CTE Mission: CubeSat

Virtual Panel with Industry Experts Transcript

Mahala Pagan:
Two quick housekeeping notes we want to mention at the top here, we are recording this session, so it will be made available to you if you would like to rewatch it, it will be posted on the challenge site. And you can also share it with anyone who isn't able to join us live today. Similar to our info session, which hopefully many of you had a chance to join a few weeks ago, which has been posted on the challenge site.

So we will be continuing to make these materials available and similar to the info session if you joined, you're welcome to use the chat to say hello, introduce yourself and for any general chatter, but if you have specific questions that you'd like us to be answering, please use the Q&A box, which is a separate button in Zoom. And that gives us a little bit more of an ability to sort the questions and make sure that we try to get to the mom.

So without further ado, I think we're going to jump right in. My name is Mahala Pagan, I'm with Luminary Labs and part of the CTE Mission: CubeSat challenge team. I'll be moderating our discussion today. As you can see, we have several amazing panelists lined up to speak to you. So we're excited to introduce them all to you, but these panelists come from a variety of different academic and industry backgrounds, and are here to really give you some more perspectives and advice on how the projects that you're working on right now can help prepare you for careers like theirs. The CTE in CTE Mission: CubeSat stands for career and technical education, and we don't want to lose sight of how projects like these really draw amazing connections to so many different careers. So that will be part of the main focus for today.

So I think without further ado, I'm going to kick it over to our panelists for introductions. And we're going to ask that you each share your name, what you do for your career and one piece of advice that you can give to these high schoolers and teachers joining today, who are interested in pursuing a career like yours. So, Albert, I think I will pass it over to you to get us started.

Albert Palacios:
Thanks Mahala and kind of going back to what Mahala said about how you got into your career, I would pursue the other people's careers. I work at the U.S. Department of Education. I have the fortunate opportunity to work with great people like Ted and Amani and Eddie and Bob Twiggs to explore various innovation topics, including CubeSats. So that's what excites me about my job. I would love to be in their positions where you get to do more hands on work because in career and technical education, that's what it's all about.

It's about that hands on learning, hands on work. At the U.S. Department of Education, we're looking to do more innovation projects like this to bring kind of the theories of the textbooks into the hands of the people who are building our future. And that's what we're looking to do through this. I guess the piece of advice I would give to high school students, I think two pieces. One is to ask questions and try to figure out how things work. And in doing that tear things apart and break things to figure out how you can put them back together and make them work and make them better. So that's it for me and I pass it on to the next panelists.

Mahala Pagan:
Thank you, Albert. So I think we're going to go in alphabetical order and we'll pass it to Amani as our next panelist.

Amani Garvin:
Awesome. So I'm Amani Garvin. Right now I am a test engineer for the Dragon Capsule at SpaceX. So we just sent up a crew mission if you saw the launch earlier in May, June? June. I'm also the creative director of Astronaut.com. So you should check us out. Let's see, my advice to high schoolers. Two pieces of advice. One, if you're going to go into engineering or science. I did physics, I also graduated in 2015.

It is going to get harder. No one told me that and everyone was like college is going to be the best time of your life, it will probably be the hardest time of your life but you can't be afraid of it. And two, if you have the ability and you get the education to build something or bring something new into the world, I just think you should recognize that power and what kind of world do you want to build? I think answering that question for yourself is really important as an engineer or a scientist.

Mahala Pagan:
I love that. It's a good message. All right, so Eduardo, would you like to go next?

Eduardo Seyffert:
Yes, hey good afternoon or good morning, everyone. My name is Eddie. I work with Blue Origin in Far West Texas, where we have a couple of local rocket engine test engines and where we launch and land New Shepard and goes right to the edge of space and it comes right back down. I'm an aerospace engineer, really enjoyed my career in test engineering. I've been a system engineer for about seven years and being able to work hands on like Albert was saying is just one of the greatest experiences that I could have ever imagined when I was studying engineering.

I think Amani's spot on this, looking to challenge yourself and building the world that you want. And the only thing I would add to that in terms of advice is that you really have to look for and find your passion. It's not easy to find your passion, but once you find it, it just makes the world of difference in terms of pushing yourselves, challenging yourselves and just working harder to really ultimately learn and enjoy. So I'm very grateful to be on the panel today and to answer any other questions.

Mahala Pagan:
Great. Thank you so much. All right, Robert, we'll pass over to you next.

Robert Twiggs:
I'm Bob Twiggs. I'm a retired professor, spent a number of years in the academic side from the aerospace perspective. I have been in academia all along. As far as getting what you need to do, my route in getting into this profession was kind of a strange one. I'm actually an old farm boy from Idaho. After I got out of high school, I joined the air force.

I spent four years in electronics, but most of that time in electronics school, which was what I wanted to do and then got out and had the GI Bill to go to college. And I've always been interested in space and that sort of thing. And I got involved in space as part of my engineering career and then went into academia.

And I think the important thing is to each have a passion for it. If it's something you really want to do, that makes it a lot easier. And if you're in high school, don't think about, you don't necessarily need to go to a university right after you get out of high school. Sometimes it's always good to go get a job, but then when you decide you want to go to a university, you're really much more determined.

So it's actually been my career in aerospace and I started out actually in electrical engineering. So I'm not an aerospace guy by education, but it's just so fascinating and so fun that it's really motivating. And that's why I like to see it as part of education. So there's lots of ways to get into this, but the main thing you have to do is have a passion and be determined that this is really what you want to do and you can do it, you can do it.

Don't let it stop you, maybe you have to have a full time job and go to night school or whatever, but if that's where you want to go, you'll get there. It might take you some time, but the passion is what you need.

Mahala Pagan:
Thank you so much, Bob. All right and last but not least Ted, please go ahead and introduce yourself.

Ted Tagami:
Hey guys, good morning, good afternoon. So Ted Tagami, co-founder of a company called Magnitude.io. We really just want to bring learning experiences right to the very edge of human discovery. So we've been really grateful having met Professor Twiggs, right when we got started and introduced simulated satellites called CanSats. We've been fortunate to be running some experiments about the international space station for middle school and high school students and now university students.

These labs are very similar to the CubeSat form factor. This is kind of what it looks like going to space, just an aluminum box. But you can see that's the 10 centimeter cube. It might be something like what you're designing there at your high schools. So we're just bringing stuff right to the very edge of discovery where we're looking at exobiology or engineering or science practice.

Word of advice. Well, surround yourself with the go getters, with the folks that really want to make a difference. It doesn't matter what their interest is. They can be a musician, they

can be a sports enthusiast, they can just be a great person, but surround yourself with those people that want to make a difference that are going to support you, especially in the more difficult times. World's kind of screwed up right now let's make no bones about it.

And the adults are leaving you with not a lot of room to make improvements. Our world has a lot of big challenges, and we're looking to you guys to come together and help us solve that. We'll do whatever we can to help. The most important thing I've found is to get out of the way. So let's give you the right tools to make stuff happen, and we're here to help any way we can. That's it.

Mahala Pagan:
Thank you, Ted. All right. Well, so as you all can see, this is our amazing panel today. We're so excited to have a chance to share the discussion with all of you and hear all these perspectives. So before we jump into the discussion questions themselves, we do want to get to know our audience a little bit more, and thank you to all of you who've been introducing yourself on the chat.

But we're going to launch a poll that should pop up on your screen in Zoom that's just going to ask you a few questions, very simple questions. So the first one is, and I should also mention that the responses to these are anonymous. So please just go ahead and respond. Are you a student? Are you a teacher? Are you coming to us from an aerospace organization or education organization? And if the answer is other there, then please tell us a bit more in the chat about what brings you here.

And then the second question is really asking a bit about how much experience you have with CubeSat. So on a scale from one to three, one being no experience and three being more advanced, how much experience do you have so far with CubeSats? So we'll just give you all a minute or two to answer this poll.

Albert Palacios:
And if you're a teacher leading a class, feel free to pick teacher or educational organization, and then tell us in the chat that hey, I'm in front of my classroom, we're presenting this as part of the class, or I guess you're not in front of the class. You may or may not be.

Mahala Pagan:
It's great to see these answers coming in.

Eduardo Seyffert:
I guess kind of to tell our audience and participants that I didn't hear about CubeSat until college. So you guys are already a step ahead.

Mahala Pagan:
Yes, I know. I wish I had heard about these in high school, so definitely ahead of the curve. All right, we'll just give you guys a few more seconds. About 90% of you have responded, so that's great and then we'll go ahead and close the poll. All right, I think we can end the poll now. You should be able to see the results, but this is really helpful intel for us.

So we can see that the majority of you are students and teachers or from an educational organization. So it's great to hear that we are speaking to our solvers, our potential participants, and then it does look like most of you have no experience with CubeSat which is great. So 75% of you answered no experience, 21% answered some. So it's very helpful for us to have that context. Thank you all for participating.

All right. So I think we are going to jump right in now. Our first question to our panelists is tell us a bit about your first experience with a CubeSat. And as we now know, many of the people here are attempting a CubeSat prototype for the first time. So tell us a bit about your first exposure to a CubeSat or some similar project that you can remember. And Bob, I think I will pass it over to you for this first one to get us started.

Robert Twiggs:
Well, my first experience with the CubeSat is kind of different than everybody else's. I was at Stanford University and working with students in the late 90s and we were building satellites, but they were called microsatellites, which were much bigger. We had an opportunity to launch a little thing called a PicoSAT, which was a little satellite about the size of your cellphone inside of a much larger satellite working with the aerospace corporation in DARPA.

And teaching students about satellites, one of the problems I had is the bigger the satellite is the more it costs you to build it. The more things you can put in it and I wasn't getting a very good response from the students and getting the satellite done.

So when we launched these little PicoSAT, I decided, well, let's see how small a satellite I can make. So the students can't put very much into it. So what we finally came up with was this thing, let's see, let me get out here a little bit. I'm sure you're all familiar with the CubeSat. This thing started out as a four inch beanie baby box. That was the model that we started with and went from there. And then the idea was, well, if I can make it that small, you can't put very much in it.

Then we developed a launch or called them a Peapod that 's like a jack in the box. I had three of those in, and that solved a number of problems, but now we have the challenge of what could we build that was useful in something that small. And what happened is we were right at the edge of when they started miniaturizing electronics for things like computers and cell phones and things like that.

So these two things converged at that time. And we wanted to build these CubeSats strictly as an educational project for students at that time in the university engineering programs. And everybody else, when we did that laughed at us. They said that that is the dumbest thing we've ever seen is why would anybody ever want to build anything that small? It's absolutely useless plus they insulted us a little bit by saying, "Hey, university professors are not smart enough to build satellites."

So you know what happens when you get challenged? So we built satellites and we got them launched. And what I want to encourage all of you to think of is this is not ... You might call it rocket science, but it's really not that hard. The things that are available today for you to do what you do in a satellite are really easy to use.

There's lots of stuff on the internet. So I think our biggest job is even those of you that don't win this competition. We need to talk and we need to show you what you can do to get started. And the most important thing about working on satellites is the technology that you learn in them.

Satellites, I like them because they're multidisciplinary kinds of things. They got computers, they got radios, they got power systems. They just got everything in and [go gone 00:18:53] they're so fun to work on. And I'll tell you the greatest thrill in my life was when we got our first satellite launched. And that thing answered back to us, to our radio is like oh my gosh, I got my fingerprint in space.

Because before that satellite flew, I went into the room where we were working on it. I put my hands all over that satellite because the students who were working on it wouldn't let me work on it, but I got my fingerprints on it. So my fingerprints are in space and your fingerprints can be in space, but getting there is the best part of.

Mahala Pagan:
Such a great story. Thank you so much, Bob. Any other panelists want to follow up on that? First experience with CubeSat that is memorable to you?

Ted Tagami:
I'll just reinforce. My first experience is actually through meeting Professor Twiggs down at Stanford, co-invented the CubeSat standard with Cal Poly and Cal Poly has a regular annual event. And when we were just starting up, everyone said, I got to go down and go to this small set conference. And sure enough, Professor Twiggs was there with this entourage of folks talking about the next new thing and professor I've been very grateful to get to know you, and just understand the way your creative thinking is about the possibilities.

But when they say think inside the box or think outside the box, really, I think the challenge is what can you do within that? I've seen so many amazing things with this. Probably the most important takeaway I can think of is once I started understanding what the CubeSats could do, it really is just extended sensories of what we are as humans. Our seeing or hearing, tasting, smelling, touch, all those things robots can do, and our sensors can do.

So whether you're putting in orbit or even something in the deep ocean or on a drone, or what have you, it's all kind of similar. How do we extend human perception? But CubSats are definitely an inspiration when you think that's something above us traveling at some 17,000 miles an hour as it goes around the planet every 90 minutes.

Albert Palacios:
Wanted to add, my first exposure to CubeSats was relatively recent. And in working with some ... In the federal government, across agencies. In 2016 we did our CTE makeover challenge. And one of the other agencies I was presenting our CTE makeover challenge, which was to bring more maker spaces to high schools. She was presenting about a CubeSat program, and I thought, wow it's a tiny little box. It looks simple enough. And she said, "Oh yeah, in fact, we've had a high school already launched one." And so I said, well

then if a high school can launch one, then I know CTE programs out there can take these on its projects.

So I thought let's figure out a way between our agencies, so that we can bring more CubeSat development into high school. So just as the high schools, we were developing maker spaces in high schools. This was a great project for them to latch onto. So the thought being this would bring together science teachers, CTE teachers, the whole schools, the whole districts, the whole communities around getting as Bob said, your fingerprints in space.

So I think it's a great driver for CTE programs to take on this as a challenge, which is why we were running as a challenge to see how far you can get with this. We're not asking you to do I would say anywhere near what Amani's joined or Eduardo, but what we are looking to do is just to get you on your path in that direction. So if this is your first exposure to a CubeSat, then you'll know that it only goes up from there.

And I remember Bob telling me a story that he said I want to do that. And that's kind of the driver because I want to do that. I want to do what we see above us in space. And I think that's an exciting part of what we're embarking on here.

Amani Garvin:
So my first experience with the CubeSat. So I actually never worked with CubeSat because I never actually wanted to be an engineer. I think I graduated high school and I was really into Cosmos, like the original Cosmos by Carl Sagan. I was a Star Trekkie. I was just like I'm going to go study stars and I'm going to be alone. And I'll have all these beautiful images. I was looking at black holes in the galactic center. I went to college, I was studying astrophysics.

And then I got an internship at Ball Aerospace where they had built satellites that were looking at planets. They had built robots that had gone to different planets. And I was just like, all right I'm going to go see what engineering is about in summer.

And we went and we built ... There's like a separate engineering program for the interns where after work, when you're dead tired at five or six o'clock, you show up and you design and you build a payload. And then we were either going to launch it on a rocket or a high altitude balloon. And so I chose the rocket, but then they put me on a high altitude balloon team to sign. But anyway, we had built this payload over the course of three months and flew it up.

And my major thing was, I was like if we're going to build something and send it into space, then it should be able to talk to people. So can we get it to tweet at others? Can we make this a tweeting payload? And everyone was like, sure, if you want to do that, and it was maybe the coolest project I've ever done, because it was that moment of like that's just like exited the mesosphere and we did that.

And I can hear it and I'm tweeting up this little bot. It was just such a cool moment. I was like look what I've put into the world and look at all these other people interacting with this space twitter. And that was the moment where I was like maybe astrophysics is a little ... No

one really, it's cool but it's like, maybe I could build something bigger that more people can interact with, that could affect more people's lives, that could change the future.

Mahala Pagan:
That's such a great example too of how the fact that these projects in CubeSats involve so many different skills, they can bring in people with different interests. And it's a great way to discover a new area that you hadn't been as focused on before. I love that story.

Amani Garvin:
Oh yeah. I did not know the difference between like a screw and a wrench or anything. I was like you guys want me to put that together? They were like, yeah. I was like hmm, that was interesting.

Mahala Pagan:
That's great. Eddie, do you want to chime in about ... I know you did a high school CubeSat project you mentioned.

Eduardo Seyffert:
No. So it was in college and there's two of them with the MIT Space Systems Lab, this year's program. And there's two of those in ISS and they're collecting data, but I think what Albert was saying about this being a challenge and then pushing us to really define the problem that you want to solve as a team.

What data do you want to collect? I think that speaks to a big story about how you're going to solve this problem, what requirements you're going to generate from there. And those are all real life skills that you're going to get to go practice as you solve for this challenge. You'll be able to learn how to communicate, how to do pass downs about your progress and really how to track it so that you're successful in this challenge.

Mahala Pagan:
That's such a great segue. So the next thing I was going to pivot us over to is talking a bit more about those skills. So one of the reasons that we all love CubeSats and this has come up in a few of your stories is how interdisciplinary they are and how they involve so many different skills, whether it's engineering or coding, or just coming up with a scientific research question, maybe it's marketing.

If you're going to help spread the word about your project or fundraising. So the variety of skills that you can be practicing with a CubeSat certainly are numerous. But we'd love to hear if you all could share a bit about what are some of the skills that you use every day in your careers, and how might they relate to these sorts of projects? So students are actually starting to build those skills now. Anybody interested in jumping in first?

Albert Palacios:
I'll start because I think about back to my high school experience and I was a CTE student, and I was in ... At the time it was called office education, but it's comparable to like a FPLA or a BPA as a CTSO. So it was in business education in high school. And all that was in my mind at the time was how do I start a business? How can I create something like a startup?

And so my mindset was always around business. So if this project came to me, I would be looking to say well how can I market that better? How can I help them raise the funds to build a better satellite or build more satellites, or get more students involved or get more technology into the classroom? So I think there's a lot of different skills like communications and marketing, budgeting, and finance that go beyond the technical skills.

In addition to that, going back to what Amani said, you want to know what a screw versus a wrench is, and how you can build and how you can solder, and how you can code, and all of these hands on skills that are going to be useful, whether you go and are launching CubeSats, or whether you're going and working on these next generation of automobiles, or you're working in a manufacturing facility, or you're working in a healthcare facility. All of these are relevant and important skills to have. So I think it's kind of don't shut any of the skills out, but try to hone as many as you can.

Ted Tagami:
I guess I can jump in with just a comment. So technical, obviously nothing can be done without the technical skills, whether it's the abstraction of your idea through design thinking, to the physical screwdriver and the wrench kind of scenario. So what we're finding, even as like students that are really book-smart getting and wanting to become doctors, maybe even like a surgeon, they don't have the manipulative skills, they don't have the motor skill memory skills to be able to do those fine manipulations. Wood crafters, what have you all are super important.

So as important as it is from a design thinking or a technical part, it is just being able to work with your hands or being able to work with people that can work with their hands to get these things done. What might seem boring to you is actually super essential in what we do day to day, which is communication and planning. All right, so you come up with that bold vision and idea. You have the technical expertise, you're surrounding yourself with some teammates that can really get the job done, whether it's soldering or communications or code or what have you, you got your mechanical engineer person really excited about doing that.

You come together as a team, but you've got to plan and you got to communicate both internally and externally, and communication will make or break even the best idea. So that's super important. Just remember that.

Mahala Pagan:
So important. Yes. Amani I see you had your hand raised.

Amani Garvin:
I guess I just want to kind of push back against this idea that you need all these technical skills. When I graduated high school, I was 16. And I think everything I already knew is what I used going forward. I had everything I really needed. I had just kind of a sense of self, a sense of what I wanted to do and just a will to go do that.

So I threw myself into NRPC because I was like maybe I'll go be a Naval pilot. I threw myself into astrophysics because I thought maybe I'll go be an astrophysicist. And then I threw myself and all of these are very different skills. I didn't know how to do a pushup, which was

a problem. I didn't know how to wink. I didn't know what was the difference between a neutral and star in a black hole?

Even the job I have now, I'm coming from pure astrophysics lab experience to being thrown into like go test that Pendle on or rocket to the Draco's roosters. I'm just like, all right, sure. I can do that. But it's just that willingness of are you willing to just throw yourself into an uncomfortable situation and figure it out, and are you willing to not be afraid of what you're capable of?

And I think that might've been the thing that held me back the most is like getting into a situation and just freezing up or being like I don't know how to solder it. Should I touch this? Am I going to break it? Yeah, go ahead and break it and then fix it and then do it again. I think that, that might be ... Take your education very seriously, because that will open your mind up. But in terms of what do you need going forward? You have all of that.

Mahala Pagan:
I think that's that confidence to try is so important in these kinds of projects. And learning by doing is one of the best ways to figure out it probably will break and so you might as well figure it out sooner rather than later how it's going to break so you can address it. I think that's a good message. Any other specific skills, whether they've been mentioned or maybe some that are kind of surprising that are a part of your job that you think could relate to a project like this? Bob, I see you're raising your hand in there.

Robert Twiggs:
Well I think one of the advantages a lot of the students have now is familiarity with computers and having computer skills. I think that's important because one of the things I really like to do is I really like to work with microprocessors. So the kind of processor that you can use in a CubeSat or any other kind of device, you always have to have a processor on from the technical side, from my standpoint, to do some measurements.

If you want to measure temperature, you like a microprocessor to run a temperature sensor and save the data so you can look at it. So computer skills are important, but one of the things you don't have to be is a real expert in any of these things. So probably later on, I hope we have an opportunity to do some demonstrations on the kind of things that you might want to do.

One of the things that I really like to do is I like to work with a little microprocessor called an Arduino. It costs me to get an Arduino. It costs me about the same cost as it does to get a hamburger at Burger King. So they're not really very expensive. And then learning to program, there's all kinds of stuff on the internet to learn how to do that.

So you don't have to be an expert really in anything. You just have to have the nerve to go try it. And I think that's the important thing. But I'll tell you, when you start out with that, if you have Arduino and the first time you turn an LED on and off, you're going to be really excited because if you can turn an LED on and off, then that computer is capable of flying an airplane.

So you really got the world by the tail to get involved a little technically, and it's really not as hard as you think. I think I could take any buddy that's in this audience today. And I think within an hour, I can have you programming a microprocessor. It's that easy.

Mahala Pagan:
That's such a great point. And it reminds me of when our team went to NASA Ames last summer and walked around and the same Arduinos that you're talking about that can be used by students. We saw Arduinos being used in the equipment there. So it's being able to kind of work with those sorts of materials some of which are less than the cost of a hamburger, as Bob mentioned.That's still directly relevant to what you might be working with in a career like this. So I think that's a great point.

Robert Twiggs:
Ted, you might tell them a little bit about some of your balloon flight experiences. I think you have some wonderful opportunities there.

Ted Tagami:
Oh my goodness there's so many different ways. Once you put together a CubeSat whether it's on your local television helicopter, Albert, you had mentioned that the other day. I think that's brilliant. We're going to talk a little bit about marketing and promotion of your idea and working with your community, one of your core rubrics. But launching high altitude balloons like Amani talked about her experience, it actually is a little bit of work, but you'll need to contact the federal aviation administration. You'll need to file a notice to airmen. It's probably pretty good if you have a ham radio license and for all of you listening here, if you're over the age of one, you can qualify. You just need to pass the test.

35 questions for the technician's license and the FCC gives you a radio call sign and you can transmit and receive on a spectrum designed just for the amateur. And whether you're talking to astronauts in orbit, other satellites in orbit, launching your own payload, aboard a high altitude balloon, or what's really fun is those high powered rockets.

Oh my goodness, you get out to a place where they give you a high ceiling, and you can get up there. It's a couple miles up, but Bob, that was your original idea around the CanSats. Just getting out there and providing a simulated horizon to horizon passive and actual satellite once it's deployed. A lot of fun stuff, if you have ... And I know you do, if you're in the United States, probably within a two hour driving distance, you'll have a flight area that's been designated by the FAA, probably through a group like the National Association of Rocketry.

And those are great folks to collaborate with. If you haven't worked on the rocketry. If you have already, well you're probably well on your way. But there's so much more we can talk about there, but I guess I'll cap it.

Mahala Pagan:
No, that's great. And I think that's a great segue to how we're going to move next into thinking about the challenge itself and where our students are right now. We're a few weeks out from the phase one deadline. And when students are submitting their mission

proposals, the challenge is going to be selecting up to five finalists to move on to phase two. But it doesn't have to stop there for people who are interested.

So even if a school is not selected as a finalist, we would love to see more schools continuing to explore projects like these, and thinking about how they can continue on and build those prototypes and launch them in other ways. So thinking about that continuation of the exploration of CubeSats, we know that financial support can be important and technical support can be important. And actually a lot of you probably have local resources that maybe you haven't considered, whether it's local companies that you could reach out to about some sort of partnership or community colleges or universities. So do any of you guys have any creative ideas on how schools can be thinking about activating their local communities and engaging with what might be available to them?

Albert Palacios:
So I wanted to start, I beat Ted, but I beat Ted to the punch. So I also noticed a question coming in about where do we get started both for educational research resources as well as kind of to your question Mahala. But as far as the ... I do want to kind of reiterate something that we mentioned before, is that you don't need any experience in CubeSats. You don't need to know anything about CubeSats. Start with our resource hub on the CubeSat, ctemissioncubesat.com website, go to the resource hub. That could give you a good starting point. The mission proposals that we're looking to receive in October don't have to be highly technically complex documents. We want to see what your visions are. How you feel like you're going to be able to get this done.

Kind of the real test is going to come when you become a finalist or after you design that mission proposal, how do you move it forward? How do you figure out how to use an Arduino to start powering your ... Maybe you're already doing some art work with Arduinos. How do you build that into some sort of four by four cube that can ... There's my little fake Arduino board. How do you build that into a satellite and make that go up some way, or as Ted was showing his real time telemetry behind him and his box that he has actually recording and transmitting data. How do you actually move forward with the components you have available to you, and then how do you communicate that outwards?

How do you get your school excited? How do you get your local community excited about it? And when you do that and other people outside your classroom and outside your school, learn about what you're doing, they're going to want to come and be part of it. And I think there's a lot of excitement around this and that allows you to expand your available resources and subject matter experts.

And as Ted mentioned, the amateur rocketry clubs, but also in one I would seek to offer, which a lot of people don't know about is that there is a contact in every state through NASA. NASA has a space grant program. So there is a point of contact in every state. You'd have to look up to see who they are, but they're typically at a university and one of their roles is to help educators with learning more about things that are going on at NASA, including CubeSats. So I encourage you to look up NASA space grants, your state space grant contact, and have a chat with them, see what they can do.

Ted Tagami:

And to reinforce that, reaching out to them also can untap some funding. So while you write your proposal for the CubeSat challenge, you can also take that proposal and put it right into your space grant consortium. They usually have funds available at university and selective budgets for high schools. So take advantage of that and I've watched folks win anywhere from like 500 bucks to 5,000. So think about once you've designed your concept and you've got an earnest mission that you believe in, you'll be submitting that in this proposal, but can you submit it in other places as well?

So back to Mahala's original question about working with your community, you might just be thinking about your town and you might be thinking maybe like your music group or your football team, or what have you, that you're going to go to the auto dealer and what have you. But think larger than that if you can, if you're in a rural area, quite often rural areas get overlooked from the urban core, go to the state level right now, especially with the pandemic. And if you can address some of the concerns that all the adults in the room have about being able to reach and provide education, you can be the leaders, whether you're a freshman or a senior in high school to say this is what we're doing. We're not sitting around waiting for someone to tell us what to do. And you will unlock some funding opportunities. So think big. And if you fall short, you're going to get much more than if you started small. So that's just a fun piece of advice.

Eduardo Seyffert:
The only thing I would add to that as well is it's hard to overstate how valuable mentorship can be, and how easy it is and in our industry, it's not unique to aerospace, but it's definitely a trade is everyone's very passionate about what they do. And always a year to go help solve problems. So in reaching out and networking and getting people together, there's a lot of opportunities if not for the funding, for the mentorship, which could be even more valuable.

Amani Garvin:
So one thing I would say is I don't know why that's doing that. So one thing I would say is that if you have something that everyone really likes to do. So I remember at my high school, that was when Smash Bros was really popular before the Nintendo Switch came out. So my engineering team, we would host Smash web tournaments and we would just get people to throw in like $20 into the pot. The winner would get 10% of whatever the entire, every participant put in and then we would get 90% for our engineering projects.

But I think it's also an interesting challenge because it forces you as an engineer to think how can I make my project interesting to everyone around me? Maybe not everyone around me wants to send a plant says space. So maybe my town wants to send like my home girls music album to space, and we could do something around that or something related to the people that you're around.

Maybe your high school is really into green energy and you guys want to figure out how to fly or how to tap into solar power. This would be a great opportunity to first tap into that and second capitalize off of it, and get other people involved so that you guys make it really collaborative. So you're not just like this little offshoot of like we're the engineers and we're over here. So making yourself central to your own community. And also it lets them know that you're there for them as well. If that makes sense.

Mahala Pagan:
That's such a good point Amani, it is also a criteria. Community engagement is one of the criteria that you will be evaluated. Your mission proposal will be evaluated again. So being able to show us that you have thought about ways to engage your community, and I think the way Amani is describing it is spot on. Thinking about how to get them excited about what you're working on is certainly a part of the process that we want you all to be experiencing. Any other thoughts on activating the local community creative ideas to think about?

Albert Palacios:
Well probably ... Sorry, Ted. I will probably talk about it a little bit more as we get into launch events and things, but as Ted mentioned thinking about your launch, how you would launch it, and launch is not necessarily a big rocket that goes up into orbit. We're not expecting that through this project because quite frankly, we want to get you through all of the steps in the sequence. So you can understand, kind of have a rudimentary understanding of what goes into it.

So it should be functional, should be able to record data or embed a sensor and do something. Or as Amani mentioned, put some music into space. So whatever you decide that your CubeSat's going to do, that's great. Now, when it goes up above your head, higher than you, there are different ways of doing that. It could be, first of all, you want to do whatever safe. You have to be safe.

If you're using a rocket, you have to be safe. If you're doing anything else, that's going to be making something go really fast, you have to be safe. But for example, can you team up with your local school, with your local news station, your television station news, they might have a helicopter, can you make a deal with them to attach it to one of their helicopters? And in turn, you also get some good coverage from them and hopefully more resources.

Do maybe partner with your local police department to attach it to one of their skids of their helicopters or your medevac helicopters? There are a lot of different flight vehicles that are available in the local community. I recall back in Texas, they had ... I could see the crop dusters going over the field. So that's another type of air vehicle. In addition to that, it may not be a vehicle. It may be a huge catapult, a huge slingshot, a huge air cannon. There are a ton of different ways to get that or orbital trajectory.

You think about angry birds and how you pulled a little slingshot back and in that simulation, you can go all the way around the planet. Well, it's the same theory. How do you launch something in space? Now I saw a question about how does the testing and the preparation for these CubeSat prototypes vary from for example, a high altitude balloon?

And really what we're trying to do is we want to get you to that build process, get you to be able to test it in a flight environment, but as far as the electromagnetic interference, the clearances of all the radio frequencies, all of those things, let's not worry about that for now. When you go through these prototypes, you don't have to worry about that.

If you do introduce something where there is some regulation like FAA, FCC, NOA, some of those, yes, you have to go through those. But for this, we're looking to keep it simple, getting it through the processes, and then seeing what creative and fun ideas you can come up with.

Mahala Pagan:
All right. I think we were almost at the turning point where we'll shift over to questions. So for those of you who have been putting questions in the chat, please use the Q&A section. You'll see on the bottom of your Zoom menu and that's the right place to be putting all your questions to make sure we can get to them all. The chat gets very busy, so Q&A is much easier.

But I think kind of continuing on the path of that question we were just covering before we get to our last question about advice. Any ideas or thoughts from your experiences on other opportunities that students can keep in mind? Whether it's internships or similar projects, if they're not selected as a finalist, but really want to keep exploring things like these, what comes to mind for you all that you would recommend these schools investigate further?

Ted Tagami:
I beat Albert to the punch on this one. This is hopefully you're opening the door and you're going to be stepping through the door, but what's the journey? If you're a freshman or if you're just starting this program, it might take a couple of years if you're persistent, diligent and you stay on target to actually put something on orbit, it can be done.

So I think if you think about what you need to do for this design challenge, it's really pretty straightforward. You've got five elements in your rubric that you're going to be mentioned on equal weighted. So maybe we'll go through that a little bit, but taking it beyond that is really, I think the greatest thing you can do. Is to imagine, especially for our educators out there, one in done really doesn't help anybody and if anything, it might be discouraging to some students, especially if they're sophomore, they're going to be a junior next year.

So make a commitment to keep this as a persistent thing. If it's a little tangential to what you do is your core work, maybe you're more of an auto shop or maybe doing woodworking, or what have you, find the way to think about the interdisciplinary, the transdisciplinary approach that you can take. I heard about taking advice and finding mentors. I think that's a great recommendation, find a local university that you can partner up with.

The best partners you can find in the world are probably within 25 miles of your local college or university, but those five components of that rubric, focus on those for right now. But the best thing you can do I think is think about this as the first step, regardless of outcome. And first of all, you'll succeed in this, whether or not you're a finalist, because you'll have that long view and you might take a totally different approach and direction as an individual or as a group. But just think about that long view. And I think it will help you out a lot.

Amani Garvin:
I know for high school it can be very intimidating to think about where I want my career to go. What's the next opportunity for me, et cetera, et cetera, just because it's high school, I

know some students are working, it's kind of chaotic. Like if I were ... I graduated in 2015 and I still don't like thinking about it. But what helped for me was that there usually is like either a teacher that hopefully takes some interest in science that you can just tag up with and be like hey can we try and start an engineering club? Could we get some people I don't know, take an Arduino and build like a Rover or something.

Even trying little physics experiments, like how can we throw an egg off of a building and see if it breaks or not. Things like that were just super interesting to me, especially in my early years it was like a freshman or sophomore year. Just kind of figuring it out and trying to understand what is it that people call engineering? What is it that people call physics? If there's a lot of clubs for it and you're interested in it and you're already a part of this mission, then start it.

Especially if you're a teacher, if you can start an engineering club, there's so many resources out there for really cool projects that early freshmen and sophomores can do. For junior and senior level, it did really help me to get connected with my local universities.

I was really fortunate to live near New York. So I was going back and forth to NYU, working with the physics professor there during the summers. If you can find a local university that has summer programs that you can take part in, usually they won't be paid. So that is kind of an issue if you would want to find somewhere where you can work and also still kind of do your science so that it's just kind of a balancing act of like, maybe you could find a professor who will pay you.

Hopefully again, I don't know of any programs specifically that do that, but there are some programs that will let you do it part time. And then if you want to work part time during the summers.

Albert Palacios:
I think to kind of add to that as far as internship opportunities and some other employment opportunities, I would encourage everyone to look at I know NASA offers internships. I know we offer internships for both high school and college students. We offer and like the departments of energy and their national laboratories, they have internships available. So I would ... Just speaking from the federal level, I know that there are apprenticeships available at federal agencies. But I would also encourage teachers to look for opportunities as well to get kind of involved in different projects.

I know NASA works well with a lot of communities around the country to get both educators and students involved in their program. So seek out those programs. And I mean, they're going to be more concentrated in areas where NASA is located, but you're going to be able to find different opportunities.

And now, since we're pretty much all virtual everywhere, it almost opens the door to more virtual opportunities across the country. So I just wanted to add that and kind of piggybacking on what our Amani said, why not create a CubeSat club where you're able to bring in all the different disciplines to coalesce around a CubeSat for your school. And I agree with Ted, this is just a starting point. It does take a couple of years, but there's nothing to say that you can't move this forward and get it into space ultimately.

Mahala Pagan:
To you Bob, any ideas that you want to share on opportunities for further exploration before I move on to our last question?

Robert Twiggs:
I think there's a lot of resources out there that can help students and teachers. One of the things that I would be willing to do is I would be willing to offer some Zoom classes for students. And if I found a high school or a group of students that wanted to start dabbling in some electronics, I'd be glad to do some Zoom courses and maybe even sponsor giving them some equivalent to work with. So I'd like to help.

Ted Tagami:
There you go Bob.

Robert Twiggs:
And I think there are a lot of people around. I'd like to be a sponsor for some of them. I'm looking for a school that says this is too complicated for us. That's the school I want to do it for. If you're already into electronics and have the capability to do it, I'm looking for the ones that say I don't think I can do this. That's the ones I'd really like to challenge you to do. And I think we can show you how to do something that it'll be fun, get started. And again, to build a CubeSat, you don't have to put the ... It's like how do you cut down a forest?

You cut it one tree at a time, and that's the way you learn how to build a CubeSat or any kind of device like this. You learn to build a little part of it and then another little part of it. And then you start hooking these things together and you build it up. And I guess having been through it, it doesn't sound that complicated to me, but I think we can really encourage you if you really say this is way out of reach to us, it isn't. It really isn't and I know myself and I know Ted, and there are probably a whole bunch of guys like us around that would want to sponsor school.

Mahala Pagan:
That is a great message, I think to move on and thank you, Bob. We'll definitely ... We can do that but I can already see in the chat, a few people are chiming in about your offer. So we'll certainly be following up. But I think before we turn it over to the questions, and I know we've been receiving some great questions from our audience, I will just open it up for a last question where you can share a piece of advice knowing that these students are now working on their mission proposals and thinking about prototyping, many of them for the first time.

Can you offer some rapid fire, just one quick piece of advice for them in thinking about that? Or just you can say one more thing that you haven't had a chance to say on this panel, if it doesn't relate to that question. Now is your chance and we'll try to turn it over to questions in three minutes or so. So who would like to chime in with their last piece of advice or last comment? Go ahead, yes.

Amani Garvin:

I think from what I've seen, get the biggest idea possible, but make sure that you can cut it into little small doable bites. That's what makes a really great proposal is as long as you know even if you're trying to get to the moon or Mars, as long as you know this is how we will get there versus the time it will take us to get there. Just make sure that you have that part flushed out. It's a big idea, it's amazing, it's great. Just make sure that you have the little pieces.

Robert Twiggs:
I'd like to give a piece of advice. Don't think about building something very complicated. What if you put your first satellite in orbit and it was a Sputnik and all it did was send down on Morse code temperature. The thing that you've accomplished is you've went the whole process.

Now, if you want to build something that measures lots of other things in space, do that. But get through something simple the first time.

Albert Palacios:
And that's part of the reason why we are looking for ... We equally weighted all of those. So it's not all about the technical capability of your satellite, but also for example how are you expanding this program to multiple audiences to get everyone from your automotive program to your carpentry program, to your health care program, to your physics and science programs.

How are you getting everyone involved in at least to have a little part of it and become part of this movement that can move forward in solving the next generation of the problem? So I would say get as many people from as many different disciplines and areas and interests. If they have an interest, there's a role for them.

Mahala Pagan:
Eddie, any last advice?

Eduardo Seyffert:
No, it's definitely about eating the elephant one bite at a time, delving into the details and not being afraid. A ship at harbor is really safe, but that's not what it's designed for. So you're going to go out there and have fun building it.

Ted Tagami:
I'm going to offer a piece of advice here. So you've got to go through some salesmanship in this, you're writing a proposal, you're going to be judged on the merits of that proposal. You're being judged on five distinct components of this rubric. Read that over again and think about how you're solving those challenges in the rubric. Coming up with the amazing science investigation or the engineering investigation in this design challenge, isn't actually going to give you a greater chance of winning it or not. It's when you meet these other criteria.

And one thing you'll realize as you get into the world is you've got to sell your idea to many different people. Sometimes you have to sell your idea to your significant other. They're going to let you go do something or your boss or your coworker, or your colleague, or if

you're writing a grant. In this case, read those five components and make sure you're answering that to the best of your ability.

So it's right now for this design challenge, we can get super excited about all the cool things you can do with science and with engineering. But if you're not hitting those five components, you're not going to score a high score and that's going to maybe not get you to the finalist. So my advice is read what they're asking for and deliver on those five components.

Mahala Pagan:
That's really helpful. Thank you all.

Robert Twiggs:
One more thing.

Mahala Pagan:
One more thing.

Robert Twiggs:
I want to work with ones that are not finalists.

Mahala Pagan:
You want to work with ones that are not finalists? Yes.

Ted Tagami:
That's why I love you, Bob Twiggs.

Mahala Pagan:
Well, that is great. We'll certainly have our finalists featured on the website when we move into phase two. But as we did with the past CTE makeover challenge, which you're welcome to go and look up online. We will also publish a list of all the eligible schools that participated in that challenge, which was I think 640 plus schools. So similarly here we'll be publishing that list of all the eligible schools that participate in this, and that's a great way for you all to reach out to one another.

If you see a school on there that's nearby and you didn't know they were participating, you can always follow up with them after this challenge, and keep working together, or people like Bob who are interested in partnering with non finalist schools, that's a great place to find those school names and we are always happy to facilitate introductions.

All right. So I think we'll move on to questions now. And the first one we can get out of the way pretty quickly, which is will the recording be sent to all attendees from the session? We will be posting this recording on the challenge site. And if you are subscribed to our newsletter for the challenge, you will receive an update when this recording has been posted.

So definitely sign up for the newsletter if you haven't yet, that's a great place to get these sorts of updates to your inbox. But everything is always going to be openly available to

anyone on the challenge site. All right, so moving onto the next question, we started to touch on some of this, but what space apprenticeship partnerships exist at the high school or community college level, to provide opportunities for young aspiring technicians in the space industry?

This one's to any of our panelists who have any ideas of apprenticeship or internship opportunities at the high school or community college level.

Albert Palacios:
I think one thing I'll add is I mentioned the federal opportunities. At the high school level there are career and technical student organizations. Some of you may be familiar with some of them or heard the names around your campus, like SkillsUSA, or Future Business Leaders or Technology Students Association or FFA. So if you have those, there are opportunities available through there. They have great connections with industry.

Albert Palacios:
Satellites, pretty much benefit all industries. It's just a matter of seeing how do they use satellite technology in automobiles, in agricultural machinery, in healthcare? How do they use it in these different industries and then connect with one of those career technical student organizations to find out what connections they have with industries. I'm sure you'll find and if there aren't some, I think with their help, you can probably make some connections with the industries where you want to target. For things like apprenticeships and internships and potential some sort of cooperative employment programs.

Amani Garvin:
So another group that any college can start or community college, university, whatever is SEDS. So SEDS is just one big aerospace group, it's national, so you can go to CEDS conferences. I think even high schools can start SEDS chapters if you want just to be a part of that network, and that'll get you connected to a bunch of aerospace professionals, you get to go to space vision once a year, it's pretty cool.

And also like Columbia, we had our own little aerospace group that was building CubeSats and designing them, et cetera, et cetera, until we finally joined up I think with CCNY and their CEDS chapter, or I think they told us to start a SEDS chapter. They were like, you guys are doing what we do, but not under our name. So we were like, okay, we'll try SEDS.

Mahala Pagan:
That is a great organization. Yes, I just chatted it to all of the attendees. So hopefully you guys have a chance to check that out.

Ted Tagami:
There is a serendipitous opportunity. NASA every year has a space app challenge. The next challenge comes up in October, just in a few weeks. Generally, when you go do one of these challenges, it's probably going to be remote this year. In fact, I think they all will be, you will find engineers from all different careers that are just they love space, and they want to work on stuff.

You have a chance to meet these people firsthand and probably join a team and collaborate with them. So check out, I'll put a link in the text there, but space apps challenge by NASA

is coming up I think October 3rd and fourth or something, I'll find the link, but that's an amazing way to kind of serendipitously meet others of like-mind from there it might turn into an internship or an interview or a recommendation or some advice, what have you.

So look at those kinds of opportunities to come up in your communities. In this case, it's virtual, so you can join from anywhere in the world.

Mahala Pagan:
All right. Any other opportunities you guys want to highlight before we move on to another question? There are lots of good ones and I will preface that we only have a couple minutes left. So any questions we don't get to here, we will be posting answers on the frequently asked questions page of the challenge site. So don't worry if we don't get to your question live. We will do our best to address as many as we can.

So here's a really good one that we've seen a few different versions of, what is a beginning budget I should aim for when thinking about a CubeSat. So thinking about how much it costs to assemble and launch these prototypes or high altitude balloons. Any thoughts you want to offer on that one, Albert?

Albert Palacios:
Not to be flippant, but start at zero, figure out what you have around your school. Do you have some Arduino processors or Raspberry Pis that aren't being used anymore? Do you have some scraps in your manufacturing course or in your building course or engineering courses that you can put together a four by four cube?

So start there and then figure out what you don't have and what you need. So it starts small, figure out all the components. A budget is something that you're going to have to explore during this challenge. But we want to see those examples of how you can get it done on a shoestring budget. So don't feel that you have to go out and raise a ton of money for this. But obviously it will help to have resources and funds available from various external donors. That's great. If you become a finalist then part of the prize pool is a $5,000 prize cash prize, as well as some kits.

But I think there are a lot of resources out there that can be found for free. And then kind of start to piece it together based on what your need is.

Ted Tagami:
I'll echo Albert's sentiment. Zero in far as this design challenge, at zero cost, you can do everything and fulfill all the requirements and spend $0. When you actually decide you want to do something, maybe even while you're going through this submission of the proposal. Maybe you want to go in and start doing some actual work, bifurcate that into your mission, which is your equipment. And then how you're going to run that mission.

Of course, if you're gonna put something in orbit, it's a rocket super expensive. It's like a couple of years worth of getting licensing, whatever. Launching it in the balloon actually is really easy. I think one of the questions was out there as what's required to launch a high altitude balloon? For those that are interested, I'd be more than happy to run a Zoom

session on all the requirements to launch your high altitude balloon here domestically in the United States.

I know you all can do it and it's just a matter of following some procedure and practice, doing some weather modeling and prediction and getting ready for a nice long hike to recover that high altitude balloon. But you do it at the right time of year, right time of day and you get the FAA, you file that notice to airmen. You're good to go, cost of flying something like that, it's a couple hundred bucks outside the helium, if you can get rid of the hydrogen.

But it's definitely worthwhile, take that budget, put it into two separate categories. Like our instruments, we run this a sensor shield fits right on Arduino. It's about 40% less than if you went and bought the parts yourself. So just in terms of seeing what an instrument can do, you've got acceleration, a magnetometer, a GPS, temp and humidity. You've got a light sensor, realtime clock, a data card, and then you've got breakouts where you can add other sensors on top of it.

For like 150 bucks if you want to get a prototype, just to get started and work on some code, you can do that. But who's not on the call, which is too bad, is our folks from South Africa with Exeta Box, they got amazing little modular components. Professor I know you've got some really cool stuff you've done with various microcontrollers.

So there's really affordable ways to get this stuff and put it together. Break it into two components, your flight, your mission. And if you work with the National Association of Rocketry, they might host the rocket flight for you at no cost. With your cube you're going to need a six inch air frame which means high power. Which you probably are going to need to make sure your rocket club has ceilings of at least 5,000 feet, probably more like 10 or 15,000 foot ceiling, which is going to limit you around the country.

You're going to have to drive a couple hours more than likely out into the desert somewhere. But it's such a literal blast to go out there and watch your rock and go up and have your payload on it, but just break that into two separate parts. But for the actual requirements here, zero cost.

Mahala Pagan:
Great, and then this might be the last question we have time to get to, but if a person were to launch a CubeSat or something similar, what permissions would they need in order to do so? So obviously the answer to this depends a bit on how they're planning to fly it, whether it's a tethered balloon or a high altitude balloon, but would any of you like to kind of elaborate on some of the permissions required to do these launches?

Albert Palacios:
I'll start with saying that this challenge is designed so you don't have to go through those permission processes. There are ways to achieve the goals of this challenge without doing that. UAs Ted and others have been talking about the different ways to get things into either high altitude or low earth orbit or near earth orbit. Those are more complex, there are a lot more permissions, there's various agencies you're going to have to go through to give them all the technical specifications and it's a very complex process.

However, it can be done, but it takes a lot longer than the period of this challenge. So we were looking to get it done with kind of at a low level to where you don't need those permissions. But if you do end up going with for example, your local news helicopter, that might be different. If you find a high altitude balloon, you have to work with them to see if they need any specific permissions based on where you're located.

So there are a lot of differences, you just kind of have to go incrementally. But you should be able to achieve everything you're looking to do here without needing all of those permissions. Again, do it safely. Those permissions and restrictions are there for a reason. And a lot of it has to do with safety and keeping the skies clear of debris and not interfering with aircrafts.

So we want to make sure everyone's adhering to the rules. And just going back real quickly to the high altitude balloons. I know I think it was Luther in Georgia who mentioned that he's done some high altitude balloons before. He might be able to give you some advice on that or ... So I think there are different people that could be available to provide some of the activities related to this.

Mahala Pagan:
Great, thank you, Albert. And we are at 3:15, which is technically the end point of this webinar. So a few quick housekeeping notes. I am going to offer any panelists who want to share their contact information, please feel free to go ahead and do so in the chat, totally optional. If any of you have additional questions you want to get through to these panelists, or just in general about the challenge, you can always email hello@ctemissioncubesat.com.

We will do our best to answer your questions there. But we will also be posting responses to some of the questions received here on the frequently asked questions page of the challenge site. So that's a good place to check for these things and Ted I see you had your hand raised.

Ted Tagami:
I just want to give a quick shout out to Eddie's company Blue Origin. We've been really kind of tamping down the ambition if you will. But what's really cool is Blue Origin has an educational program that can get the suborbital. You'll go up to 60, 70 miles, you'll pass the Kármán line, you'll be in space. You'll come right back down again, it's a parabolic flight.

You'll get a few minutes of microgravity. And I know the team at Blue Origin ... Eddie I'm just getting a chance to meet you, but Erika Wagner and other groups over there, they're really interested in working with students on your stepping stones to space. So you might start with putting it on the back of a bicycle or a backpack. You might end up doing it on a skateboard because you want to check out the accelerometer, but you end up going through a tethered balloon or a high powered rocket suborbital as your next step, you shake and bake. You do all the testing of your required equipment.

That's a great mission to validate that you can actually do this. And then you've got that three, four, five year plan. You're going to put something in low earth orbit. You can do it and it's five figures. So 10, $15,000 to get out at Blue Origin, but that's doable.

Eduardo Seyffert:
Ted, thank you. We do appreciate the opportunity to work and really much more accessible to anybody and get everybody to go on our clubforfuture.org website.

Mahala Pagan:
Yes. Blue Origin's Club for the Future has been a great sponsor for this challenge. And we thank all of you. Our panelists today, you all have been so amazing. Amani, Bob, Eddy, Ted, you guys, your perspectives have been invaluable to these schools. I'm sure for us certainly. And we really appreciate you making the time to join us today and be so open with your experiences and advice.

So I will leave this open for just a minute longer, if any of you need to grab any of the links that were shared in chat. You're welcome to do so. And we're also going to just put up a quick poll to ask you how helpful was this session for you, scale of one to three, not helpful, somewhat helpful, very helpful.

We always like to know how this felt for you all. So please let us know, give us something on this feedback and thank you again for making time to join us all today and good luck with your submissions. The deadline is coming up so soon enough, you'll be building prototypes like Ted's 3D printed prototype he's showing. I know Bob has a CanSat in his office as well.

We can't wait to see your mission proposals that you submit on October 16th and really look forward to seeing many of you make it to the prototyping process in phase two. All right, thank you so much. I think we are done for the day. So hope to hear from you all again soon, and thank you so much.