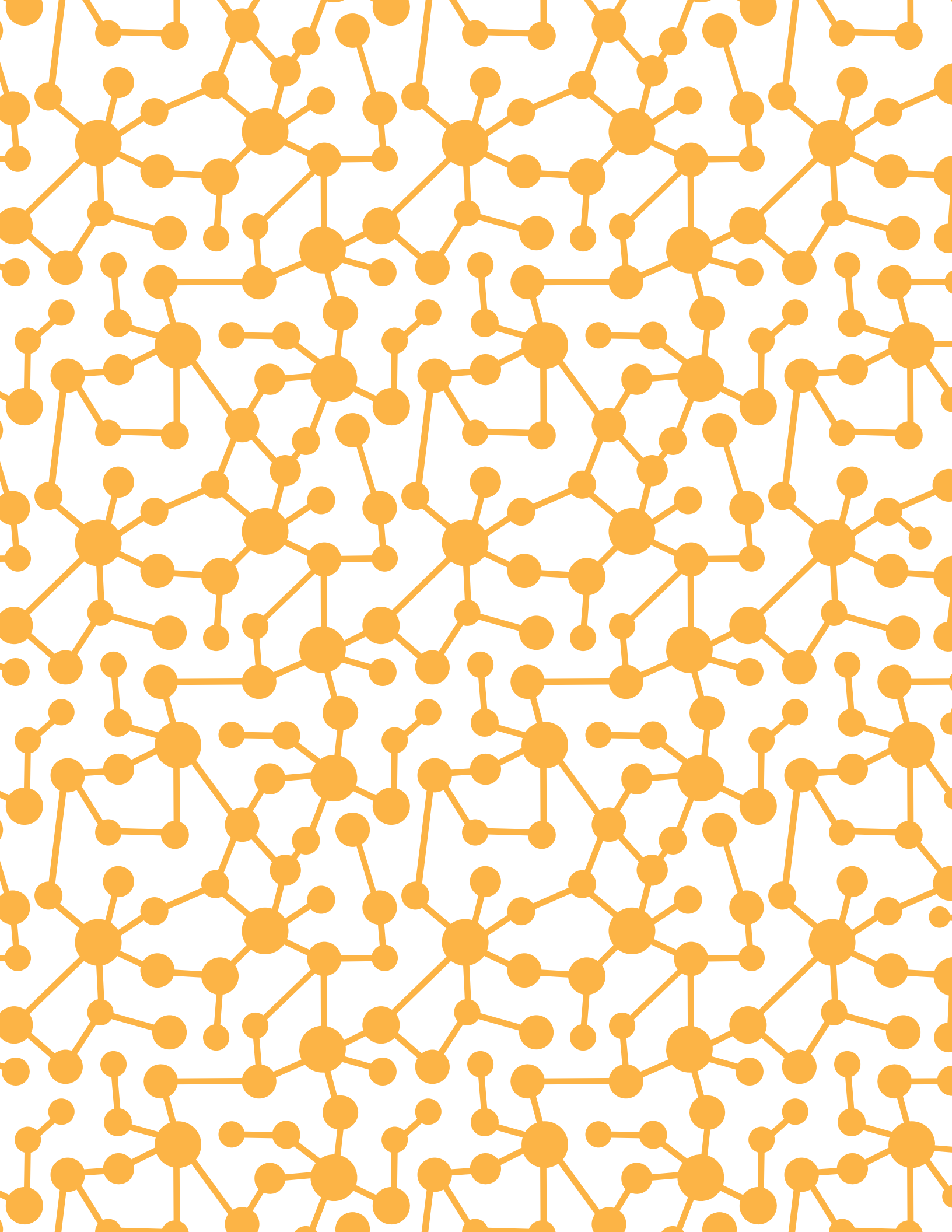
The iGEM Digest

iGEM AFTER iGEM

Issue 03 - June 2019



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The iGEM Digest

Director, After iGEM
Meagan Lizarazo

Editors
Amy Chen and
Hassnain Qasim Bokhari

Contributors
Sam Wilton-Clark
Elisha Krauss
David Kong
David Lloyd
Shaheer Sabz Ali

Original Design
Ana Sifuentes

Design Updates
John Girgis

Additional Editing
Guilherme Kundlatsch

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From The Editors

Dear Readers,

The iGEM Competition is an experience of a lifetime because it creates meaningful relationships and an enduring sense of community. These connections extend beyond the competition, mobilizing groups to support one another in an effort to share their passion of Synthetic Biology with the rest of the world.

In this issue of the iGEM Digest, we feature groups that have integrated their iGEM experience into other avenues of science and technology. These groups have captured the iGEM value of interdisciplinary collaboration as they have united like-minded and passionate individuals to inspire change and support the growth of Synthetic Biology.

Each one of the stories demonstrate the immense amount of strength and creativity that is generated by communities and collaboration. Music is a universal language that can unite people from around the world. Our first story features David Kong and his group's efforts to create an inclusive community and an interface between the public and research by merging music, bacteria, biotech, and technology. Next, we see how iGEMers have literally gone above and beyond to expand the impact of Synthetic Biology as they fly in microgravity, integrating their Synthetic Biology work with space research. We then join iGEM Peshawar and relive the intensity of the final days leading up to the parts submission deadline, reminiscing the late nights in the lab, the panic, and laughter shared with our teammates. Finally, we recognize the organizations and regional sponsors that believe in the potential of iGEMers and the support that they have provided by sharing an example of a local organization that has made a tremendous impact on the iGEM community in their region.

By sharing the stories of iGEMers past and present through the iGEM Digest, we hope to continue strengthening the connections within the iGEM community. We are truly grateful to be a part of this diverse international community with you all and look forward to witnessing and celebrating your achievements and successes together.

Sincerely,
Amy Chen
and
Hassnain Qasim Bokhari
Co-Editors-in-Chief

Defying Gravity

Astroplastic: In 2017, the Calgary iGEM team developed a start-to-finish process which converted human fecal matter into biodegradable plastic known as polyhydroxybutyrate (PHB), which can be 3D printed. This project, titled, “Astroplastic”, was designed with space travel in mind; by producing a plastic with myriad possibilities through 3D printing from inevitable human waste, space crews could be able to perform longer missions in a more sustainable manner.

Following the presentation of Astroplastic at the jamboree, the project was taken one step further through the Canada Reduced Gravity experiment, which allowed the project to be tested in zero gravity through parabolic flight. This initiative, made possible by SEDS Canada in collaboration with the Canadian Space Agency (CSA) and the National Research Council (NRC), selected four teams from across Canada to test their experiments in zero gravity aboard the NRC’s Falcon 20 research aircraft. This opportunity allowed the team to design and test the engineering side of Astroplastic as opposed to the biological side. The team built a prototype of their PHB extraction system, which recovers PHB through a process known as dissolved air flotation and tested it in zero gravity August 28th, 2018.

For Astroplastic, this opportunity was definitely worth it, even though the Falcon 20 aircraft, also known as the “Vomit Comet”, truly lived up to its nickname. This was an excellent experience which allowed the team to properly execute and test their project. The challenge also promoted testing of the non-biological components of an iGEM project, an aspect of the project that the team hoped to investigate further after the iGEM Jamboree last year.

Written by:
Sam Wilton-Clark
Calgary iGEM 2017, &

Elisha Krauss
Queen’s University iGEM 2017

Photo credits:
iGEM Foundation

Have you ever dreamed of going to space? Wondered what is it like to be in a zero gravity environment? Last summer, students from 4 universities across Canada were selected for an experience of a lifetime. They were chosen to design an experiment to test in zero gravity.

Elisha Krauss: Memorize, regurgitate, forget, repeat. At the undergraduate level, it can feel like there isn't any room for creativity and inquiry, and if you want to succeed, there is a rigid set of facts and concepts that need to be memorized. In the biological sciences, this is especially true. We learn about a system or a theory, but there lacks an opportunity for practical application and creativity. Scientific research has focused on deconstructing the world; explaining how the world works. This has led to profound realizations, but this knowledge is wasted if we don't do anything with it. Scientists don't just stop when they discover the cause of diseases, they use this knowledge to find treatments and develop cures.

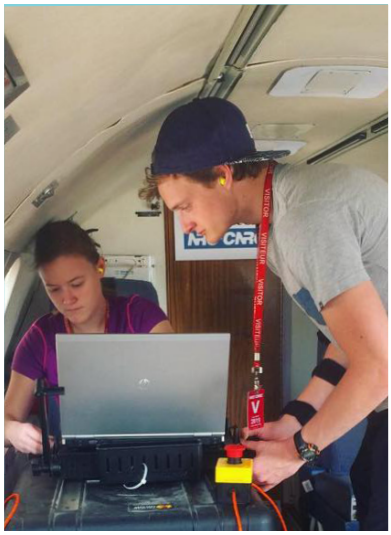
If we want students to take interest and continue in science, it must be engaging. Therefore, competitions like iGEM are critical to education. Students are challenged to apply knowledge from the classroom in the fast-evolving field of synthetic biology and to tackle current real-world problems relating to medicine, food and nutrition, sustainability, and more. Rather than deconstruct the world, we engineer biology to shape it.

My love of scientific innovation has influenced my position as a team leader for the Queen's Canada iGEM Team. I've learned lessons from this experience about critical thinking, problem solving, and teamwork that could never be taught in a lecture or a seminar. It has been an exceptional opportunity to think creatively, design my own experiments, and hone my skills as a young scientist. This experience allowed my good friend Aaron Rosenstein and I to submit a winning application to the Canadian Reduced Gravity Experiment Design Challenge run by the Students for the Exploration and Development of Space (SEDS). Our proposal to test the potential impact of microgravity on DNA Polymerase I error rate, was one of only 4 experiments accepted from entries across Canada. On August 30th, after hundreds of hours of preparation, we ran our experiment aboard the National Research Council's Falcon 20 Jet, while floating in microgravity. It was the ride of a lifetime!

With my undergraduate education behind me, and having just started graduate studies, I look forward to one last chance to share my love for creative scientific innovation at the undergraduate level, through my team's presentation at the 2018 iGEM competition. See you at the Jamboree!"

Editor's Note: We loved seeing meeting Elisha, his team and their presentation at the Jamboree last year. Onwards and Upwards!

"If we want students to take interest and continue in science, it must be engaging. Therefore, competitions like iGEM are critical to education."
- Elisha Krauss



Beats, Bacteria, Biotech: David Kong's Story

Dr. David Kong,
Director

Media Lab Community Biotechnology Initiative

Interviewed by **Hassnain Bokhari**

All images provided by MIT Media Lab

With a mission of empowering communities through Biotechnology, David Kong has been engaged with both the community and biotechnology in different roles for many years. A synthetic biologist, community organizer, musician, and photographer, he currently serves at the Director of MIT Media Lab's Community Biotechnology Initiative (CBI) which explores the interface between Biotechnology and Community.

Kong's relationship with iGEM dates back to its earlier years when it was started as a month long course during MIT's Independent Activities in 2003. He grew up in the Boston area and was a graduate student during the time Randy Rettberg, Tom Knight and Drew Endy were coming up with the idea of iGEM.

Over the past few years Kong has been involved with the iGEM Competition in multiple roles. From helping to create the microfluidics and hardware tracks to being the official DJ of the iGEM, he has had made sure that everyone has fun doing biology.

That is not all! In 2016, his community lab the EMW Streetbio participated in the iGEM Competition and worked on the project "Biotabeats".

"The project brought art and science together and it was a great opportunity for us to create a compelling narrative in invention and innovation. Music is a universal language and serves as an important tool to engage the public."

You might be wondering how they managed to create music out of an organism which is not widely known it singing abilities.

Well, the team grew cultures of the human microbiome on a petri-dish, and applied codes for a program which translated the images taken of the petri-dish into music.

We took human microbiomes from distinct body areas (specific to the individuals continent) at the Jamboree, cultured them on the Biota-beats petri-dishes and created music which was representative of each continent's microbiome.

Those who got a chance to be at the 2017 Giant Jamboree, where a lucky (massive) bunch of people, since with their microbiome David Kong and his group took this a step further and created **Uni-verse**.

"Imagine Earth as an organism where each continent is an organ. We took human microbiomes from distinct body areas (specific to the individuals continent) at the Jamboree, cultured them on the Biota-beats petri-dishes and created music which was representative of each continent's microbiome. It was all very exciting, since we just had 72 hours to get the microbiome, do the code and turn that all into the Uni-verse which we showcased at the Giant Jamboree"

Kong's work with The Community Biotechnology Initiative at the Media Lab in MIT combines two major parts of his life, biology and community engagement.

If you're a part of the general public, where do you go to study the topics pertaining to Biotechnology or Synthetic Biology? The answer, nowhere. So the Community Innovation is an important interface between the public and research.

While speaking in detail about CBI, he informed us about the "How to Grow (Almost) Anything" course, which not only is being taught to people living in the Boston-Cambridge area but also many individuals from different parts of the world are part of this course and it has ensured a distributive way of knowledge sharing.

"At How To Grow Anything we are revisiting our business model to make it more accessible to communities, most of the current infrastructure is based on the Western Business Models, but we have to revisit it so that our technologies become more accessible."

Kong's research group has 3 focus areas. The first one of them is Community Innovation. This area is grassroots driven. "When you talk about technology, the stakeholders which come to your mind are Academics, Industrialists and Government officials. Since 2009, there's an emerging community inclusion in Synthetic Biology but if you're a part of the general public, where do you go to study the topics pertaining to Biotechnology or Synthetic Biology. The answer, nowhere. So the Community Innovation is an important interface between the public and research."

The Community Innovation group organizes events, the biggest one of which is the Global Community Bio-Summit. During the Biosummit they convene the participants at the Media Lab and develop a transformative environment. Individuals who are working on or inside community labs from all over the world gather and provide an important opportunity to organize the community.

"People coming from every part of the world realize their part of the global community. When you meet and share vision, it changes you and makes you feel that you're not alone. It makes you feel like a family"

Last year the Bio Summit was organized for the second time. Speaking on the event Kong said "The biggest thing we are focused on this (2018) years' biosummit it to crystallize collaboration. The first year was sort of a family meeting and this year we are planning on doing action."

And the summit exactly saw what Kong talked about as at the end of all the participants developed the "Statement of Shared Purpose":

"Our shared purpose is to fundamentally transform the life sciences and democratize biotechnology to inspire creativity and improve lives by organizing life science change-makers and bioenthusiasts to build an inclusive global network, cultivate and accessible commons of knowledge and resources, launch community laboratories and projects, and enable local educators."

Our shared purpose is to fundamentally transform the life sciences and democratize biotechnology...

His research group is also working with the Harvard Business School and the Sloan Institute to study the community and the technology. While talking about the robustness of the open-source infrastructure in IT on which companies like Alphabet and Facebook, work on, Kong pointed out that with a similar open-source infrastructure for biotech, the technology can have a huge impact even for the communities living far off.

The other key area of CBI is Participatory Biotechnology. "How do we develop a framework which will allow the community which is working on biotechnology to become a part of the technology development framework."

The group is currently working with designers and social scientists so that they could also be a part of the discussion surrounding biotechnology.

On the technical front his research group is working on Microfluidics. "We are developing microfluidic platforms for microbial systems, cell-cultures and 3D printing. Another important project which we are working on is Metafluidics. It is an open-source collection of design files and other information required to build microfluidic devices."

Combined together, the Community Biotechnology Initiative intends to make a cultural impact of which Biotabeats and their recent work in Komaci are two great examples.

Speaking on identifying distinct problems of different regions Kong pointed out the need for researchers at top institutes need to be more humble. "At MIT we can think that we are little too smart but we need to be more humble. Last year we organized an event in Ghana. So in order to start working in Ghana, we asked ourselves first, what were the issues and the most prominent one was Gold Mining. There are many concerns about the illegal mining and toxicity. We collaborated with organizations to work on models for detection and remediation (open source) to develop solutions and developed a space in Komaci for open-source and hardware design. That's an example taking problem centric approach to creating solutions. Many of the regions lack an infrastructure for learning and sharing new technology and Scientific education."

This year the Bio Summit will be happening from 11th October to 13th October, 2019 and applications are already open at:

www.biosummit.org

He said that the iGEM Competition is a great platform to development a knowledge sharing platform which could benefit the developing and underdeveloped countries but he also pointed out that for such communities to take full advantage of this opportunity, iGEM should develop a structure which will make cheaper for teams from such regions to participate.

The Giant Jamboree and the Global Community Bio summit have a lot in common (they both take place at the same time last year). The most important being the people. Most of the participants of the Biosummit have been a part of the iGEM Competition and have taken up important initiatives in Research, Community Science and Open Science, Startups, Policy Making with regards to Synthetic Biology. Kong appreciated and acknowledged the work and impact created by these individuals across the globe, he said

"Impact is significant and wide ranging which has been highly influenced by their experience of the iGEM Competition. Going forward it's important that all these individuals and those who are doing similar stuff but haven't participated in iGEM to come together, share their work and collaborate"

This year the Bio Summit will be happening from 11th October to 13th October, 2019 and we hope to see more of our iGEMers sharing their work with the rest of the community and working together with them to create a larger impact.

FREDsense Interview with David Lloyd

David Lloyd,
CEO, *Cofounder of FREDsense*

Written and Interviewed by:
Amy Chen and
Hassnain Qasim Bokhari

Photo credits:
FREDsense Technologies

David has been an iGEM student, advisor, Human Practices Committee member, and judge and is now the CEO of an iGEM-based startup called FREDsense Technologies. His specialty is in entrepreneurship, user-focused design, and safety and ethics through the lens of product development. The iGEM Digest had to pleasure to speak with David to hear about his iGEM experience and how an iGEM project led him and his teammates to founding FREDsense Technologies.

The idea to use bacteria to sense compounds in industrial water began in 2011 when David's iGEM team decided to tackle a major challenge in the oil and gas industry, tailing ponds. Tailing ponds are big pools of contaminated water that result from the oil extraction process, leaving toxic and corrosive compounds in the environment. The team did some proof of concept experiments using bacteria to sense some of the toxic compounds and used an electrochemical system to report them. The idea seemed to work so the team carried the project idea forward in their 2012 iGEM project called FRED and OSCAR. The project aimed to develop a collection of toxin-sensing and degrading organisms to bioremediate the toxins in tailings ponds, turning them into usable hydrocarbons. David's iGEM team did very well at the competition that year, winning more awards than any other team since the competition started in 2003. This project got a lot of traction and led to them founding FREDsense.

FREDsense Technologies combines biology and engineering to detect chemicals in our water. The company has developed a wide variety biosensor to detect chemicals such as arsenic, iron, manganese, and acidity. They even have a platform for people to inquire about making custom sensors.

Starting from Zero

At the start of their startup journey, David and his team had zero business experience, zero funding, and little to no real scientific backing. They had a problem with IP too as their technology was in an open source registry. To make matters even more difficult, they had used university resources, so the university also had rights to the IP that was developed. Lastly, they had a team of 30 individuals that had developed the technology and only 6 had wanted to pursue the company. However, they were fortunate to get some fantastic legal council to tackle the challenges.

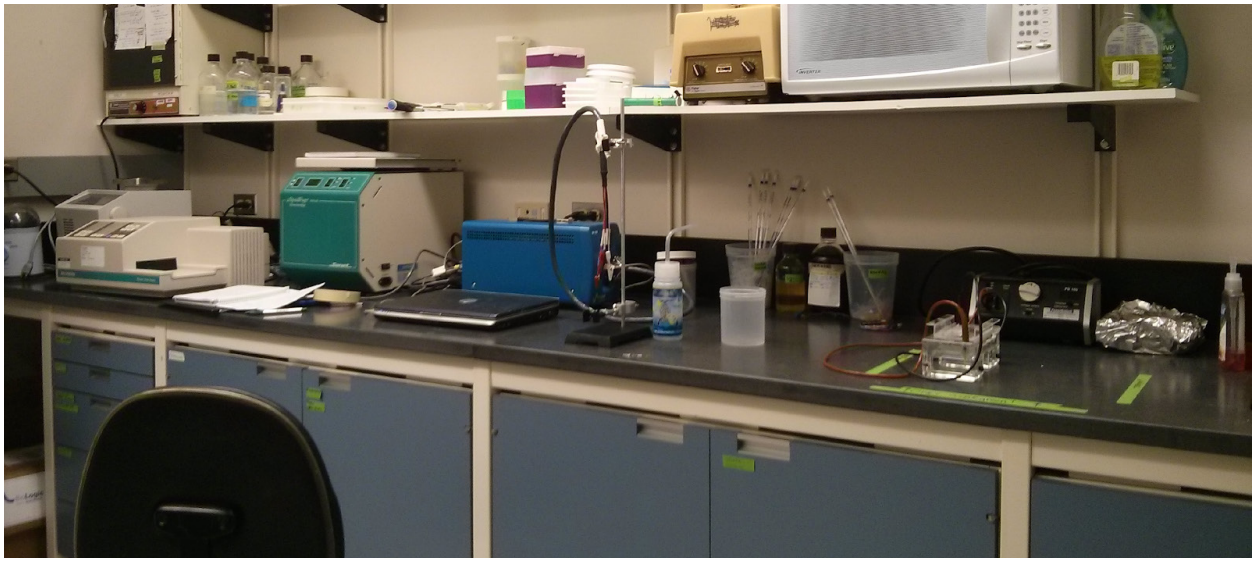
Space for Innovation

One of the first major challenges the team encountered was the space necessary to do technical development work. As there was limited opportunity at their local university to provide economical space for the company, the founders endeavoured to build out their own lab infrastructure. After winning numerous business plan competitions to fund the company, the team rented a ~130 sq. ft. lab space in the basement of the Calgary Research Park. Here, they begged and borrowed equipment, found used hardware systems and even DIY'ed some of their own equipment to do their work.

Their hard work resulted in the first sets of data the company could use to attract investment and outside interests allowing them to fundraise through an accelerator program at Singularity University in Silicon Valley. This allowed the team to move into a 1,400 sq. ft. former automotive repair shop bay. With some elbow grease and time, the team converted the space into a synthetic biology lab space where the work continued. The team was able to find creative solutions to numerous issues surrounding equipment accessibility and the high cost of particular materials that were necessary to continue their work, truly demonstrating that synthetic biology is hitting an age where "garage biotechnology" efforts can be made.

Their hard work resulted in the first sets of data the company could use to attract investment and outside interests allowing them to fundraise through an accelerator program at Singularity University in Silicon Valley.

The team now works out of a 6,000 sq. ft. space as a formal lab, office and manufacturing area.



What words of Advice do you have for current iGEMers?

"Look for opportunity in the strangest of places"

A central theme in FREDsense's development has been identifying unique and creative ways of overcoming adversity. Where it was fundraising for the company through winning seven major business plan competitions in north America, or building out technology through a bootstrapped DIY-bio approach, the team has always hit challenges head-on.

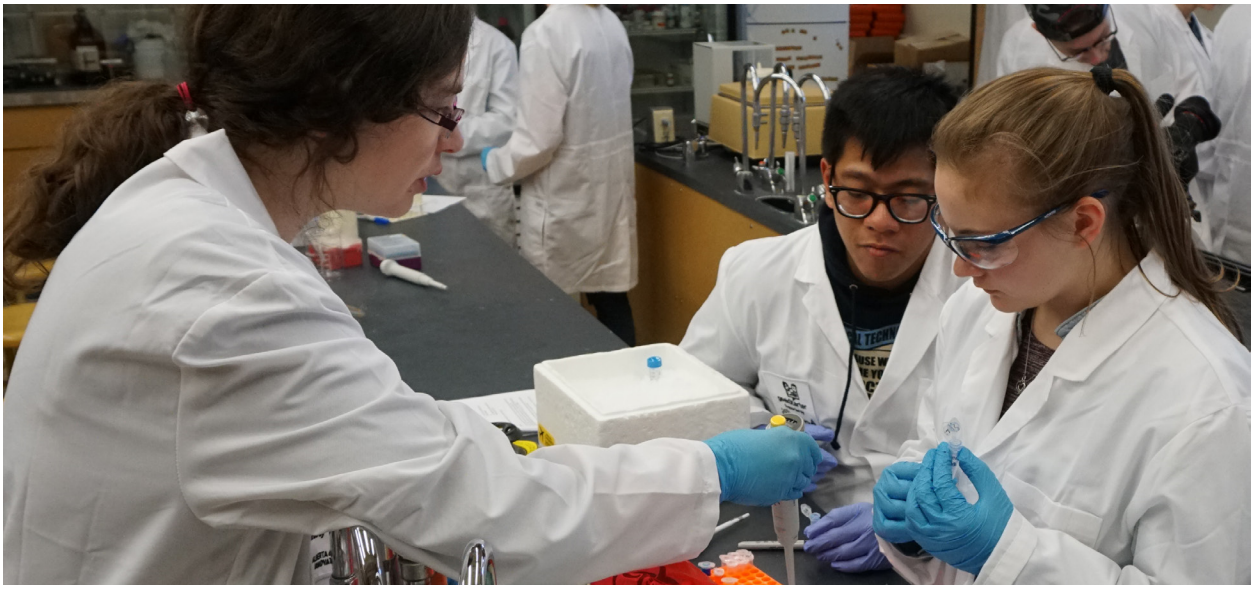
You currently sit on the Human Practices Committee and have been a judge in the past. What Does Human Practices Mean to You and how have you integrated these principles into running a company?

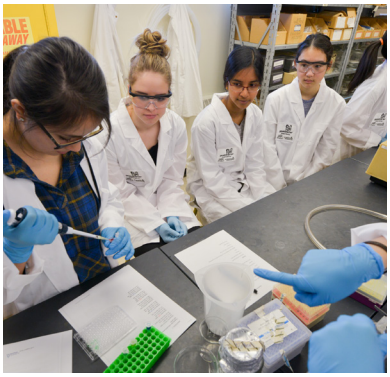
"Be 100% focused on solving a customer problem". says David. It is important that your solution works for the target group. It is incredibly useful to go and validate assumptions around your idea. Sometimes, a simple phone call and conversation can change everything. Through this process of going to the end users and validating their assumptions that David found out that the initial sensor they were building didn't have value for the oil and gas industry. Therefore, they changed the sensor to assess other market opportunities.

What are some of FREDsense's current initiatives?

FREDsense is working with various clients and customers to build out novel sensor solutions for the water utility and mining space incorporating novel synthetic biology hardware systems to translate R&D activities that normally occur in the lab into comprehensive field-based solutions for industry. FREDsense's sensors have recently been authorized by the Canadian environmental regulatory agency as an approved approach for environmental monitoring applications, meaning that the company has identified not only strong industrial opportunities for the product but also worked with government stakeholders to change the way we think about understanding what is in our water.

Local Organizations Supporting Local Teams





MindFuel is a non-profit organization building STEM (science, technology, engineering and math) educational resources for the 21st century and beyond. Established in 1990 as Science Alberta Foundation, MindFuel's purpose is to make STEM learning meaningful and exciting to young people, and to empower them to become competent problem-solvers and responsible leaders and citizens. They have been working towards this mission by supporting local iGEM teams with various initiatives.

The geekStarter, a program that engages students in finding and solving real-world challenges, and building solutions based in emerging STEM, was started by Alberta Innovates Technology Futures and has been supporting regional iGEM teams for over ten years. As the partner organization, MindFuel took over the program in 2015, and has been running it and continuing to support Alberta's iGEM teams ever since. To support iGEM teams within Alberta, MindFuel's geekStarter program holds several workshops throughout the year tailored to teams working on solving real-world problems with biotechnology, including synthetic biology. These events are well aligned with iGEM and many of the participating teams are iGEM teams. One long-standing tradition has been the aGEM competition and workshop, which takes place in the second half of September – the "a" in aGEM stands for Alberta. This competition gathers Albertan teams for a mock-presentation and allows them to interact with relevant experts from industry and academia. To foster an entrepreneurial spirit in the region, MindFuel also hosts a startup event in late November where they invite all the Albertan geekStarterteams – collegiate and high school – regardless of how advanced their project is or their particular STEM area.

Written by **Amy Chen**

All images provided by MindFuel

According to Magda Pop, Project Manager at MindFuel, iGEM has had a multidimensional impact on schools in Alberta. “Participating in iGEM provides Alberta’s students with unique and rich learning opportunities. From an education standpoint – i.e., for 21st century skill- and career-building – the impact of iGEM in the region is very significant. It is worth noting that Alberta is the only Canadian province that has several high school teams, most of them working out of regular school labs. However, from a technology and business perspective, the impact of iGEM in Alberta is surprisingly low so far. Given the large number of exciting iGEM projects and teams Alberta’s students have started over the past 10+ years, it’s disappointing so few of them have stood the test of time. We are, of course, very proud of our local company and close partners FREDsense Technologies – which started as an iGEM project in 2012 – and we would love to see more of our teams persevering and succeeding on the entrepreneurial path.” Magda explained.

Seeing the local teams’ consistently strong performance and results at the giant jamboree, makes those at MindFuel feel very proud and honoured to be supporting the teams in the region.

Not only has iGEM had a great impact on the students in Alberta, Magda expressed that her own understanding of synthetic biology and its potential as a technology has grown a lot since she first learned about iGEM upon joining the geekStarter program in 2013 as a mentor. “My grasp and appreciation of the highly interdisciplinary nature of synthetic biology, with its huge promise in terms of benefits and also huge risks and controversies, has grown over the years as well” says Magda. Seeing the local teams’ consistently strong performance and results at the giant jamboree, makes those at MindFuel feel very proud and honoured to be supporting the teams in the region.

MindFuel is just one example of a local organization that has been supporting local iGEM teams in developing solutions for local problems. iGEM teams across the world have received support from organizations and sponsors in their region that believe in what they are doing. These relationships not only benefit the students but also foster the development of solutions for local problems.

From The iGEM Diary

There are so many stories to begin with, that made us laugh, cry, angry and terrified at different times, even all on the same day at times.

I'll begin with the one situation that made us panic till the last day. The situation spans over ten days though. So now, it's the last ten days till parts submission. The leaders plus the mentors came out of PI's office after a lengthy meeting devising strategy about how to solve the final transformation problem we had been facing for the past couple of weeks. All other deliverables currently were being worked upon at the right pace and hence, we were not so worried about those. Also, getting these parts was very important because if not, that would've been a huge blow to the SynBio campaign started in the country and it was just 1 year old at the time.

So, we come out, with some final motivational words from the PI, and went to the lab to try again. We tried four different transformations, but none worked. OK, no issue, we try again tomorrow. No results. The next day, another try, no results again.

So now its four days to the deadline, and we're sitting in the lab and one person who was not actually part of the team but very close to the team since the beginning starts saying, "I don't think we're going to get any parts this year, we will fail to submit any parts" and all this, whilst everyone is super tensed and worried about everything happening.

Written by:
Shaheer Sabz Ali

Photo credits:
Shaheer Sabz Ali

"It all came down to the last couple of days."

I lived in the same city, but I don't remember visiting my house during the last four days. We worked day in day out in the lab, slept in a side room, tried every method and protocol to get some solid results that could be presented at the Giant Jamboree. There was a sense of helplessness, thinking that it all came down to the last couple of days. The efforts during the summer depended on these two days and the results from the lab.

Finally, on the last day, we come into the lab, go directly to where the plates were kept, and we were greeted with blue transformed colonies. When I remember that moment, it still gives me goosebumps because of the feeling of relief we got by seeing the blue color.

Nevertheless, we succeeded in submitting those parts along with other deliverable, because in the end we won a silver medal at the GJ along with a nomination for Best Safety and Security Practices.

There are many other stories of panic and laughter, but this one tops the rest for me personally since a lot was riding on these results.

In our next issue...

The Gut, The Bacteria and The Legislation, Legislating Probiotics in Brazil: An iGEM teams story
By Rafael Tuma

iGEM and The Value of Responsibility
By Christopher Whitford

Stay tuned!

Interested in writing for The iGEM Digest? Get in touch at after@igem.org.

We're looking for stories from the community as well as volunteers to join us as writers, reporters, and editors.

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