

Wednesday Meeting Updates

Sept 28th 2016

UBC Chem-E-Car | Engineering Design Team

The University of British Columbia, Vancouver

WWW.UBCCHEMECAR.COM



ADMIN UPDATES - 1

- **Generate 2016** conference, registration closing soon!

Anyone else interested? Talk to Abhi, Said or Victor



- **Why join?**

Free conference tix worth \$100+

Fancy food at the Hyatt downtown

Potential \$500 prize for the winner

Presentation experience

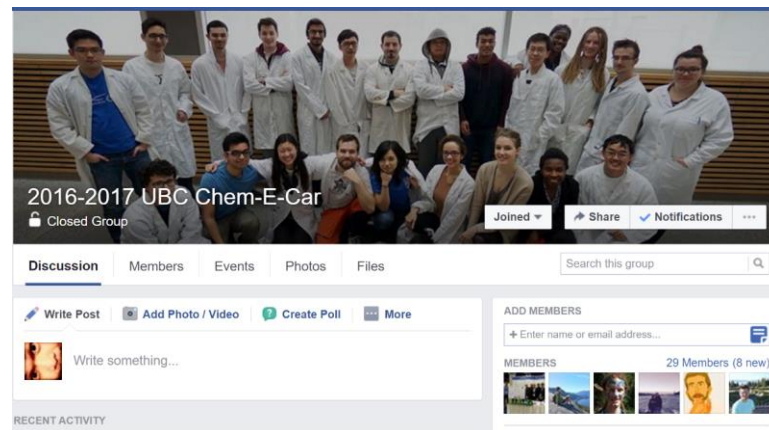
Networking with co-op employers

(huge advantage over your peers if you're in second year)



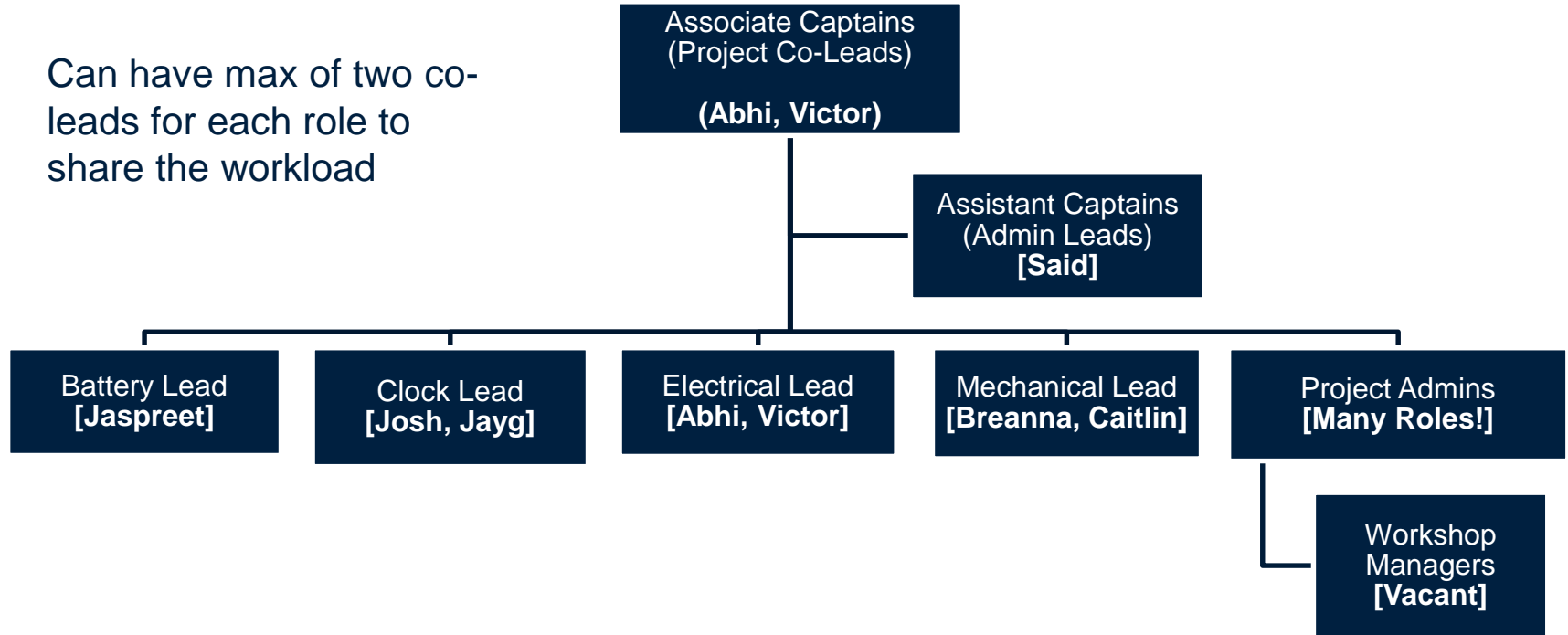
ADMIN UPDATES - 2

- Sign up for the mailing list
www.ubcchemecar.com/joinus.html
- Join the FB group, search for **'2016-2017 UBC Chem-E-Car'**
- Join your sub-team's group chats



JUNIOR CAR ORGIZATION CHART - UPDATE

Can have max of two co-leads for each role to share the workload



CHEM-E-CAR OVERVIEW

- AIChE (**American Institute of Chemical Engineers**)
- Professional organization for chemical engineers in North America
- AIChE organizes the annual Chem-E-Car competitions (regionals and nationals)
- **FREE** membership for undergraduate students. Why register?
 - Access to educational videos and industry updates
 - Student membership required for participation in AIChE conferences and Chem-E-Car competitions
 - Link to register:
<http://www.aiche.org/community/students/student-membership>



CHEM-E-CAR COMPETITION

OBJECTIVE

Design a shoebox-sized car that will accurately travel a certain distance while carrying a specified weight of water.

This is not a race. Competition is about accuracy, not speed.



CONSTRAINT 1

Car must **start and stop** using only chemical reactions. That means no timers, video cameras, remote controllers etc.



CONSTRAINT 2

The car's **motor** must be **powered** using only chemical reactions. Can be pressure-based, electrochemical-based etc.



No commercial batteries allowed for the motor, but can be used to power Arduinos, sensors or other electronics.

CONSTRAINT 3

Distance and weight of water: not given until an hour before the competition.



CHEMICAL CLOCK

Chemical clocks control how far the car moves. Clock timing manipulated by concentration, pressure etc.



EXAMPLE: Iodine clock

- Two solutions, A & B
(both colorless initially, black after mixed)
- Time needed to change color
dependent on concentrations of A and B
- Color change measured by
light sensors and cuts off circuit

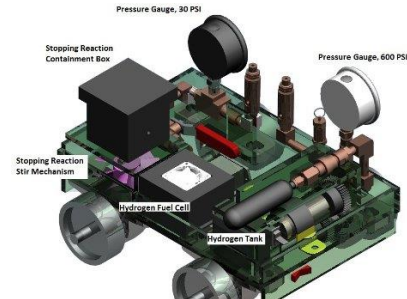
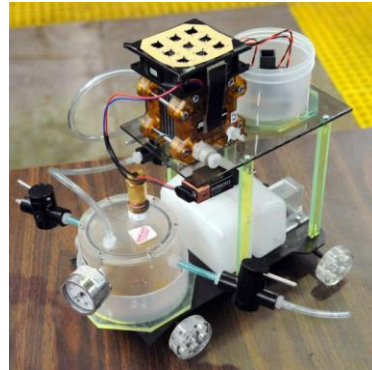
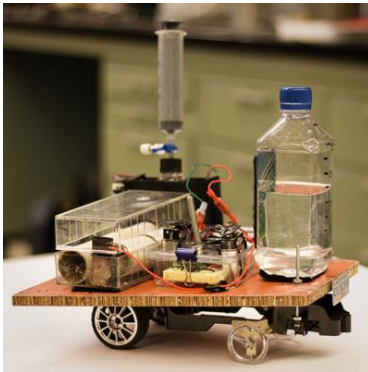


POWER SOURCES

- Pressure tanks, Batteries, Fuel cells
- **Biological reactions**

AIChE is offering a special \$1,000 award for

“Best Use of a Biological Reaction to Power a Car”



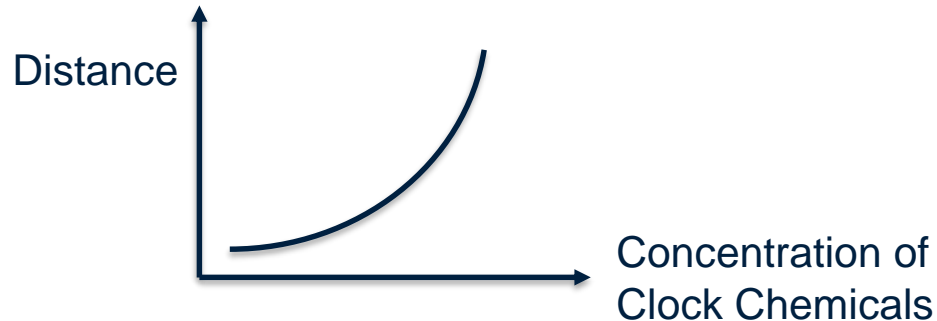
BEFORE THE COMPETITION

- **Prepare and submit an Engineering Documentation Package (EDP) to AIChE for inspection. [TIP: APPOINT AN EDP MANAGER!]**

Very detailed document on all aspects of the car including chemical reactions, chemicals used, safety considerations, electronic components etc. Easily 60+ pages including electronics specs sheets, MSDS and other appendices.



- **Test the car and collect data. Generate calibration curves.**



BEFORE THE COMPETITION

- Make a research poster explaining how the car works and the reactions used
- Poster will be presented to the judges during the competition. Award available for best poster presentation.



UBC Chem-E-Car 2016 - Zinc Air Attack

Athanasios Kritharis, Ray Bi, Kyle Como, Aliya Mitchell, Phillippe Rocos, Jordan Wright
Department of Chemical & Biological Engineering, University of British Columbia, Vancouver, B.C. Canada

Introduction

Zn/Air Battery Details

Anode: $\text{Zn} + 4\text{OH}^- \rightarrow \text{Zn(OH)}_2 + 2\text{e}^-$ $E^\circ_{\text{red}} = -1.25 \text{ V}_{\text{NHE}}$
 Bromine: $\text{Zn(OH)}_2 + 2\text{BrO}_3^- + 4\text{OH}^- \rightarrow \text{ZnO} + 2\text{Br}^- + 2\text{H}_2\text{O}$ $E^\circ_{\text{red}} = -0.34 \text{ V}_{\text{NHE}}$
 Cathode: $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$ $E^\circ_{\text{red}} = 1.39 \text{ V}$
 Overall: $2\text{Br}^- + \text{O}_2 \rightarrow 2\text{BrO}_3^-$

A zinc/air battery operates by oxidizing zinc on the anode and reducing oxygen on the cathode. The anodic reaction releases electrons which pass through an external circuit and travels to the cathode where oxygen is reduced to form water. Zinc/air cells are notable for their high energy density.

Environmental & Safety Concerns

- Zn is a non-precious metal and is naturally abundant in the environment.
- MnO_2 is environmentally benign.
- Zn/air battery by-products, ZnO , is non-toxic, and has many applications such as: baby powder, ceramics, food additives, etc. This requires neutralization before reusing ZnO.
- 6 M KOH solution is highly corrosive but it is contained in an anode compartment designed for safe usage.
- Wire connections are insulated with heat shrink.
- The following MSDS symbols are for those reagents used in both the iodine clock reaction and the Zn/air battery:

Methods

Zn/Air Batteries

Anode: SS-116 plate in contact with Zn powder in 6 M KOH to form a paste

Cathode: Commercial MnO_2 catalyst layer supported on gold-plated nickel mesh (manufactured by Gaspeak® [1])

Separator: Visketek 2027 filter paper manufactured by Fluorocelberg

Iodine Clock Reaction

$\text{I}^- + \text{Amylose} \rightarrow \text{Amylose-tri-iodide complex (color change)}$

Carbon Fibre Body

Carbon fibre is a composite material made of resin and carbon fibers.

Carbon fibers are micrometers in diameters and are woven into a fabric.

Layers are set into molds for the desired shape; every later is rotated to increase stress distribution

Control Mechanism: Circuitry

• Photoreceptor senses the color change within the iodine clock and Arduino turns the motor off.

• Both the photoreceptor & the internal microcontroller clock allows for data to be collected on distance and time travelled, which is then recorded to a micro USB card allowing for fast and reliable data collection.

• PCBs were designed in Eagle software, exposed to UV light and finally additional parts were soldered on.

Results

Single Cell Polarization Curve

- Stable open-cell voltage of 1.4 V
- Low cell internal resistance of 140 mOhms
- Continuous constant current discharge at 250mA up to 6 hours

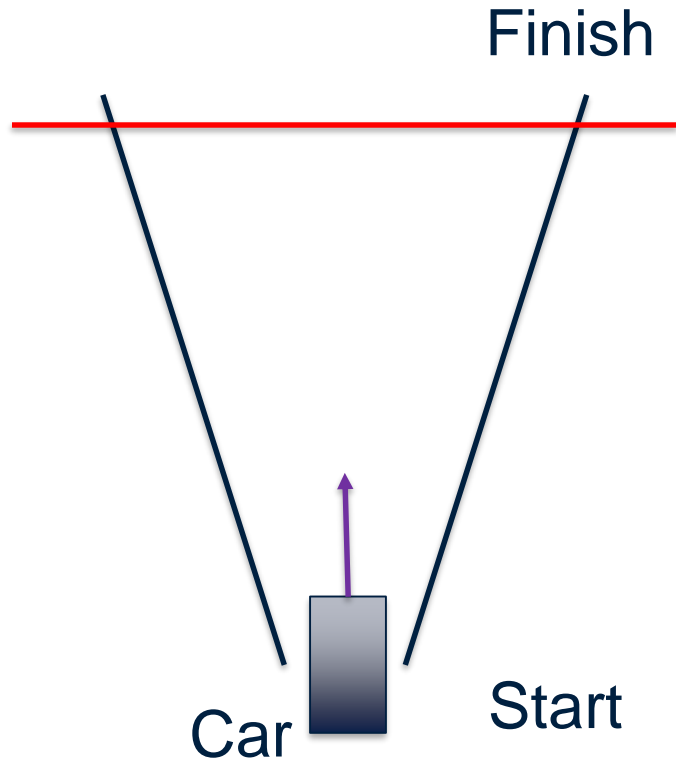
References

[1] I. Hefner, "Gaspeak: (http://gaspeak.com/)", Gaspeak, 2016. [Online]. Available: http://www.gaspeak.com/products/iodineeng_index.html. [Accessed 18 Apr 2016].

[2] R. Kelly, "NIST Material Information: Zinc", NIST, 2014. [Online]. Available: <http://materials.nist.gov/materials/public/commodity/zinc/>. [Accessed 17-Apr-2016].

Sponsors

COMPETITION DAY



- Teams given **15 minutes** to prepare batteries + clock chemicals. *Important to have a battery and clock that's easy and fast to assemble*
- V-shaped markings on the floor. Disqualified if car runs outside the markings. *Mech team: make sure car moves in a straight line*
- Teams scored by measuring distance from the front of the stopped car to the finish line. Team with smallest distance wins!



APP COMPETITION RULES (FROM THE AIChE WEBSITE)

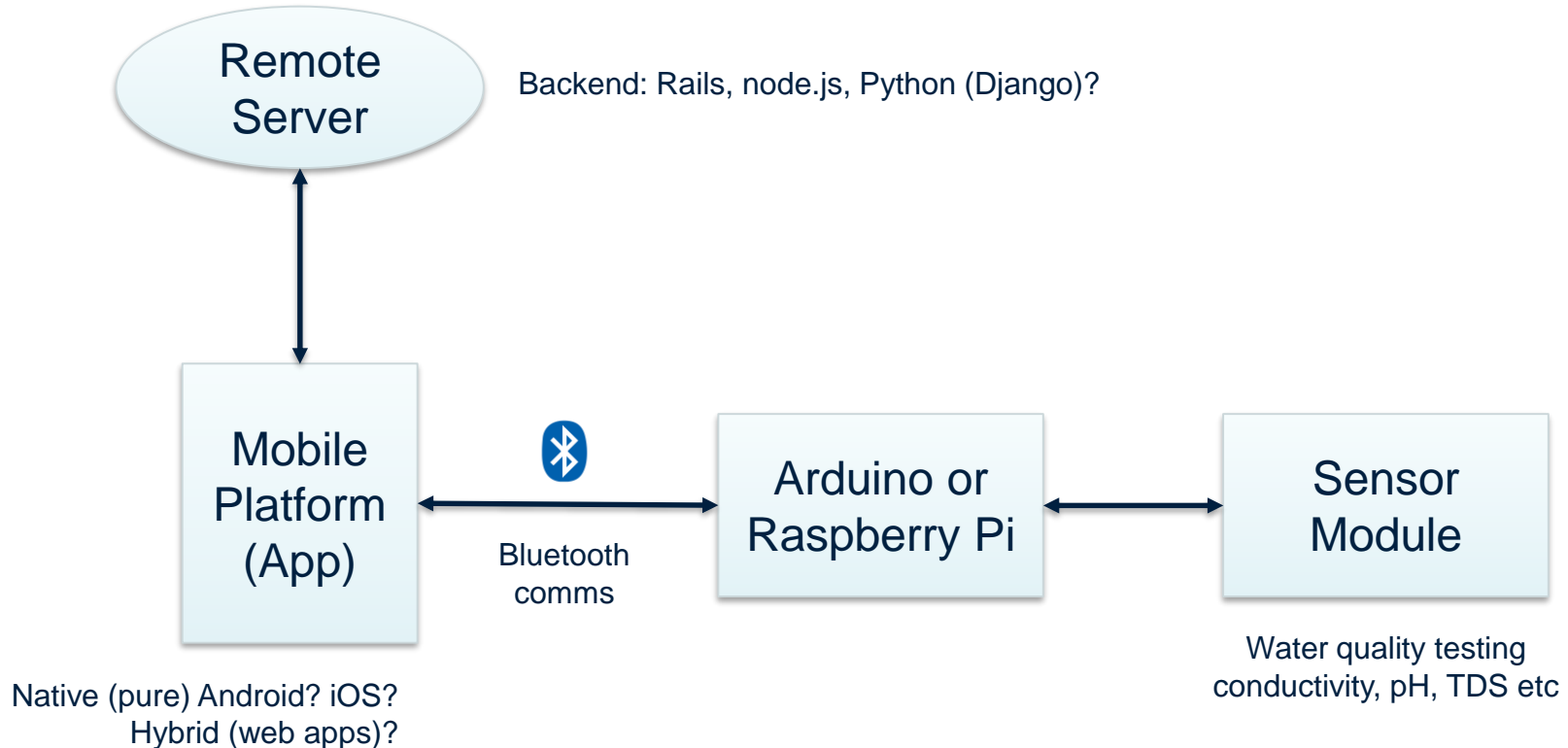
- APP must be useful for an AIChE member.
- Possible application areas: **scientific, engineering, teaching and professional meeting organizers.**
- For example, teaching apps could include a game designed to teach chemical engineering concepts.



Suggested features of a winning APP

- APP enhances student or professional performance/quality of life.
- APP is built using high quality content of ChE/Chemistry/Engineering
- APP functions with few to no errors
- APP should be more than just a handbook
- APP may be a game to promote chemical engineering to society

CURRENT IDEA: WATER QUALITY TESTING APP



GETTING STARTED: ANDROID

- Learn some basic Java
- Download **Android Studio** from android.com
- Read the tutorials on <https://developer.android.com/training/index.html>



Android Studio

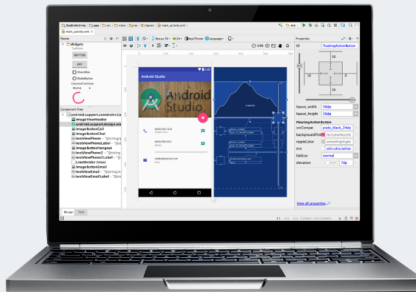
The Official IDE for Android

Android Studio provides the fastest tools for building apps on every type of Android device.

World-class code editing, debugging, performance tooling, a flexible build system, and an instant build/deploy system all allow you to focus on building unique and high quality apps.

DOWNLOAD ANDROID STUDIO
2.2.0.12 FOR WINDOWS (1615 MB)

[Read the docs](#) [See the release notes](#)



ACTION ITEMS: BATTERY AND CHEMICAL TEAM

Battery and chemical clock proposals (the sooner the better):

- Will give lab access when we receive solid and detailed proposals
- Team leads work together with your members to choose the best proposals (or top 3? If you have multiple good proposals)
- We will help you order chemicals when you are ready!



If you need help or feedback from the senior team, talk to **Andy**, **Mani**, **Arjun**, **Negar** or **Ray**

ACTION ITEMS: JUNIOR MEETINGS

- Senior team will be busy with Nationals car for the next few weeks.
- But we will be around to help if you have any questions. We'll give some 1-hour tutorials on certain Saturdays (will notify junior captains in advance), but we'll mostly be working in the workshop or lab during meetings.
- **Junior captains and team leads will serve as meeting chairs for future meetings.** Can plan your own meetings, or have it the same time as us (Wednesday 6pm, Saturday 12pm) for convenience.



Junior captains email: juniorlead@ubcchemecar.com

NEXT STEPS?

- Break into groups, talk to team leads and figure out next steps and timeline.
- No team leads yet? Take initiative and volunteer yourself!
Want to be co-lead? Welcome aboard!
Talk to junior captains.
- Need people to volunteer for administration, talk to junior captains:
 - Documentation manager – EDP and Poster
 - Finance manager (coordinate with team leads, prepare budgets)
 - Workshop manager
(make sure work space is clean and that everyone is working safely)
 - Any other roles you can think of? Or add more when needed





a place of mind

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