



2019 INCOSE SD
Mini Conference

#RoboSub Influencer 2020 - Inspiring the Next Generation of Systems Engineers

November 2, 2019

Mabel Szeto, Colin Szeto
Team **Inspiration**



robosub
Team Inspiration
San Diego, California, USA
robonation

Team Inspiration #11128
San Diego, California, U.S.A.
learn, to share, to innovate, to INSPIRE

DUKE
ROBOTICS

Team Inspiration
To Learn, To Share, To Innovate, To Inspire
11128inspiration@gmail.com

We are a rookie team made up of middle and high school students. Our team has been in the making since 2011 when our coaches dreamed of us, then third graders, doing RoboSub. Our team has been thriving and growing since its inception when we first competed in FIRST Lego League (FLL) in 2011. We are very fortunate to have many mentors guiding us in our robotics journey.

Outreach

Our team does extensive community outreach in promoting STEM locally and globally. We reach out to youngsters at science museums, at major STEM fairs, as well as at special needs and the homeless in the San Diego region. In addition, our team members have served as mentors and coaches to the younger robotics enthusiasts and their coaches.

We successfully grew over 35 award winning teams. We also teach summer robotics camps for elementary and middle school students, including those in underserved communities. In addition, we helped to introduce robotics to the California State. Besides spreading STEM locally, Team Inspiration mentors a robotics team in Benin, West Africa via call every Sunday. By partnering with the U.S. Embassy, our team Sp and FemCoders, a local Beninese organization, are able to support the implementation of the Focused Robotics Training Program by donating robotics kits, reaching 700 students in Benin, majority of whom are female. In 13 secondary schools, in addition, our team mentors robotics teams in Togo, Nigeria in West Africa, as Paraguay in South America. We become leaders in the community by teaching, sharing, and coordinating major events.

Thank You to Our Sponsors!

Qualcomm brain corp
NORTHROP GRUMMAN
FORECAST
NAUTILUS DRYDOCKS
Medtronic

14 team members ranging from grades 6th to 11th

About Team Inspiration



- Team Inspiration's Mission
 - To Learn, To Share, To Innovate, To Inspire
- Robotics Involvement
 - Learning robotics since 3rd grade
 - Compete in FLL, FTC, Robocar and RoboSub
 - Host robotics events in local communities since 2012
 - Host robotics events in global communities in 2019
 - Advisory team for *FIRST* Global
- STEM teaching since 2017
 - Weeklong robotics camp
 - Guide local/global robotics teams and coaches
 - On average, weekly STEM teaching



NATIONAL TEAMS

The *FIRST* Global Challenge is a truly international robotics event with more than 175 nations across the world participating.

Participating teams are composed of students – aged 14 through 18 years – with the common goal of increasing their knowledge of Science, Technology, Engineering, and Mathematics so that they can become the next generation of scientific leaders who will work together to solve some of the world's most pressing problems, from food security and access to clean water, to finding better medicines and securing cyberspace.

By clicking on the map below, you will find photos and short biographies for each of the teams making the trip to the *FIRST* Global Challenge. You can also click on a country to support the national team! Our map will be updated as new teams are confirmed to attend.

To see a listing of all 2019 nations, visit this page.



Teams not shown on the map: Andorra; Cayman Islands; Cook Islands; Hong Kong, China; Hope (Refugees); Kiribati; Maldives; Marshall Islands; Nauru; Samoa; Tonga.

See our archives for our 2017 and 2018 attendance maps.

FIRST Global 2019 nations

Contributor of Mentor Guide for *FIRST* Global, 175 nations
Coach Teams Benin, Bolivia, Paraguay and Togo

2019 focus: Leadership, systems engineering, global impact

Vision & Reflection



- Team members have observed RoboSub competitions since 2011
- Reflection and close observation occur in every stage of the life cycle from concept development to final [competition](#)



Program robots in 3rd grade - 2011



Photo taken in 2017

Dream big and incorporate lessons learned along the way

Systems Engineering “V” is an Enabler



**Competitor Research,
Industry Survey**

Mission Exploration

Planning

Requirement Development

Design Review

**Modular & Parallel
Development**

Self-Awareness

Reflection

System Testing

Subsystem Testing

Component Testing

Best practice with focus on reflection and self-awareness

Competitors Research & Industry Survey



- Learn from competitors
 - Survey [RoboSub](#) teams from last five years
 - Identify equipment usage
 - Identify lessons learned
 - Ask for advice
 - Study their subs
 - Learn from industry professionals
 - Systems engineering process proven at TRW, NASA JPL, Northrop Grumman
 - Marine industry products
 - Interview professional from Scripps Institute of Oceanography



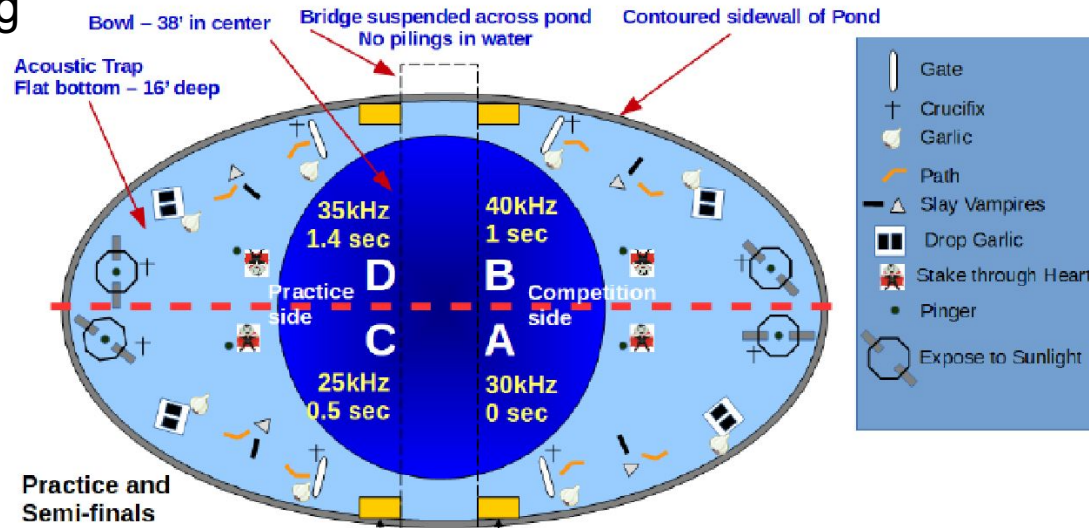
Mission Exploration

- Understand objectives and rules of engagement

- Fully autonomous
- Navigation
- Object recognition
- Beacon localization
- Retrieval and deposit of objects
- Torpedo targeting
- Time limit

- Paying close attention to team constraints

- Schedule (20 weeks)
- Resources (garage lab vs national/university lab)
- Performance (low cost components vs professional marine grade components)
- RoboSub knowledge (zero to competitive)



Understanding mission and constraints are paramount

Planning



- Draft schedule at Kick-Off – schedule focus
- Develop schedule backward from goal with contingency
- Long lead material procurement – RoboSub components
- Rapid prototype – weekly increments
- Parallel and modular development
- Early testing – start from the beginning
- Multiple decision milestones

Week	Agenda
16-Mar	Kick off – RoboSub team research
23-Mar	RoboSub team research – refine requirements – assign role
30-Mar	Identify/procure long lead items – Select computer – prioritize requirements
6-Apr	Connect benchtop vehicle – test component
13-Apr	Identify all equipment
20-Apr	program remote control
27-Apr	put together simple underwater vehicle – first prototype
4-May	Experiment first prototype in water
11-May	Program autonomous
18-May	Experiment with IMU and depth sensor
25-May	Experiment with computer vision
1-Jun	Draft technical paper
8-Jun	Review draft – Experiment with second prototype
15-Jun	Final technical paper
22-Jun	Submit technical paper
29-Jun	Experiment sonar
6-Jul	Experiment with final vehicle
13-Jul	Data correlation with vision input Pre-qualification
20-Jul	Refine autonomous programming
27-Jul	Pack robot for competition
Jul 29 - Aug 4	Competition at NIWC PAC TRANSDEC

Plan with flexibility and contingency

Requirement Development



- Understand systems requirements
 - Flow down to mechanical, software, test, operation
- Understand interface
 - HW-HW, SW-SW, HW-SW, user
- Prioritize requirements

30%	Team capability
25%	Schedule
20%	Cost
10%	Risk
15%	Performance
100% Weighted	Criteria



Understand team capability is a major risk mitigation

Self-Awareness



- Team members capabilities and resource

- ~~Printed circuit card development (knowledge, resource & schedule)~~
- ~~FPGA (knowledge, resource & schedule)~~
- ~~Artificial Intelligent (knowledge & schedule)~~
- ~~Neural network (knowledge & schedule)~~
- ~~Machine milling part (cost)~~
- ~~Complex sensors (cost & complexity)~~
- General robotics knowledge
- Integration
- Programming
- Garage lab and pool
- Systems engineering
- Teamwork
- Dedication
- Passion and drive
- Mentors



Design Review



- Design review is critical to align the team direction and awareness
- Trade study allows better decision making
- Rapid prototyping allows concept validation
- Weekly status review provides valuable feedback

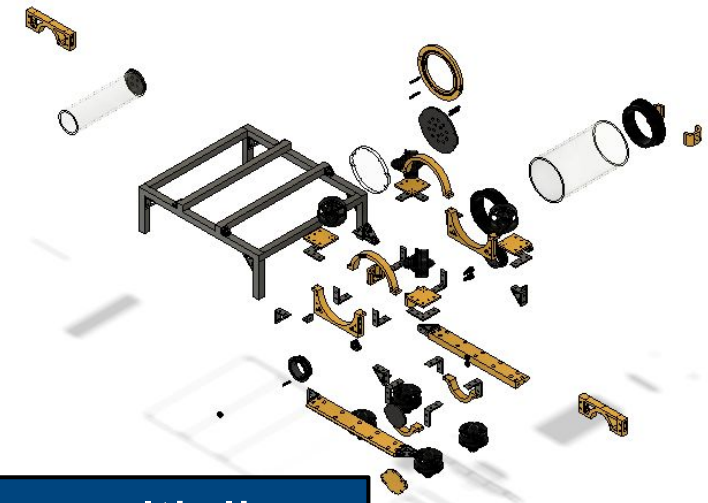
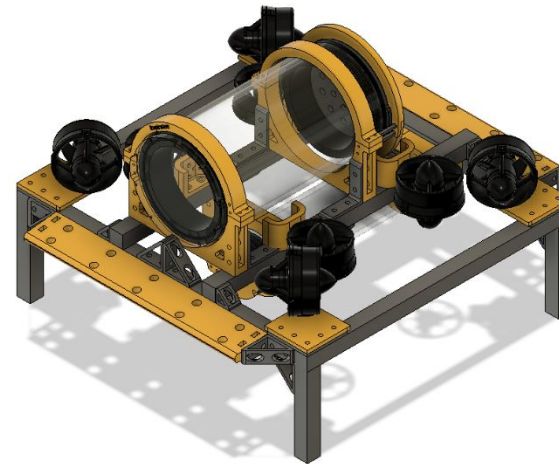


Review to solicit input and cross train

Modular and Parallel Development



- Modular development allows team members to tackle multiple payload investigation simultaneously
- Parallel breadboard, simple vehicle, remote control vehicle testing allow timely design concept verification to identify development shortfall
 - Lessons learned are incorporated into the final vehicle development
- CAD and 3D printing allow quick modeling and testing of the design

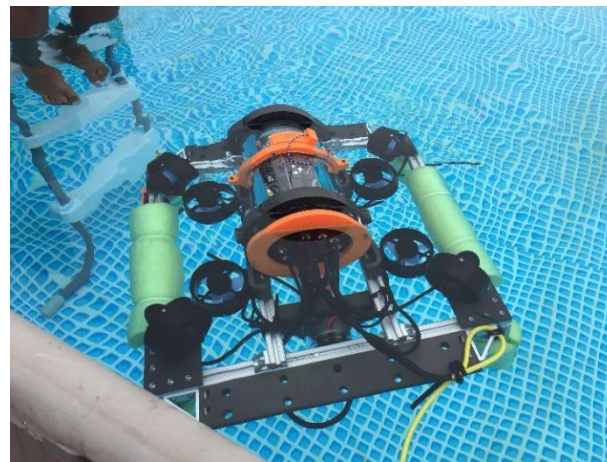


Modular and parallel development – amazing time multiplier

Testing, Testing, and More Testing



- **Breadboard** testing starts in the second week is key to shorten the development life cycle
- **Remote-control vehicle** testing allows observation to incorporate features into the final design
- **Incremental** testing allows rapid lessons learned
- **Early subsystem and system level** testing allows us to improve the design and development **weekly** similar to the agile process



Test to understand and discover the limitation

Accomplishments



- 2019 International RoboSub Competition (55 of the 59 teams from universities around the world)
 - 5 high school and 9 middle school students
 - 2nd in US and 3rd in the world for static judging of technical paper, technical presentation, video, and pre-qualification
 - 7th in US and 12th in the world for overall robot performance
 - Most Inspirational Team award
 - IEEE Innovation award
- *FIRST* robotics
 - 2017 7th ranking in the world robotics championship
 - 2018 39th ranking in the world robotics championship
 - 2019 Winning Alliance and 3rd place Inspire in San Diego Regional (state)
- Robocar
 - Multiple awards in local competitions
- Coaches multiple award winning teams and mentors
 - 2017 Team Benin ranked 7th in the *FIRST* Global World competition, 1st in Africa
 - 2018 *FIRST* Global Best Mentor (Team Benin) in the world



Know the mission – understand the problem to solve

Keep It Simple Silly
Reliability
Passion
Teach
Fail quickly
Teamwork



Systems thinking is applicable to any project and any level

Acknowledgement



- Team Inspiration Members

- Mabel Szeto (Team Captain), Aditya Mavalankar, Ashika Palacharla, Ashiria Goel, Colin Szeto, Eesh Vij, Eric Silberman, Ilan Cosman, Noah Tang, Pahel Srivastava, Raina Shapur, Rishi Veerepalli, Shreyas Rangan, and Shruti Natala

- Lead coaches

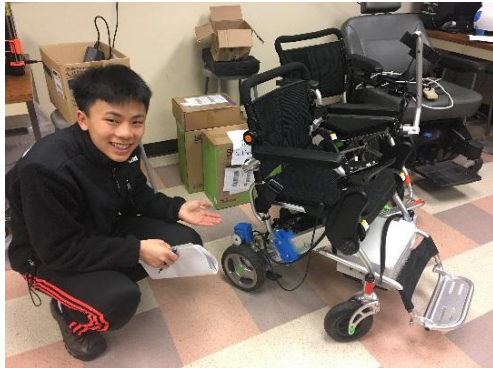
- Alex Szeto, Jack Silberman

- Mentors

- Amit Goel, Dave Warner, Eric Lo, Eugene Kim, Kenzo Tomitaka, Kris Chopper, Kunal Srivastava, Lindsay Westerfield, Pamela Cosman, Pat McLaughlin, Phil Yao, Michael Arnstein, Valibabu Saladi, and Venkat Rangan

- Sponsors/supporters

To Inspire




Join our journey to share your systems engineering knowledge and lessons learned




Train the next generation to be **Systems Thinkers**




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 [teaminspiration11128](https://www.facebook.com/teaminspiration11128)

 [Inspiration Robotics 11128](https://www.youtube.com/channel/UC...)

 11128inspiration@gmail.com

 team11128.wixsite.com/main



Benin Robotics Training/Competition



- Team Inspiration co-hosted a robotics training/competition in Benin with US Embassy, Team Spyder, femCoders' support
- Our goal is to have STEM classes in every high school in Benin and replicate the success model worldwide
- The event attended by:
 - 13 Benin schools
 - Representatives from Nigeria and Togo
 - Benin Minister of Education, Minister of Economic Development, and US Embassy Public Affairs officers
- The team met with US Ambassador to discuss STEM initiatives



Sharing and teaching
are keys to team
learning