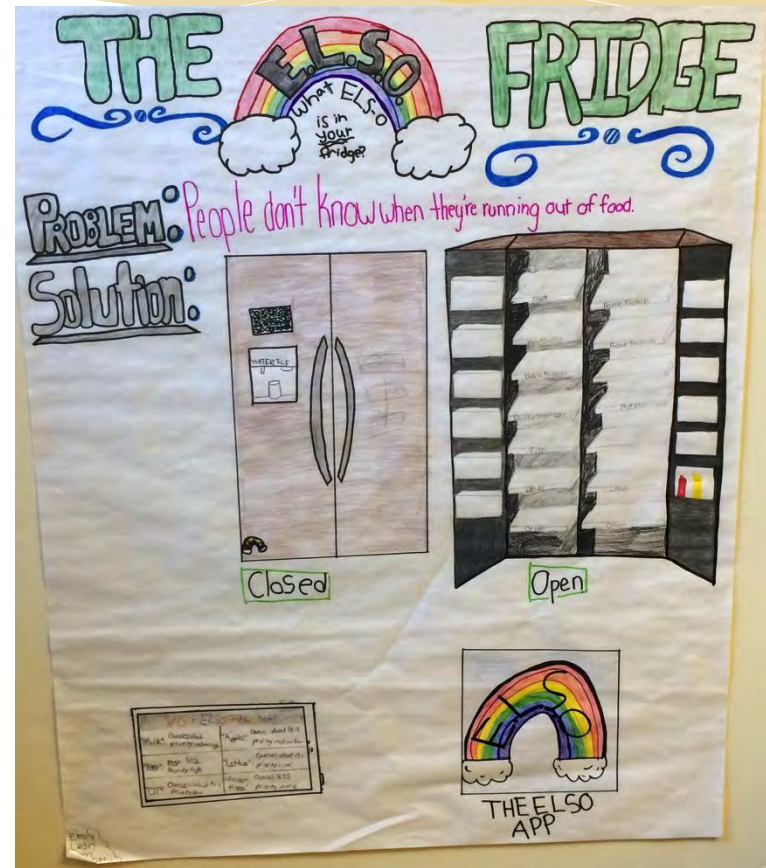
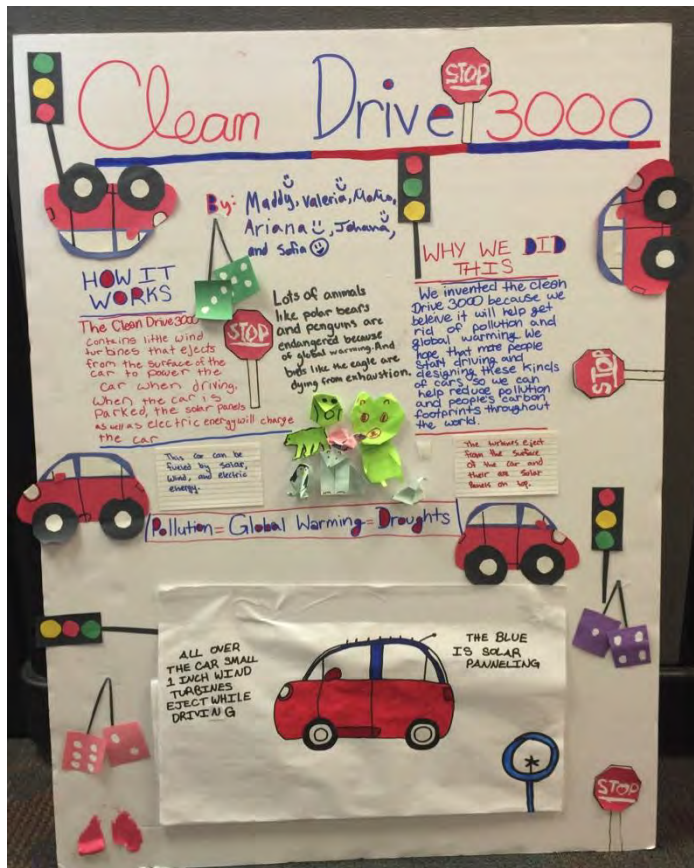
New this year: high school volunteers



"I loved sharing my love for science with younger girls and I LOVED Twitter!"  
[volunteer]

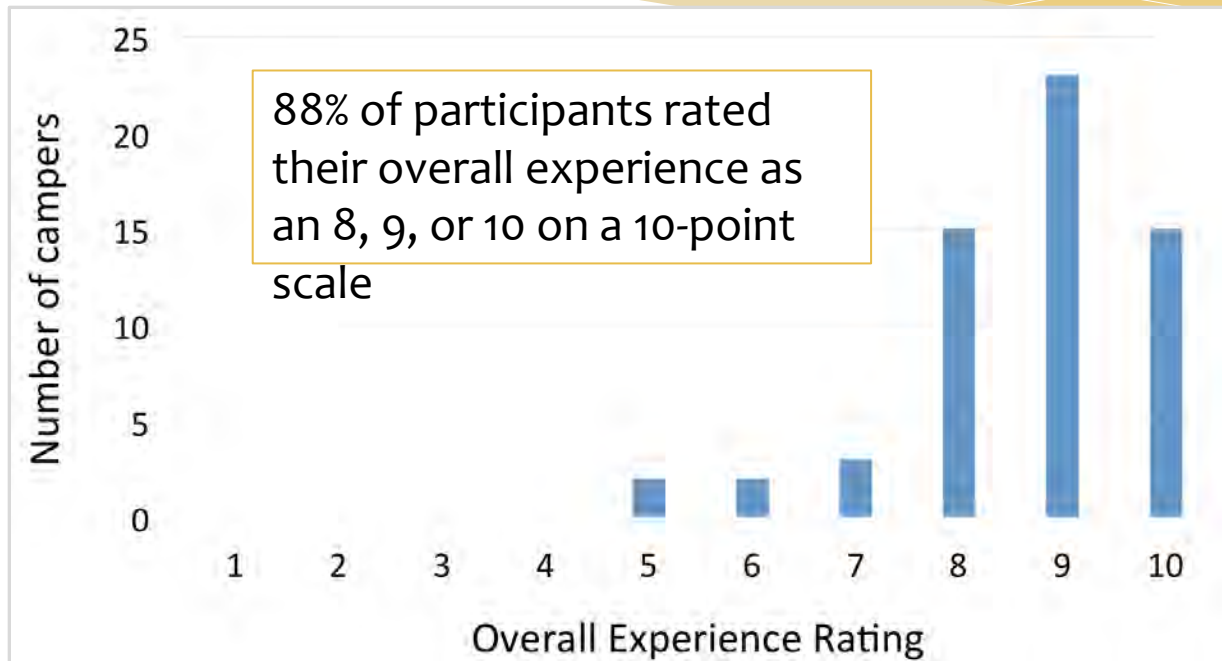


# Berkeley GiE: Team Projects





# Berkeley GiE: Survey Results



- \* Survey results were overwhelmingly positive
- \* 95% of the campers would recommend the camp
- \* 100% of parents would recommend the camp



# Berkeley Girls in Engineering

## Summer 2014 Post Surveys

- \* After program, girls stated more likely to take math and science classes at school.
- \* 85% of parents felt their objectives were met:
  - \* Expose child to engineering, science, and technology profession.
  - \* To have their child learn more about engineering.
- \* All parents would recommend the program highly to other parents and students.

Post-Survey Questions (Scale of 1-5)	Mean	Std. Dev.
How would you categorize interest in Engineering before the program?	3.39	1.45
After program, considering a career in Engineering.	4.42	0.72
After Program, would take more science and math classes.	4.25	0.62
Girls felt they learned a lot in Girls in Engineering.	4.42	0.61

# Berkeley GiE: Summer 2016

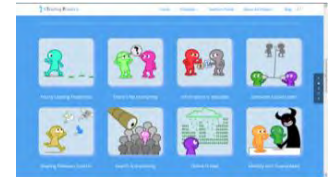
- \* Doubling number of sessions
- \* Expanding eligibility to all girls in the San Francisco Bay Area
- \* Involving more women faculty from throughout the engineering school
- \* Considering adding programming throughout the year



# Berkeley GenCyber Camp: CYBEAR

## CYBEAR@BERKELEY – Program Structure

- \* 4-week summer program to engage high school students in privacy and cybersecurity. (Dates: June 29<sup>th</sup>-July 24<sup>st</sup>)
- \* Challenging curriculum based on [teachingprivacy.org](http://teachingprivacy.org)
- \* Goals:
  - \* Increase readiness of students in transition from high school to college
  - \* Provide college preparation
  - \* Exposure to career options and multiple STEM Careers
  - \* Specials lectures and family nights for parents and school support programs
  - \* Inclusion of module focused solely on SCADA



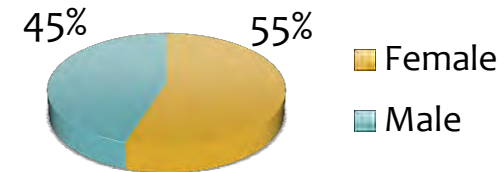
# Berkeley GenCyber Camp: CYBEAR

## CYBEAR@BERKELEY – Demographics

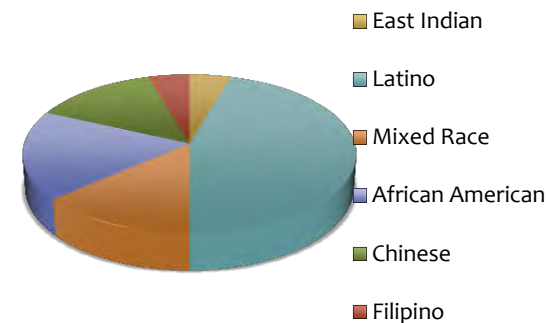
- \* 22 high school students
- \* 50% of the fathers and 36% of the mothers have less than an Associate's Degree.
- \* 41% of the fathers and 23% of mothers have less than a high school degree
- \* 95% of the students are from schools where they do not have access to a computer science class.



### Gender (n=22)



### Race/Ethnicity (n=22)



# Berkeley GenCyber Camp: CYBEAR

## CYBEAR@BERKELEY – SCADA Module

- \* Focus on defining SCADA and it's applications
- \* Discuss vulnerabilities within SCADA networks
- \* Provided readings to help students understand why attackers would be interested in SCADA Networks
- \* Students debated what what Nation States should do to secure SCADA networks



### SCADA Attacks

- Supervisory Control and Data Acquisition (SCADA) is used to provide control of remote equipment
- SCADA attacks are cyber warfare attacks to ruin such SCADA systems.
- Can use anything from Trojans to worms and spyware



### STUXNET

- Can cause plants to explode
- Used machine code, which is impossible to read
- Compromise security systems
- Can be transferred wirelessly like a normal worm
- Source Code is Generic



# Berkeley GenCyber Camp: CYBEAR

## CYBEAR@BERKELEY – Program Outcomes

- \* Highest Ranked GenCyber Camp on External Evaluator Report

Variable Mean Score by Student Camp

	Learning Enjoy/Desire	Learning Comp Science	Learning Cybersecurity	Interest	Interest Cybersecurity	Interest Comp Science	Self-Efficacy	Pre-Career	Post-Career	Camp Experience
Average	4.35	4.40	4.30	4.21	4.18	4.23	4.30	3.37	3.92	4.45
University of California Berkeley	4.63	4.85	4.42	4.79	4.62	4.85	4.46	3.54	4.44	4.70



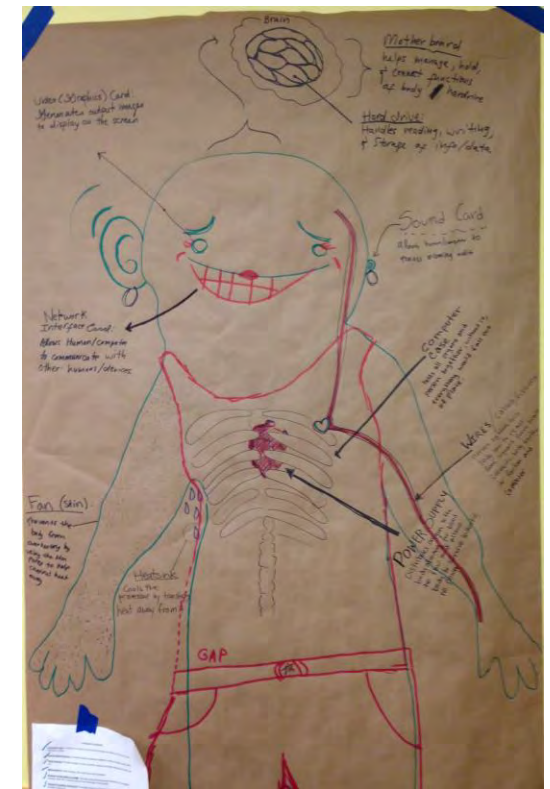
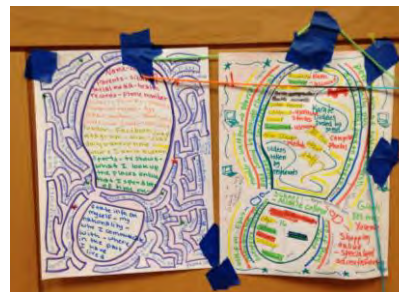
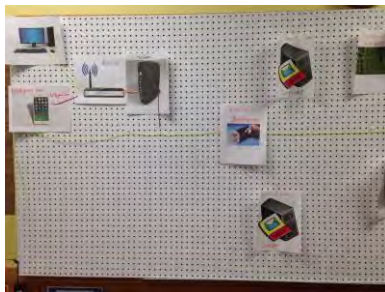
- \* Children's Attitudes toward Technology pre/post  $-.46^*$
- \* Critical Thinking in Everyday Life pre/post  $.63$
- \* Children's Hope Scale increase pre/post  $.54$



# Berkeley GenCyber Camp: CYBEAR

## CYBEAR@BERKELEY – Next Steps

- \* Adding an additional 2-weeks
- \* Introduction of hope interventions
- \* Making CYBEAR into a national model
  - \* Exploring Funding Opportunities
  - \* Finalize the curriculum
  - \* Expand to other GenCyber or summer programs



# Moving Forward

## Online Module Development

- \* Development of RC/EI Online Modules
- \* Based research and new courses in development

## K-12 Module Development

- \* 3<sup>rd</sup> Cycle of Girls in Engineering this Summer. Exploration of new curriculum modules and new format.
- \* Expanding CYBEAR as a national model of privacy education for high school students.