BOSTON LATIN SCHOOL

CATAPULTA

<<IACIENS SCIENTIAM IN VIAM>>

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WE THE CATAPULTANS of Boston Latin School, in order to illuminate scientific processes, phenomena, and recent developments, pique interest in the sciences, combine the contemporary with the classical, and secure the blessings of knowledge to ourselves and our fellow classmates, do maintain and publish this Catapulta science newsletter for the entire BLS committee.

Sydney Do is a Graduate Research Assistant and Doctoral Candidate at the Massachusetts Institute of Technology. This past summer, Mr. Do ran a program called ICED 2012, which a Catapulta editor and another Boston Latin School student attended. Recently, Catapulta had the privilege to interview Mr. Do.

Why are you interested in this particular field of science?

I should probably first clarify that I'm an engineer, rather than a scientist. I'm more interested in creating the systems that enable exploration and the associated science to happen. I'm particularly interested in engineering because I love the fact that it enables you to create something real and valuable to humanity. I love the process of moving from crazy idea to detailed analysis and design through to fabrication, testing, and operation. Whatever you engineer, you've created it, and you do gain an emotional attachment to it.
As for aerospace engineering in particular, I've always been fascinated with space and the systems that enable humans to survive and perform in space. Engineering systems for space introduces a unique and very interesting set of challenges that really do demand out of the box ideas and approaches to solving problems. It's this unchartered creative territory that I really enjoy exploring as I work on aerospace engineering problems.

What are your goals for the MIT-NASA ICED program and what do you want students to get out of it?
There are two basic goals for the ICED program:
- to give students a taste of the passion and excitement that engineers experience in their day to day lives as they tackle tough, yet very interesting challenges
- to gather ideas from students that might inform a solution to a real world challenge. This is especially application to aerospace engineering problems where the solution, can come from any whacky idea. The more ideas we have, the better our chances of finding a good and feasible solution

What kind of students were/are you looking for or would do well in this program?

The basic requirements are for students to have passion, and an open mind. It doesn't have to be a passion for engineering, it just has to be the ability to relate new concepts and ideas to things that they're already passionate about. The theory is that by mixing concepts from different disciplines together, you can generate new and novel ideas which may end up becoming solutions to the problems that you are working on.

What is a brief overview of what the program is about and the people involved?

The program is fundamentally about getting tough problems out there to the masses to encourage innovative ideas, while getting more people interested in the challenges that NASA is working on. The ICED Program had run in various forms since 2008, but the 2012 version was the first time that we brought both high school teachers and students from various states together.

Basically, ICED2012 consisted of two one week workshops, followed by an extended program that is currently running throughout the 2012-13 school year. The first one week workshop aimed to introduce the challenge problem to the teachers - this year being on developing highly reliable life support systems and approaches to space radiation protection for a crewed mission to Mars. We put the teachers through a "bootcamp", where they were given lectures on both of these topics, as well as the engineering process.
The second one-week session consisted of bringing high school students to the MIT campus to participate in a similar bootcamp. The focus of the second week was to immerse the students within the challenge problem, and to get them to start generating possible ideas to address these problems. A unique feature of the program is that we've set it up to mirror how real world organizations work on engineering problems - students work

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in teams to come up with ideas for various aspects of a problem. They also collaborate with other teams in "functional conferences" to gather further ideas, and acknowledge the source of their ideas - be it from a published reference, a member of their own team, or a member of another team. This second week of the program sets the students up for the extended program, where the students, working under the supervision of the teachers we've trained, continue to develop their ideas and ideally work towards a prototype. Throughout this process, students can email MIT student mentors or NASA subject matter experts with any specific questions they have regarding the feasibility or implementation of their ideas.

In regards to the people involved in its organization, the program typically consists of a lead university and a set of NASA subject matter experts who work with Dr Charles Camarda (former astronaut and NASA Senior Advisor for Innovation). In 2012, the program was based at MIT and involved approximately ten NASA subject matter experts from across its agencies, nine professors from universities around the country, eight high school teachers from four states, and seven MIT students who helped to develop and run the program.

What do we as a race hope to gain from space colonization?

There are many perspectives on this, but I'll give you my take. I view colonization as a process that goes hand in hand with exploration, or in other words, the search for knowledge. The very nature of searching for knowledge is that you never really know what you'll get out of it. You don't even know if you'll get enough data to answer a particular question that you were asking. What I can say, is that we have gained a lot in the past from space research. The entire environmental movement began in the late 60s when the "Blue Marble" photo of the Earth was taken, allowing the common person to see their home planet in its entirety for the first time. Countless technologies have spun out of the space program, including the cameras on every smartphone, miniaturization of electronics, and things as ubiquitous as weather predictions, and GPS. Besides this, arguably the most valuable thing that has occurred by studying and exploring the cosmos, is that we've continually redefined our own perspectives as we've gained a deeper understanding of our place in the universe. Over the past decade, we've found hundreds of planets outside of our solar system, gained a deeper understanding of what it takes to make a planet habitable, and what conditions are required to enable life to evolve. So I'd say that the value really comes from exploration. Colonization both enables and is a natural follower of exploration.

The problems of this program are currently being researched by experts, people at universities and NASA, and those who do this for a living. How do you think students from high school or perhaps even younger can contribute?

Ideas. It's all about the creative ideas. As previously mentioned, the problems that we deal with in the aerospace engineering field are so complex that we're really looking for as many ideas as we can get. The value in reaching out to high school students is that they bring about a new perspective to the problem. There's a term that people who do research in innovation and invention use: "the experiential prison" - basically the impediment to creativity that occurs to a person who spends every day looking at the same problem, and is heavily influenced by how things have always been done. We're looking for out-of-the-box, crazy ideas, which may just evolve into a feasible and implementable solution.

What are some of the current issues/possible solutions scientists and engineers face in astronautics and Mars colonization?

Probably the toughest challenge that we're currently facing is the issue with protecting astronauts against the adverse effects of space radiation. This has been called the "Sound Barrier" preventing us from spending significant amounts of time in deep space. Basically, space radiation comes from two sources - the Sun, and from outside of our Solar System, from sources like dying stars (this form is called Galactic Cosmic Rays, or GCRs). We have a pretty good idea as to how to protect astronauts from radiation from the Sun. GCRs however, are really tough to shield against. What happens is that you have these heavy, highly charged particles coming into our Solar System as stars in other galaxies reach the end of their lives and explode. As these highly charged particles come into contact with humans in space, they can damage cells and/or modify DNA, leading to the increased risk of cancer. We're fortunate on Earth in that the magnetosphere deflects these particles out into space. Unfortunately, putting either a physical shield, or an electromagnetic shield around a spacecraft or an astronaut appears at the moment to require too much mass, and hence, be too costly.

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How long do you think terraforming Mars will take (ie how long until we actually get there)?

Terraforming Mars is an option to make Mars habitable, but it's not the only option. Some estimates state that with highly genetically modified plantlife, we could do it in around 300 years. I personally, don't think it should be seriously considered as an option until we have a good understanding as to whether or not there is some form of life on Mars. There would be many ethical issues associated with terraforming a planet that is already inhabited by some form of life. For now, I think we should take a minimalist approach - Do what we can to sustain a small crew on Mars such that they can perform the necessary science, while minimizing our biological footprint on the environment.

Can you tell us some general info on the biologically engineered plants that are designed to survive on Mars?

I can't really tell you much about this. I can tell you that there has been some work at both NASA Johnson Space Center, and also through a DARPA research contract on this. Selecting plants for growth in space and on other planetary surfaces is a very challenging task. You want to maximize the edible portion of the plant, minimize its lighting and nutrient requirements (in order to minimize mass), minimize maintenance requirements, and you want to ensure that it is resilient against any possible disease which may cause crop failure. You also want to ensure that your selection of plants meets the nutritional needs of the crew.

Getting something up to space definitely costs a lot. How will this affect the amount of hydrogen we can bring to Mars? How do we currently get such large objects to space?

Getting hydrogen to Mars to generate methane fuel is one option for doing a mission, but it doesn't have to be our only option...

As for getting large things into space, the Space Shuttle was basically the only vehicle capable of getting large-ish objects into space before its retirement in 2011. It was basically the truck that brought all of the ISS modules up into space for assembly. NASA is currently working on a new launch vehicle called the Space Launch System (SLS) that will be capable of carrying up to 130 metric tons into Low Earth Orbit

Is colonization of Mars the first step to interstellar travel and colonization of the other planets in our solar system?

With regard to our solar system, Mars is probably the only other planet which makes sense to consider colonizing. There's our Moon and the moons of other planets which may be worth considering, but in terms of natural resources, proximity to the Sun, gravitational environment, and science potential; Mars is the place to go.

In terms of interstellar travel, I'd say colonizing Mars would be one step towards it, but not necessarily the first. The common thread in all exploration missions is the needs to sustain a crew of a given size over some period of time. Any interstellar travel will take hundreds of years and will hence require multiple generations of crew members. So the challenge is really to engineer an entirely closed environment which is capable of supporting the birth and death of multiple generations of people. In addition to this, you also need this environment to be able to handle the rigors of moving through space (which is something you don't deal with when you're on the Martian surface).

Why colonize Mars? Do we need to? Why not just use it for industry/machines/power plants? Why not the moon instead?

Well I think it's too early to talk about colonization. Currently, we're really interested in exploring Mars, and sending humans there to do what robots can't do. Many scientists believe that Mars once had a rich atmosphere, and liquid water on its surface - ingredients which indicate the potential to support life. So the reason why we're exploring Mars is because we're looking for signs of life.

Colonization maybe something that we consider further down the line but for now, we're really interested in the science.

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