A First-Hand Report: Competing in MIT'S THINK Science Competition

by Erika Tan* (Advanced Biofuels USA) Let me introduce myself - my name is Erika Tan, and I'm a current sophomore attending Freehold High School in New Jersey. If someone had told me at the beginning of this year that I would be writing an article for a nonprofit biofuel organization, I wouldn't have believed them at all. But here I am, and I'm so honored to be able to tell you my story.

Over the summer I had been apathetically looking online (as many teenagers do today) until I saw a link to a competition hosted by the Massachusetts Institute of Technology called "THINK". Since I look forward to competitions like this, I took a look at the THINK website.

The competition consisted of having to write a ten-page research proposal for any idea that would make an impact on the science community. Six finalists would be chosen, and those six would win a free trip to MIT's XFair (a technology expo) where they could talk to mentors and get funding for their experiment proposals. And if that wasn't enough, the finalists were able to talk to exhibitors from today's top tech companies such as Microsoft, Facebook, and more.

Who would say no to that? And so, when the school year started, I talked to my friend Shaena about joining the competition together. We had participated in a couple other science competitions before in 8th grade (such as those hosted by the Technology Students Association) and succeeded in the statewide and national competitions for our projects regarding (1) cephalopod camouflage and (2) the benefits of using switchgrass as an energy source.

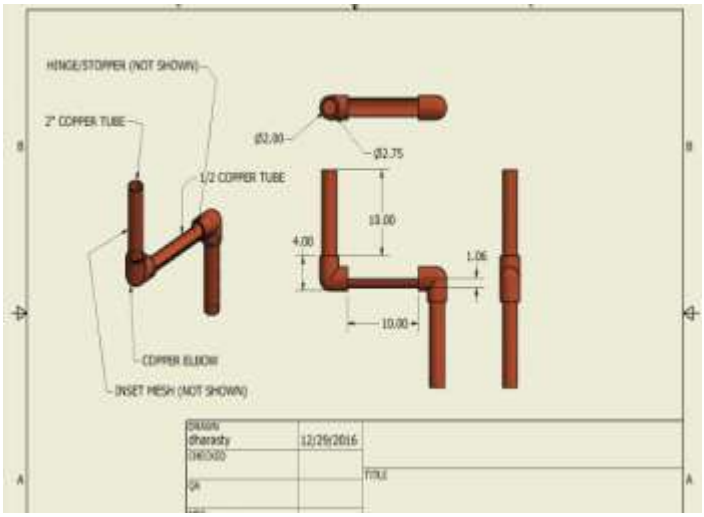
Since octopus camouflage was kind of a hard topic for us to imagine realistically doing research on, we decided on doing something related to switchgrass for THINK. Our focus shifted to cellulosic ethanol in general, since our original idea of proposing a novel way to harness energy from switchgrass proved way too much of a challenge for us - some of the articles that we read about hydrolysis and saccharification sent my head spinning.

After (many) cumulative hours of staying at each other's houses to brainstorm some experiment ideas, Shaena brought up the idea that we could do something about inhibitors in cellulosic ethanol hydrolysate. Her plan was to somehow filter the inhibitors out, and we both worked to design a filtration system that could help implement this idea.

I'll backtrack for a moment and explain our design. Hydrolysate (well, the word "hydrolysate" can refer to different things for different people; the specific type of hydrolysate that *we* were looking for) is the mixture that results after enzymes have been added to the pretreated energy plant. This plant could be switchgrass, miscanthus, etc. The hydrolysate is used for fermentation and distillation, in which ethanol vapors result for collection.

Unfortunately, some pretreatment processes cause inhibitory compounds to arise in the hydrolysate, including furfural and acetic acid. They "inhibit" the efficiency of microbes that work during the fermentation phase, affecting the process and yield.

Our filtration system would use different substances that could potentially remove the inhibitors, such as activated carbon, ammonia, and sulfur oxyanions. Shaena made this greatly detailed diagram using Autodesk Inventor to show parts of what the actual system would look like. For each vertical copper tube shown, we would place the inhibitor-removing substances inside with a mesh, so that the hydrolysate would be filtered by passing through the mesh and chemically reacting with the substances.



As we were writing our proposal, we came to the part where we had to list the materials needed and describe how, if we were selected as finalists, we would stick to the budget of $1000 according to the materials we would buy.

This is where we came to the biggest challenge of writing the paper: where do we buy cellulosic ethanol hydrolysate? It's definitely not a common item that people look for on eBay, nor is it sold on most lab equipment websites. We looked for a bunch of biofuel organizations/companies that we could contact, and all in all, I sent emails to about 5 different people including:

1. Advanced Biofuels USA: the first and definitely the most successful one that I contacted, since I got a reply almost immediately and was directed to two more helpful people to contact. And not to mention that I'm writing an article for this organization now!

2. Two people from POET: POET is a biorefinery company and I was guided to talk to two people here by Ms. Ivancic at Advanced Biofuels USA. The people at POET agreed to sending us the hydrolysate, for free, in the case that we were selected as finalists. I am still very thankful that they were so generous, and even more thankful that Ms. Ivancic was kind enough to direct me to other people and ultimately allowed us to secure the material for our project.

3. DuPont: even though it's a very big company, I didn't get a reply until about two weeks after, saying that they couldn't offer us the product that we needed.

4. Abengoa Bioenergy: I didn't get any reply from this company.

5. Some other company whose name I forgot.

And of course, throughout this entire project, we had to read through various different articles to support our experiment. I was very fortunate to have found an academic article that was solely dedicated to inhibitors in cellulosic hydrolysate (imagine that!) and referenced it a lot during the planning of the filtration system. I was also very glad that it was a full document, and not just the abstract (here is the link if any of you want to take a look at it; it's a very educational read: http://www.sciencedirect.com/science/article/pii/S0960852415014042).

There were many other resources that Shaena and I dug through during our research, some of them being blog posts, others being academic research papers, and even more being YouTube videos that had information about ethanol production. Ms. Ivancic from Advanced Biofuels USA also sent me some additional articles about biofuels, my favorite one being this post about two women who entered an engineering competition with their idea of using oxidizers to reduce the effect of acetic bacteria in the fermentation

process (now doesn't that sound familiar?): https://www.cargill.com/story/bringing-the-food-industry-to-life.

Obviously, writing a ten-page paper is pretty tough, but I think the hardest part for me was waiting for the results to come out. The THINK team from MIT doesn't have set dates for letting applications know the results; on their timeline it just says that finalists will be notified by the "middle of January". At times, just thinking about the results would keep me up at night with nervousness and excitement. When it got to around January 16-17, I was pretty much checking my email and the THINK website every day.

And then the results came out. On the main page of the website, there was a "thank you" note to all of the applicants, saying how great it was that everyone submitted their projects. There was a blue button below the note that brought people to the results page.

Somehow, the very millisecond after I clicked that blue button, I knew that my and Shaena's names wouldn't be there. And sadly, they weren't. A few days later, honorable mentions were posted on the website, and our project wasn't listed on that list, either. It was a pretty sad experience for me, at least at first, since I had worked on this with Shaena over the course of four-five months.

But the most important thing I've realized from this was that I'm incredibly fortunate to have so many people that supported me. Of course, there's Shaena, who, with her always-optimistic personality, cheered me up just by texting me not to feel bad and to look to the future. And then there's my family, who has stayed with me through thick and thin. Last but definitely not least, are the new people that I've met during the culmination of this project; most notably Ms. Ivancic, who we couldn't have done this project without. I have to say that she is one of the most helpful, considerate, and eloquent people I have ever met in my life. I would also like to extend all of my gratitude to those at POET who agreed to send us the hydrolysate for free, even though we ended up not needing it anymore.

Although I was pretty sad that we weren't chosen as finalists, or even for honorable mentions, I have to say that this long journey has been an exciting one. I learned so much more about switchgrass and cellulosic ethanol than when I was doing switchgrass research in 8th grade with Shaena. And I met some truly inspiring new people from Advanced Biofuels USA and POET, who have been invaluable to us completing our project and going beyond. In the words of Ms. Ivancic, this really has been a "character-building experience".

I definitely plan on doing the THINK competition next year, with perhaps another idea, in addition to entering our filtration system into another science fair/contest if we ever get the chance to build it in person.

I appreciate this opportunity to share this experience so much and I hope to be able to write more, as a series, in the future.

For anyone who's experienced or is experiencing a time of disappointment, I want to just say that the future is only what you make it to be. We find ourselves constantly moving in between the frozen past and the unknown present. What's happened has happened, but don't ever forget that the future is still in your hands for you to make the most out of it.

Also, I highly encourage any other high school students to compete in the THINK competition - it's a rigorous yet fulfilling experience overall.

With all of that being said, I'd like to leave off with a quote from MIT's blog that I found particularly inspiring and relevant to the topic at hand - "Bloom where you are planted."

Erika Tan, a sophomore at Freehold High School in New Jersey, agreed to share her team's experiences working on a project for the Massachusetts Institute of Technology's THINK competition so that others can have an idea what it is like to participate in such events. Unfortunately, this particular effort ended sooner than hoped. We expect Tan to continue as a correspondent/writer for Advanced Biofuels USA or other publications about her adventures in science.