ELECTRICAL & COMPUTER ENGINEERING

UNIVERSITY of WASHINGTON

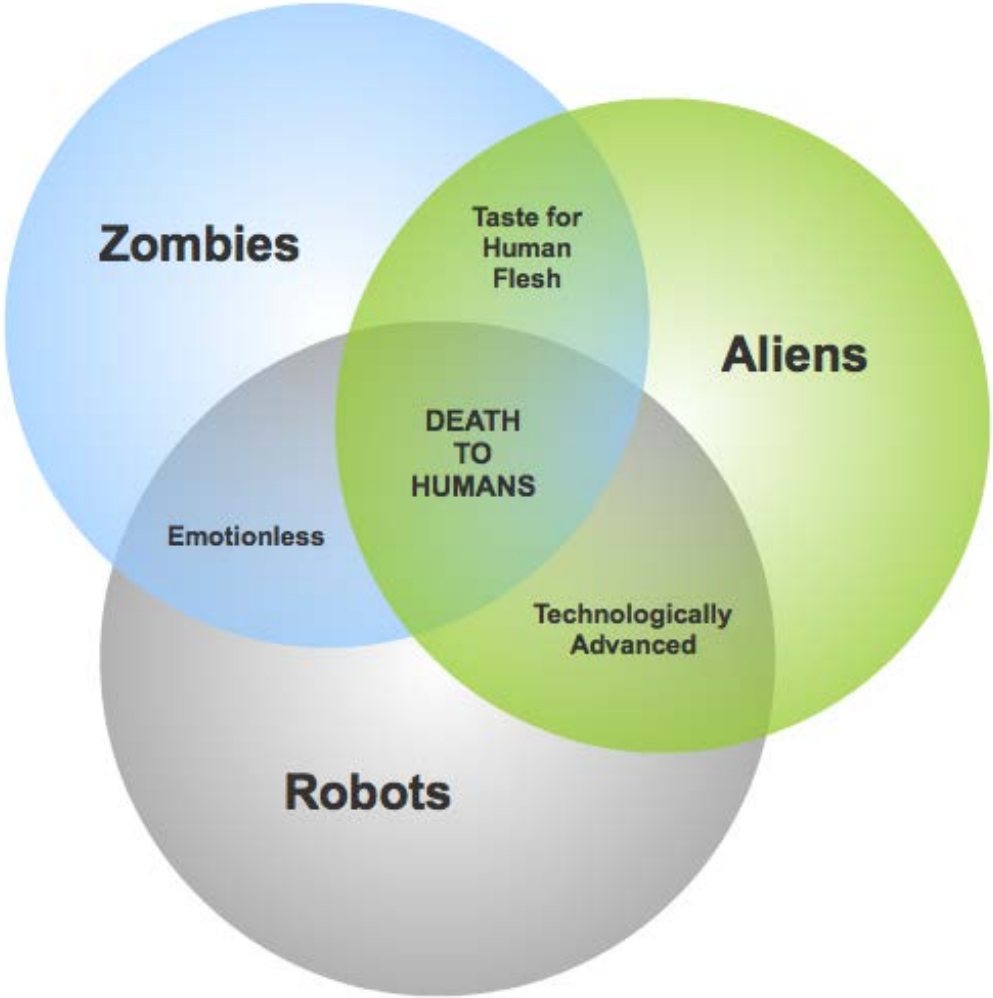
Robotics in ECE Education

Blake Hannaford, UW ECE and GIX

Outline

- Robotics is a team sport
- Robotics in higher-ed overview
- Robotics projects in ECE curriculum
- Robotics *vis a vis* teaching Engineering Ethics
- The coming wave
- Example: ARUW / Robomasters

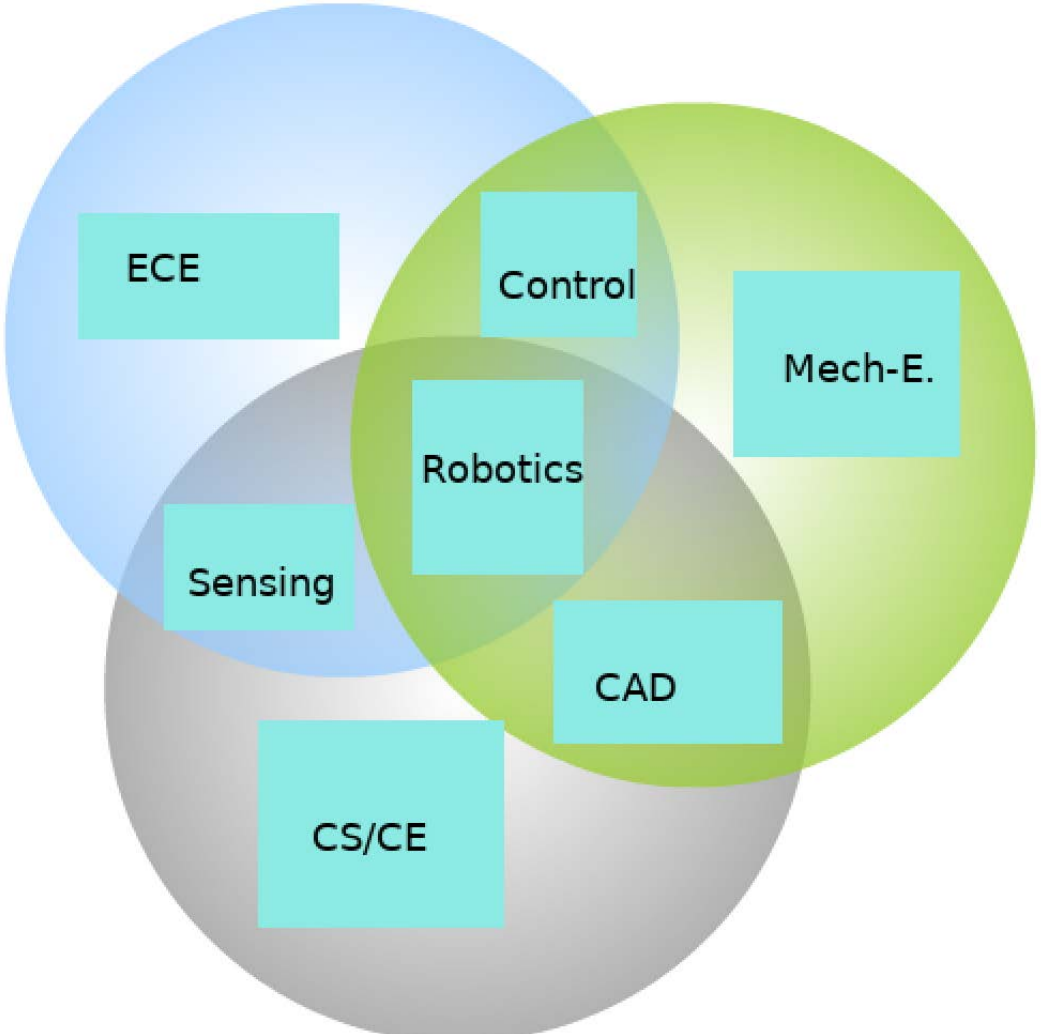
Robotics is a team sport



Robotics is a team sport

Ooops!!!

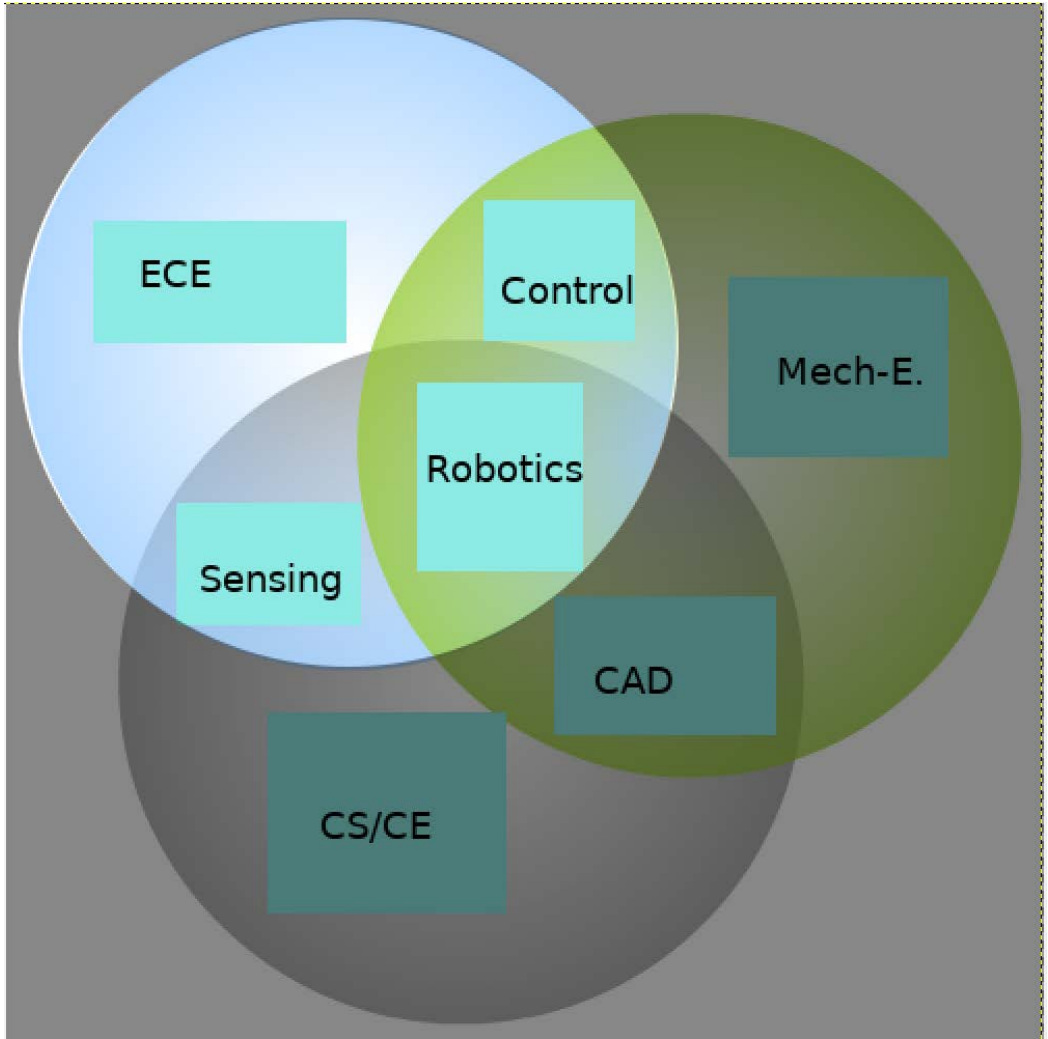
… that's better.



Not a Zero-Sum Game

Wrong Goal …

… maybe right tactics?



Robotics in ECE UG Curricula

Robotics in undergrad overview

- Special issue on Robotics Education, IEEE TRANSACTIONS ON EDUCATION, VOL. 56, NO. 1, FEBRUARY 2013
  - Robot platforms
  - Learning computation skills via robotics
  - Project based activities - intro through graduate
  - Design and systems perspective
- Most typically, BS level robotics is an option in CSE in schools with strong robotics labs, faculty, centers.

Robotics in higher-ed: survey

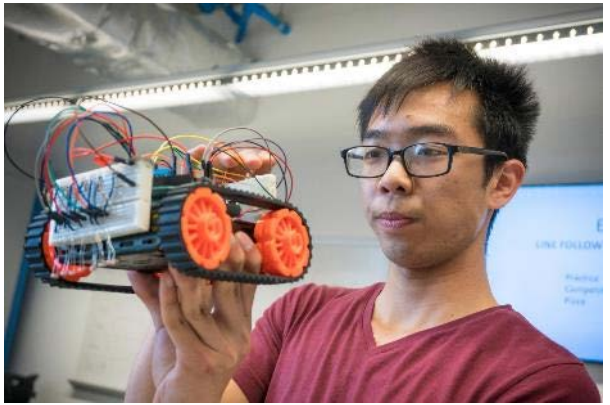
- Jung, Seul. "Experiences in developing an experimental robotics course program for undergraduate education." IEEE Transactions on Education 56, no. 1 (2013): 129-136.

  Survey of many UG programs

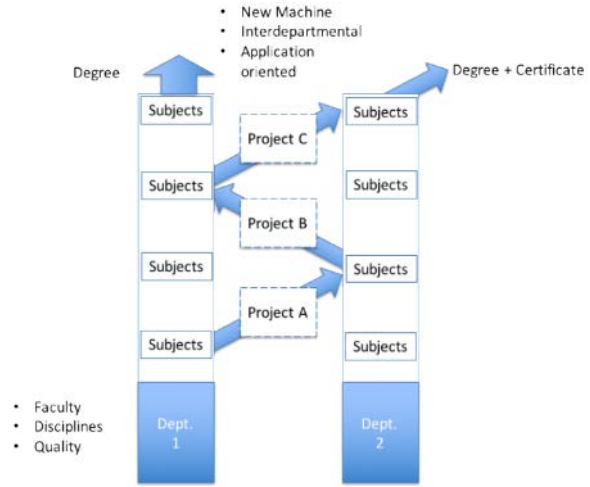
  - Robotics course **curricula**:
    - Hands-on experiences are required for engineering education.
    - Robotics laboratory practicals are necessary, along with in-class teaching, for practical learning.
    - The robotics laboratory should offer a variety of robots to provide students with a range of experiences.
  - Robotics course **projects**:
    - Competition-based projects are beneficial to stimulate students' creativity.
    - Teamwork-based projects encourage students to communicate and cooperate with each other.
  - Robotics course **roles**:
    - Robotics courses can incorporate outreach activities to educate children and high-school teachers from local schools.
    - Research on robotics can be integrated into the curricula of undergraduate robotics courses.

Robotics Projects in ECE curric

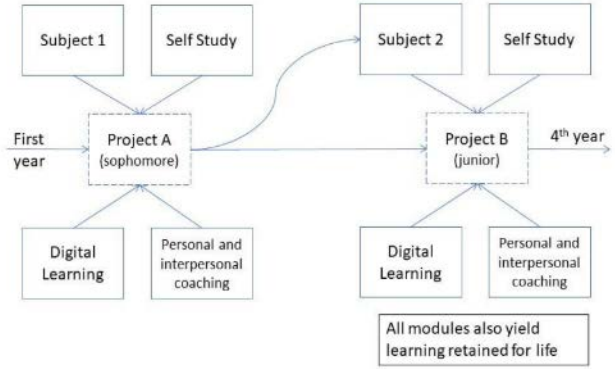
- Can provide cohesive focus for coursework
- UCSD "making, breaking, hacking stuff"
- MIT "NEET" pilot: project-centric intro ECE curric:
  - Living engineering systems & **Autonomous systems**
  - Within Dept / between depts



UCSD



MIT



MIT

Robotics in ECE curric

Carnegie Mellon
THE ROBOTICS INSTITUTE

- CMU: "Additional Major in Robotics," Choose a course from each of 10 categories. Or "Minor in Robotics" 5-courses.

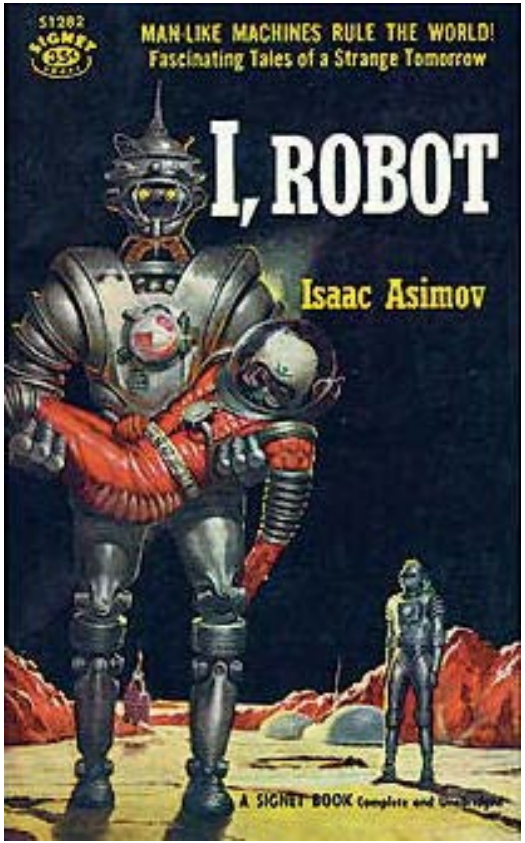
- Olin College: robotics is offered as a student-constructed "Engineering" major

Robotics vis a vis teaching Engineering Ethics

- **Old** Engineering Ethics: engineers making ethical choices in their work
    - Classic Reference: IEEE code of ethics
- **New** Engineering Ethics: engineers creating autonomous agents which make ethical choices.
    - Classice Reference: Asimov's three laws

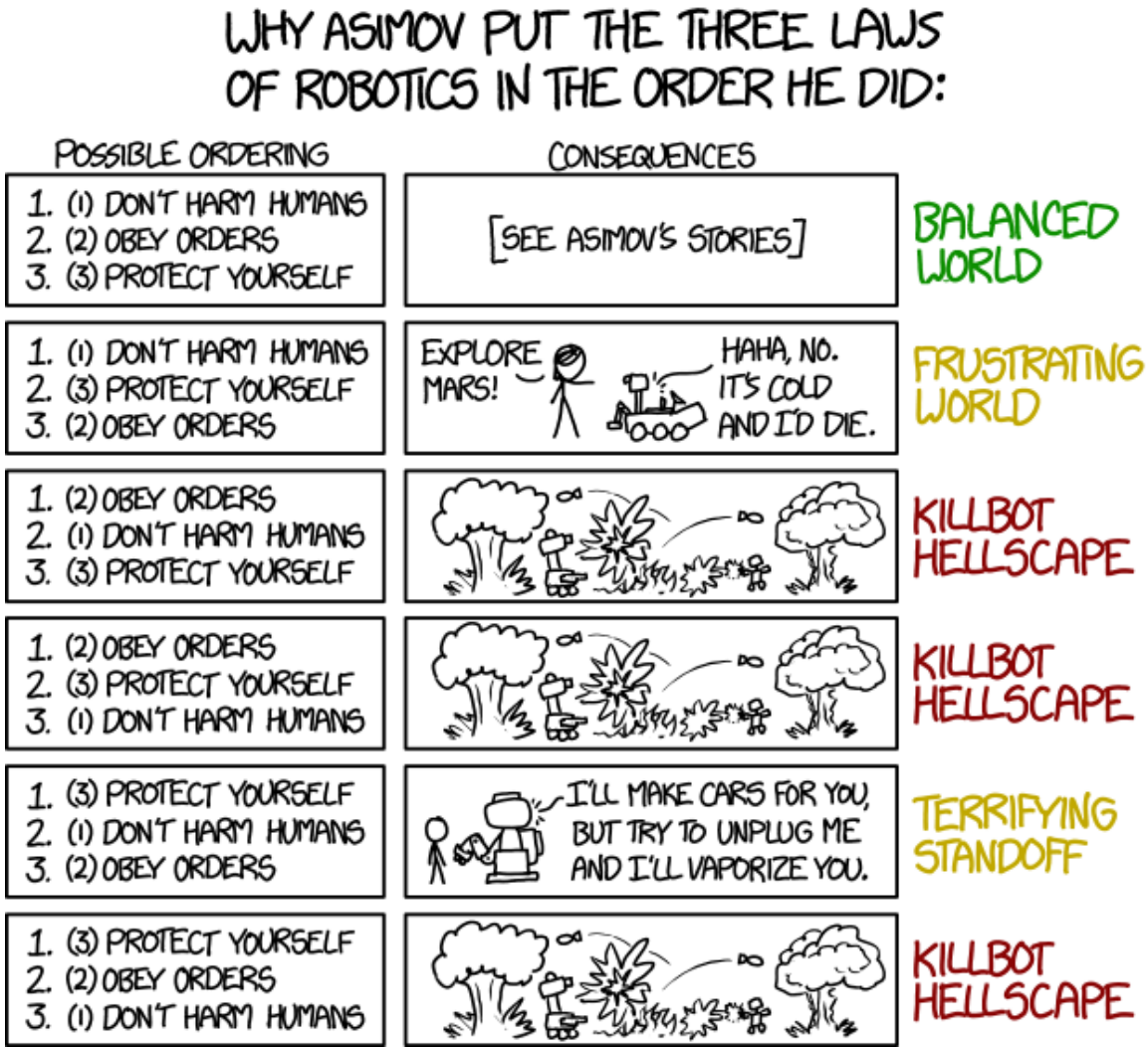
Robotics vis a vis teaching Engineering Ethics

- Asimov's three laws:
  - A robot may not injure a human being or, through inaction, allow a human being to come to harm.
  - A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
  - A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.



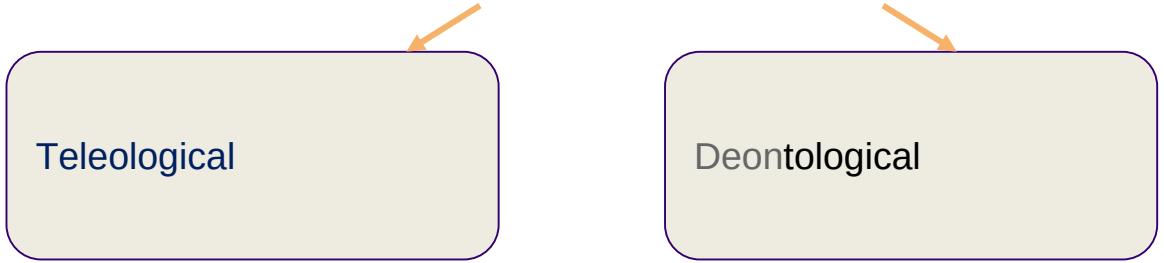
(Asimov, Isaac (1950). *I, Robot*.)

Asimov's Three Laws



(xkcd comics)

Ethical Theories



- Only the **outcome** matters
- Choose action based on best outcome

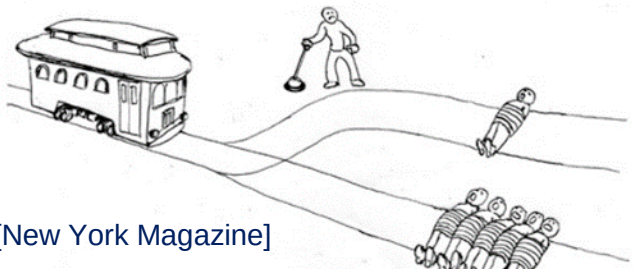
- Choose action based on **Laws and Principles**
- Regardless of outcome

"Deon" = "that which is binding, needful, right"
(http://www.perseus.tufts.edu)

Anderson & Anderson, "Machine Ethics: Creating an Ethical Intelligent Agent," AI Magazine, May 2007

Trolley Problem

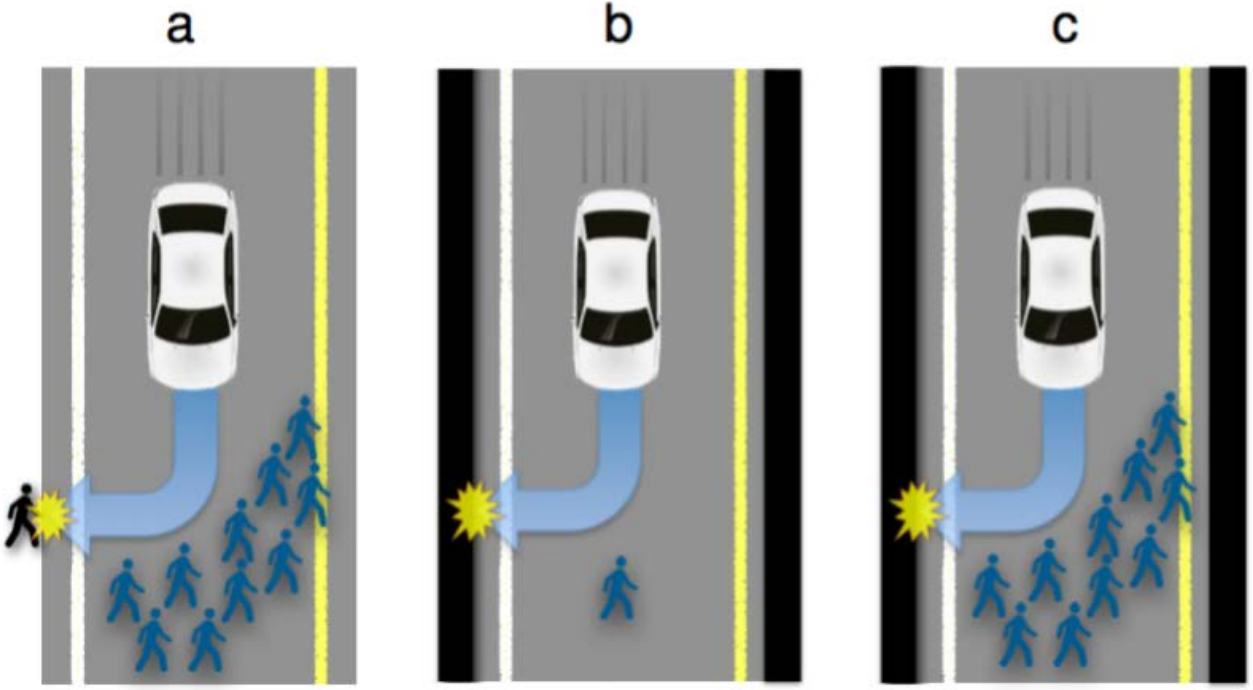
- An empty trolley car is out of control heading down a steep hill
- You have a switch
- Default: 5 people are on the track
- You throw the switch: 1 person is on the track.



[New York Magazine]

Property of Museum of History & Industry, Seattle

Self Driving Car Versions



(MIT Technology Review)

The Coming Wave

FIRST Robotics

2018 competition: 3,660 teams, 91,000 participants

Globally: 61k teams, 530k students, 45k robots built

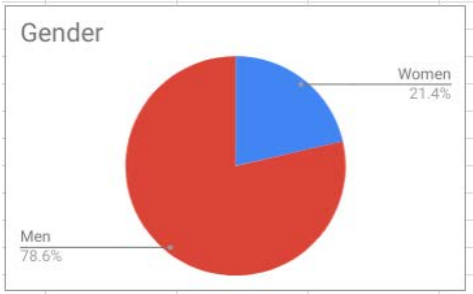
2017-18 First **Lego** league: 35k teams, 280k participants, 95 countries

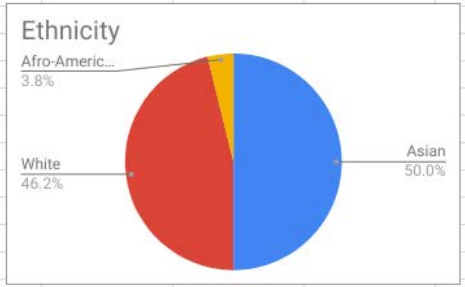
The Coming Wave

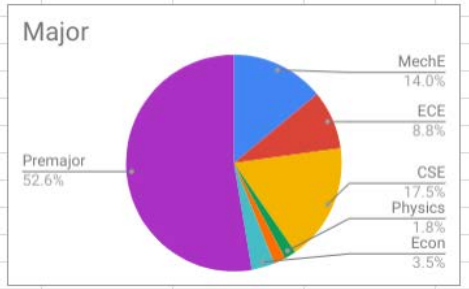
- Freshmen are coming in with up to 4 years of robotics project experience.
- Minnesota has 225 High Schools (MN Dept of Education)
- Minnesota has 225 High School Robotics Teams (MN Public Radio)
- USA has ~36,000 high schools.

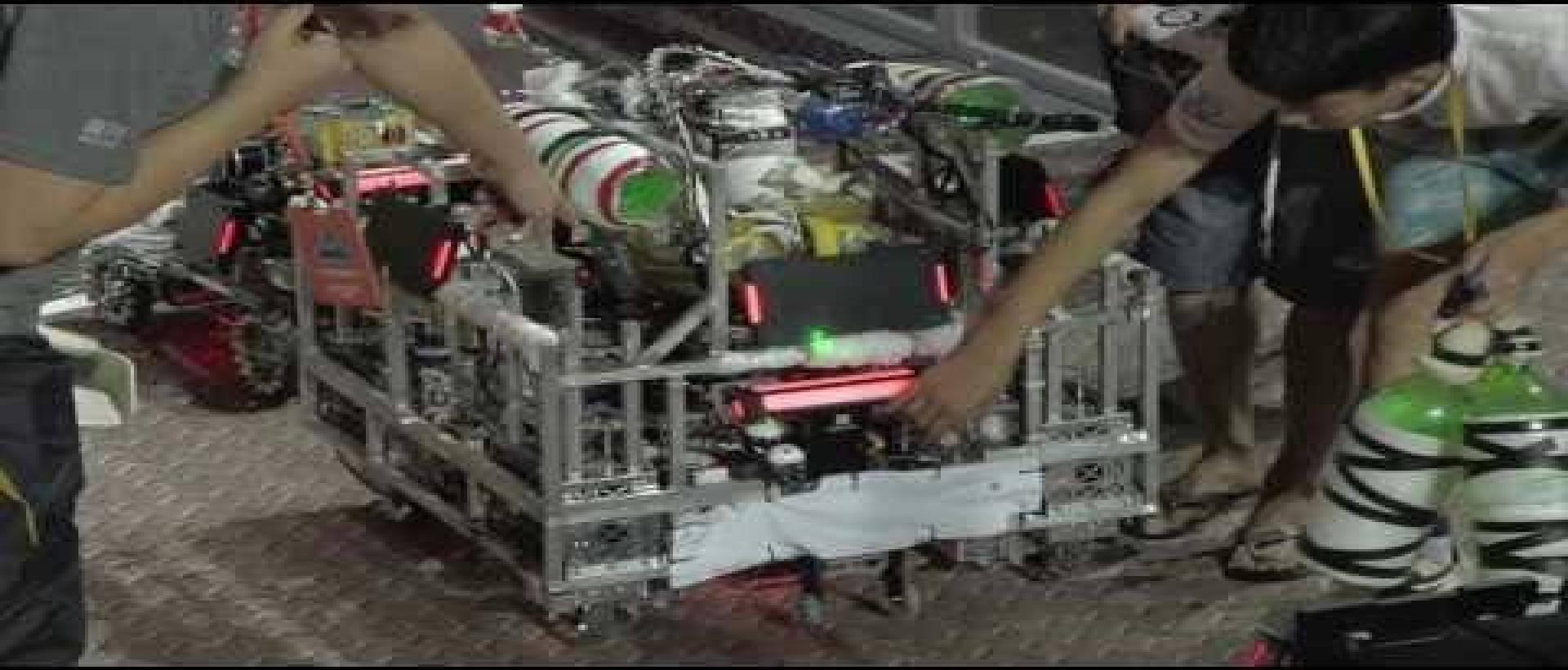
Example: ARUW / Robomasters

- Self-organized 2016-
- 2017 100 students
- 2018 52 (planned)
- 26/100 traveled to Aug 18 competition in Shenzhen









GIX MSTI and Robotics: a plan

GIX robotics goals

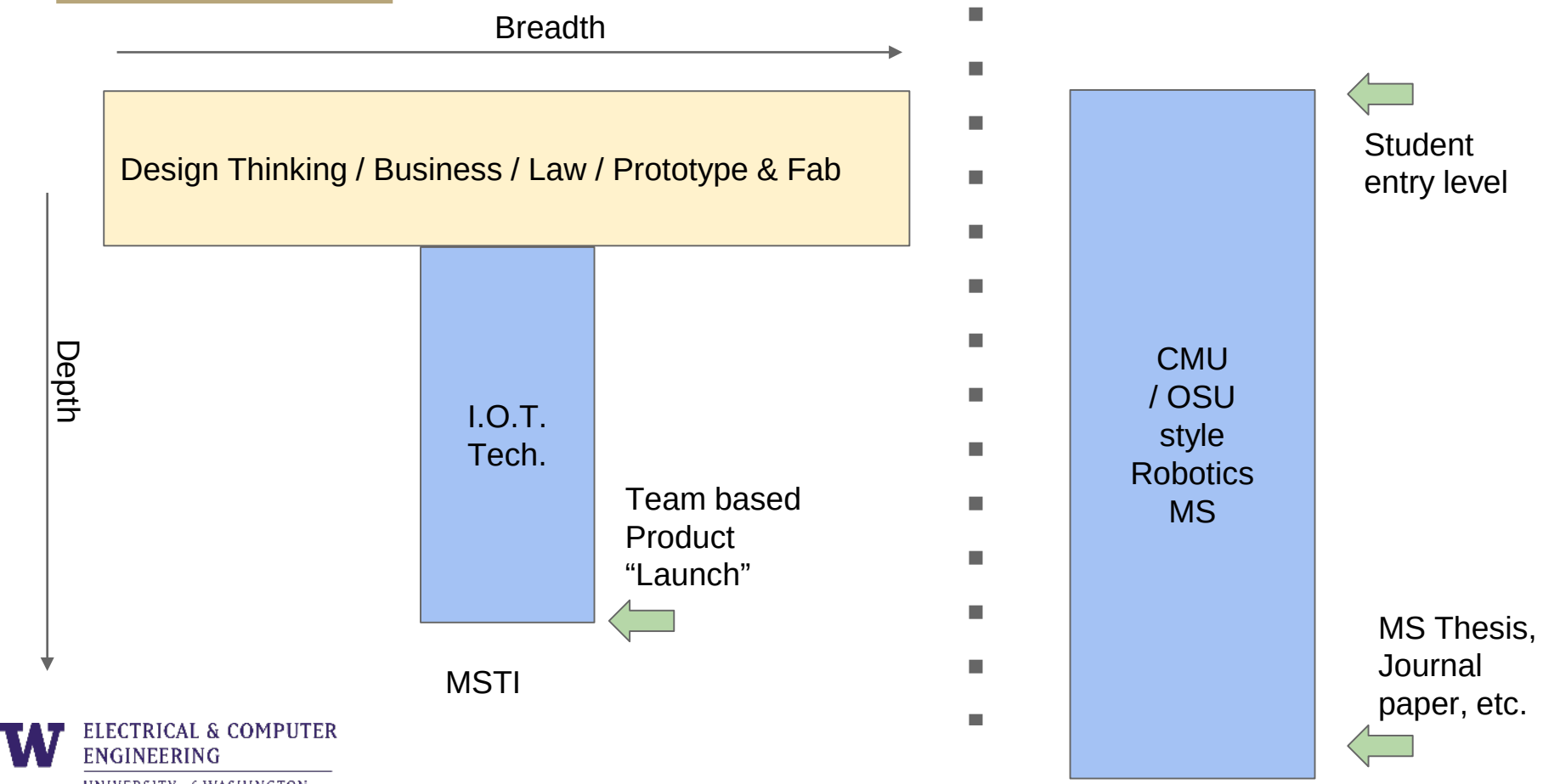
- A **new specialization within GIX MSTI***: Robotics
- Need: Rapid growth in robotics, $2.7B VC Investment in 2017
- Rapid growth of MS Programs in Robotics:
  - Northwestern, CMU, Michigan, OSU

. . .

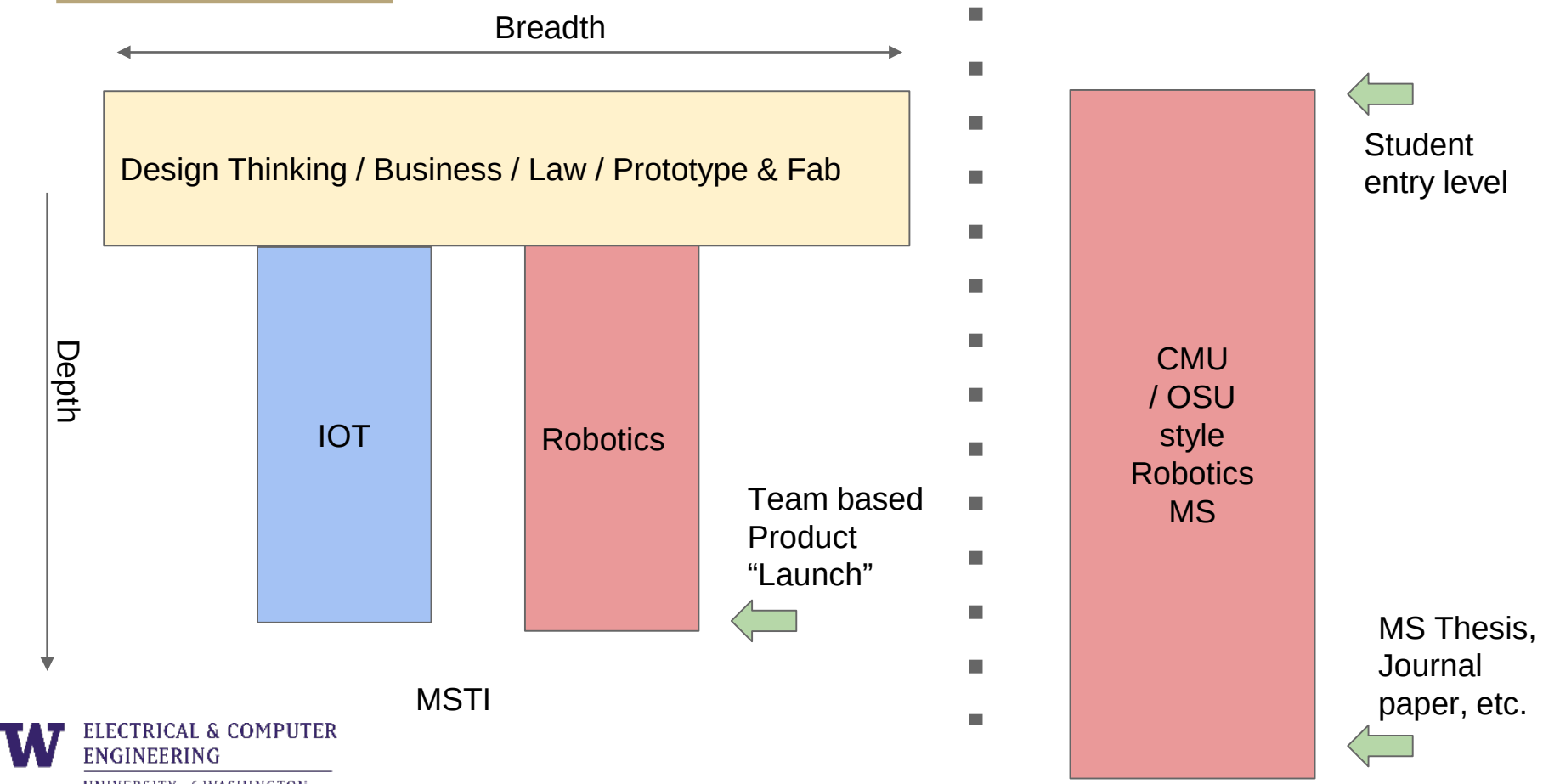
  - →**None** feature entrepreneurship and design thinking

* Masters of Science in Technology Innovation

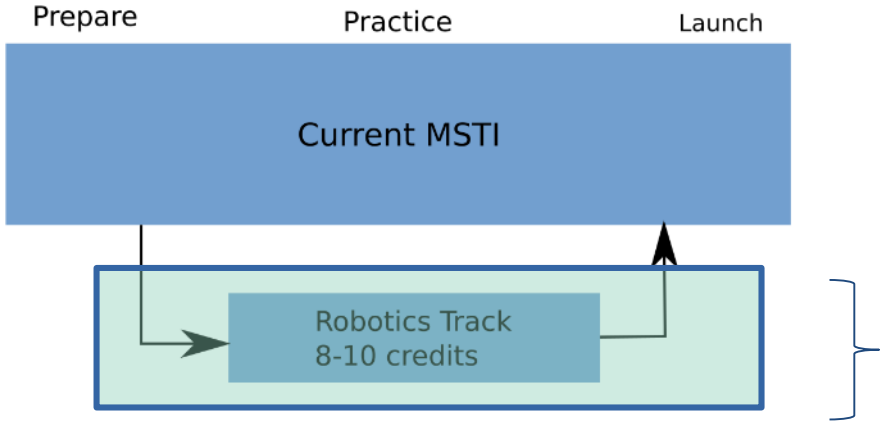
GIX robotics goals: "T"- Compentency



GIX robotics goals: "T"- Compentency



GIX: DEVELOPING CURRICULUM INITIATIVES (2020?)



Substituting for
“HW/SW Lab
1&2”
(IOT courses)

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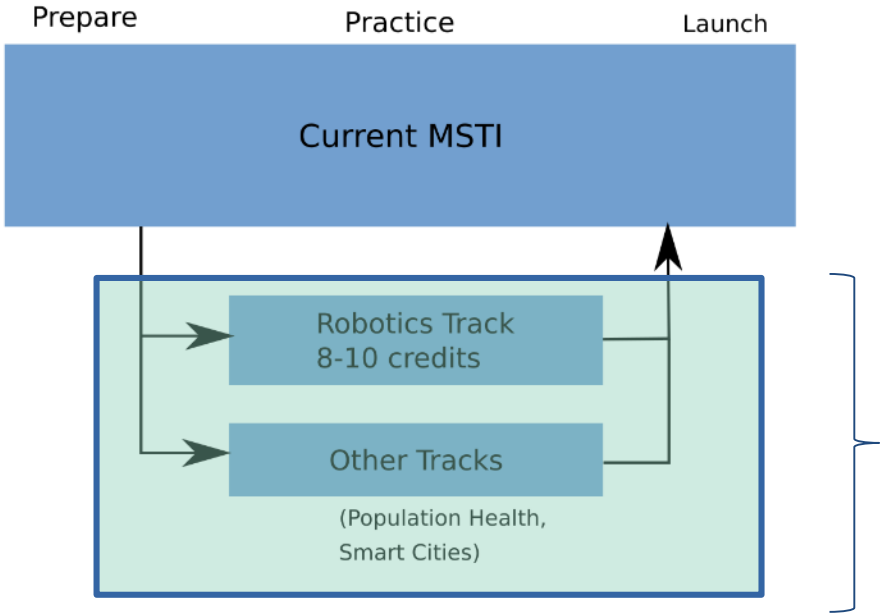

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