ENGINEERING SUMMER HIGH SCHOOL INTERNSHIP

Program Review

El Segundo | August 2018, Volume 7

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DR. BILL SARGENT

CHIEF ENGINEER
SATELLITE SYSTEMS
SPACE & LAUNCH

"I am always impressed with the enthusiasm the high school interns have and what they accomplish. I look forward to having many of these students back at Boeing as full-time employees after they obtain their college degrees. I also appreciate our Boeing mentors who are passionate about their profession and realize the importance of STEM, keeping the engineering pipeline full, and educating the next generation about who we are and how important our products are as we move into Boeing's next century."

INTRODUCTION

The Boeing Engineering Summer High School Internship Program was established in 2004 under then Anaheim Chief Engineer Daryl Pelc. The program began when representatives of Troy High School in Fullerton contacted Boeing about a possible internship program for high school students. The program grew quickly through the guidance of then Huntington Beach Engineering Operations, Resources & Labs Senior Manager, John Kremer.

Huntington Beach became the main location for the program in 2007 as the Anaheim campus was closed. In 2011, Huntington Beach reached out to Satellite Systems, formerly Space & Intelligence Systems (S&IS) El Segundo, to start a pilot program with eight students who were interested in the space and satellite businesses. It was extremely successful, and in 2012 the El Segundo campus became the second major internship program hub, adding eight schools. Pat Sandoval, Project Management Specialist, and Eric Eichinger, Huntington Beach Analytical Lab Manager for Chemical Technology, have been the High School Intern Foci for Los Angeles County and Orange County high schools, respectively.

For the summer of 2018, Boeing welcomed 58 students from Bosco Tech, California Academy of Mathematics and Science, Da Vinci, El Segundo, Hawthorne, Mira Costa, Palos Verdes, Peninsula, Port of Los Angeles, Redondo Union, Sacred Heart, South Torrance, and Windward. Throughout the internship, students interacted professionally alongside engineers, managers, and executives to understand each engineering department. Interns were presented with Science, Technology, Engineering and Mathematics (STEM)-related tasks that provided the necessary information to succeed in the engineering field. In addition to rigorous tasks, interns were encouraged to attend special tours of sites and labs, participate in technical and career development sessions, and network with fellow interns and employees to decide if a career in engineering is their correct path in life.

Boeing employees assist the internship program by mentoring students and providing interns with real-life work experience in an aerospace engineering environment. Mentors drive the program and make it successful. In the upcoming years, mentor participation is critical as more high school students are interested in experiencing life at Boeing. Students participating in the Satellite Systems Engineering High School Internship Program have a strong background in math and science and come from high schools with STEM-based programs. Requirements comprise completing 125 to 160 non-paid work hours, including 15 training hours in a seven-week period.

GEN Z VS MILLENNIUMS

By Sabrina Kardashian, Windward High School

James Dellaneve and Dr. Santor Nishizaki explain the data they gathered during their work to discover more about Generation Z in the workforce

A generation is defined as a society-wide peer group, born over a period of roughly the same length as the passage from youth to adulthood [in today's America, around 20 or 21 years old], who collectively possess a common persona. And, it remains no surprise to me that Boeing employees reach across these generational boundaries to collaborate in the same workspace. From the great generation to generation Z, Boeing hosts a diverse group of personalities and attitudes in the workplace. However, as millennials age and climb the corporate ladder new job opportunities arise for the next generation on the edge of entering the workforce: Generation Z.

Led by Dr. Santor Nishizaki, CEO and founder of Mulholland Consulting Group LLC, and James Dellaneve, a computing engineer at the Boeing Company and adjunct professor at Pepperdine University, the focus group about Gen Z compared to other millenniums helped me gain insight into my own generation and their demands for an improved working environment. Defining the generation as all individuals born after 2000, Mr. Dellaneve and Dr. Nishizaki proceeded to describe the various aspects of Gen Z.

According to the lecturer's research, the most important factor Gen Z looks for in a workspace is the opportunity for advancement. Sixty percent of Gen Z wants their work to make a difference within a company that offers growth and potential leadership positions. Continuing the same mentality of Millennials, Gen Z still prefers a work life balance although it is anticipated that Gen Z will take on more side jobs with new services like Uber, Lyft, and TaskRabbit. This inclination for multiple careers is understandable as researchers find that Gen Z demonstrates a better ability to multitask compared to their predecessors. Having grown up with cellphones, tablets, and the internet, Generation Z is used to handling more than one screen or task at once. Furthermore, Gen Z proves to be more practical than previous generations taking on internships in order to obtain work experience and instruction. These internships, such as the high school internship conducted by Boeing, help Gen Z learn more about fields of interest to them and build a professional network.

While my generation may consist of dedicated entrepreneurial minds, Gen Z also has areas for improvement. For example, almost half of Gen Z uses technology for over 10 hours a day. In the discussion on June 21st, Mr. Dellaneve, in particular, stressed the importance of the concept of mindfulness to my generation. He emphasized that being present in the moment was a vital component of success especially in the workforce where most people are on gadgets for a majority of the day.

After finishing their lecture on the attributes of Gen Z, both Mr. Dellaneve and Dr. Nishizaki began a Q and A portion of the event. Through this Q and A I learned that my generation prefers a combination of collaborative and individual spaces in a business office. Also, accustomed to information at their fingertips and immediate responses my generation revealed that they wanted their future managers or bosses to check in on their work and projects at least 4 times per week- an astounding amount. Finally, with the minutes running out on the clock, the Q and A portion ended the event.

This discussion not only helped me understand my own generation better but the dependency of companies to adapt to a new workforce. Companies at the forefront of technology like Boeing will soon need to adapt to attract the new talent pool composed of Generation Z. With an attitude of hard work and determination to learn and advance, Generation Z will provide a new competitive edge to any company.

BUILDING THE FUTURE ONE LAYER AT A TIME

By Benjamin Tait, Redondo Union High School

Interns tediously removing carbon fiber layer backing before layering onto their mold fixture

During the summer many interns participated in material scientist Robert French's Huntington Beach Composites session. This class was one of a kind because for once we interns weren't just on the outside looking in. In other sessions we were able to learn and see amazing things— the Mission Control Center, anechoic chambers, the bigger than a house vacuum chamber, and even a real satellite preparing to go to space. And while seeing those things was like being a kid in a candy store for we kids who eat, breathe, and sleep STEM, something was missing. Seeing and hearing are great, but for any curious person the most important sense for discovery is touch. As humans, touching and feeling is one of the most fundamental ways to gather knowledge and explore the unknown. The young child who finds something on the ground doesn't just sit and stare at it; his immediate reaction is to poke, to prod, to pull, to feel—aka to touch. And in building 45 in Huntington Beach, we all got to embrace our inner child and make composites ourselves.

What we got to do was create an actual carbon fiber component by hand, with real, as strong as steel yet three-tenths-the-weight, carbon fiber. The way a structure is built with carbon fiber is by slowly building up your component, layer by layer, in the desired shape, almost like industrial, more scientific, paper mâché. With each layer we had to make sure to slowly stick it to the one below and flatten out any air bubbles. In our case the shape consisted of two flat parts joined by a vertical piece, meaning on each and every layer we had to carefully shape the carbon fiber around the two corners. It took a while to build up the composites, but that was just the start. The resin-soaked carbon fiber sheets don't just magically come together to form a composite; they have to be cooked. But not just any big oven will do--what they need is something called an autoclave. An autoclave not only gets to hundreds of degrees in temperature, but also uses incredible pressures of up to 100 psi, almost 15 times atmospheric pressure, to push all the layers together and cook them into one solid composite. In order to prepare our composites for this process, we actually had to make our own airtight, vacuum sealed bags. We had to fold the bags, tape them together, cut holes for valves, and then test for leaks and readjust--a completely hands on process. All in all, the composites session was a great opportunity to do what humans do best and make something with our hands while also getting great insight into the material that is so important in so many Boeing products.

Sabrina Kardashian makes adjustments to her carbon fiber layer

SATELLITES 101

By Henry Rosas, Bosco Tech High School

The process of building a satellite is a complex system that requires care at each stage of its development. From the seemingly minute details found inside the bus to the large, expanding sides of the solar panel, the satellite parts built at Boeing all play an important role in the success of the satellite. As such, many different experts are assigned to each part to ensure its success. Dan Roukos shared his knowledge and experience with the summer interns during a training session and spoke about the process of building a satellite.

To start the presentation, Roukos asked the interns a simple question: What is it exactly that satellites do? While the interns had a general idea of a satellite's functions, Roukos described how the main purpose of a satellite can range from providing internet access to gathering valuable weather related data. As a satellite systems engineer, Roukos was responsible for ensuring that the enormous project of building a satellite was completed without error.

Although complicated when viewed from a technical standpoint, Roukos explained how satellites can be broken down into major sections, as well as subsystems within those sections. For example, the bus is responsible for the various subsystems that allow the satellite to perform its mission. From the telemetry and command modules, which allow for communications, to the reaction control system, which uses propulsion to maintain the satellite's orbit, the bus is what allows the satellite to function. Meanwhile, the payload, the section of the satellite that performs the mission, is where channel processing and switching take place. Antennas attached to the satellite are used as well to transmit signals back to earth via reflectors and various pointing mechanisms.

Soon after explaining the different parts of the satellite, Roukos went on to describe the various orbits that satellites are located at to perform a given mission. Satellites in a low earth orbit (LEO) are located anywhere between 200-1000 miles above the earth and are primarily used for gathering data from the earth's atmosphere. Medium earth orbiting (MEO) satellites are found around 6000-12,000 miles above the earth, and are used for a variety of purposes, from GPS to in-space surveillance. However, the most valued space for satellites to exist in is in a geosynchronous earth orbit (GEO), due to the fact that, at 23,000 miles, satellites have a 24 hour orbit exactly and stay in place relative to their position on earth.

After a brief explanation of the physics of a satellite as it orbits around the earth, Roukos described a common problem that engineers run into: how to work around space junk. The term space junk is used to describe the bits of debris floating through space at high speeds that have the potential to harm satellites as they orbit the earth. Roukos described how even a piece of debris no larger than the head of a needle could cause serious problems for a satellite, as it is currently almost impossible to detect at such a small size.

However, space junk is just one of many factors that needs to be kept in mind as satellites are made. Satellite systems engineers must account for the fuel capacity of a satellite, the weight of the payload, and the launch vehicle capability, just to name a few. Roukos once again emphasized the complexity of satellite building when he displayed a chart showcasing the bureaucratic process of communicating with the customer while still staying on schedule to build the satellite.

Knowledge pertaining to the complexity of satellite building is gained through years of experience as a systems engineer. From his own experiences, Roukos advised the interns to study a broad field of engineering and then focus on a more specific field of study once they join the industry. As the training session came to a close, the future engineers gathered in the room were one step closer to understanding and building the satellites of tomorrow.

HI BAY TOUR

By Henry Rosas, Bosco Tech High School

Our tour of Hi bay started off near a model of the Syncom satellite, the simle looking mockup that acted as the catalyst for the creation of the satellite testing facility we were about to enter. With a sense of excitement and

anticipation, we eagerly headed towards the facility. After putting on our protective glasses and smocks in order to keep foreign objects away from the satellites, we began our satellite manufacturing tour.

As we viewed the massive size of the hangar around us, our tour guide gave us a quick run-down of the different pieces of hardware and test environments we found ourselves surrounded by. To our right was a large chamber suspended on a platform that our guide identified as the thermal testing chamber. By lowering the satellite into the chamber, engineers are able to simulate the different extreme temperatures that a satellite will endure as it travels through space. While the chamber that we were viewing was currently undergoing recalibration, our guide commented that when operational, the chamber is able to hold and test up to two satellites at the same time.

A little further down the walkway was the vibration testing table, where a satellite can be tested to ensure that it can withstand the intensity of the initial launch out of the earth's atmosphere. By measuring the satellite's vibrations per second, the engineers are able to exactly pinpoint the limit at which the satellite will fail and can plan accordingly.

Experiencing the size of the testing unit, an intern asked how the satellite, with its massive solar panels spanning over a hundred feet long, was able to fit on such a tiny platform. Our tour guide then explained that in order to be as efficient as possible with the space that they had, engineers had designed solar panels to fold inwards in order to take up less room. This made it relatively easy to perform testing with the aid of a lift that moved and rotated the satellite into the position that the engineers needed.

Soon after, our tour guide led us to what appeared to be a large, open pocket in the wall with a massive door to the side of it. The guide explained that this was where they perform pressure testing for satellites by pushing the air out of the chamber once the door was closed in order to simulate the vacuum of space. We then had the opportunity to step inside of the anechoic chamber, the room where the satellite's radio frequency is measured and validated. Because engineers were currently working inside the chamber, we only had a chance to glimpse around at the foam covered walls before returning to the main section of Hi bay.

The care and caution that went into building a satellite gave all of the interns present a distinct understanding of what it means to be an engineer. As we left Hi bay that day, we felt one step closer to becoming full-fledged engineers who would hopefully one day work on creating the next generation of satellites.

Interns pictured with replica of Syncom satellite

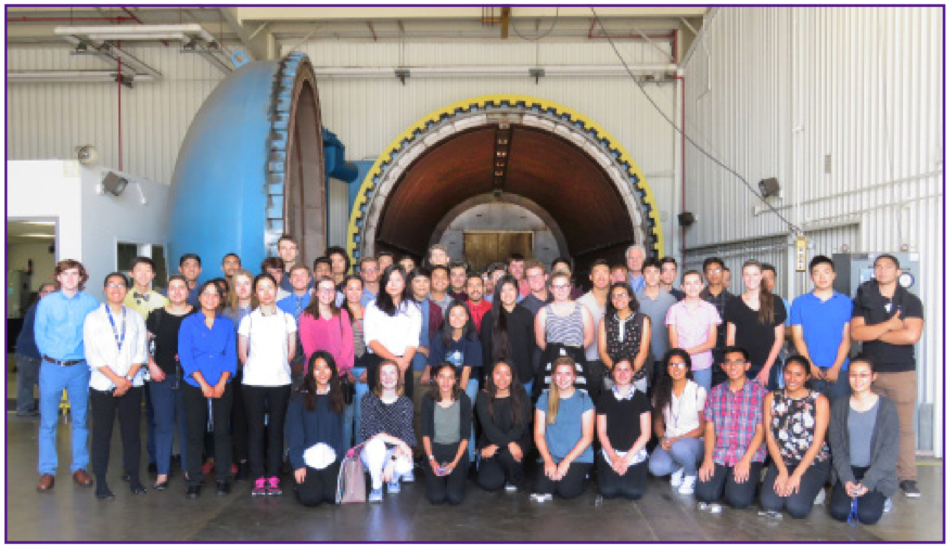
SPACE HARDWARE

By Joy Uehara, Da Vinci High School

It was a hot day to be standing outside, but that was what almost forty high school interns were doing as they waited for whoever would take them on the "Space Hardware Tour" for which they had signed up. With a mix of interns from both the El Segundo and Huntington Beach sites, it was very clear who was who as there seemed to be an invisible barrier that prevented the two groups from interacting with one another as they waited for Mark Kasprzak and Bob French to start the tour.

When Mark and Bob did finally arrive, they came with a large plastic bag full of safety glasses and a happy, lively attitude that excited everyone. Giving us a quick history lesson prior to the tour, Mark and Bob spoke of how the Huntington Beach facility was founded right before President John F. Kennedy's assassination with President Kennedy's Vice President, Lyndon B. Johnson, just touring the site only a few weeks before Kennedy's assassination. Mark and Bob even pointed out the positions of the sniper guards that had protected the future president.

After a rundown of the site's history, the interns were easily split into two groups with the El Segundo interns following Bob and the Huntington Beach students following Mark. Bob led us to a tall building, over 90 feet tall, to show us the biggest pieces of flight hardware we would see that day: farings. There were several different sizes, all depending on the size of the payload. Farings are considered to be a part of the launch vehicle. They encase the satellite (or whatever is being sent to space) to protect it during launch. Once it is in space, airbags are deployed forcing the faring pieces to separate and fall away which allow the payload to enter orbit. It was amazing to see the huge cylinders from only a few feet away and one intern was even permitted to touch it as Bob explained how the vertical lines that looked like bend lines were from the brake that was used to form the cylinder.



El Segundo and Huntington Beach interns

The intern- our own Tony Lee-Taylor III from Hawthorne High School- reported that he couldn't even feel the bend lines!

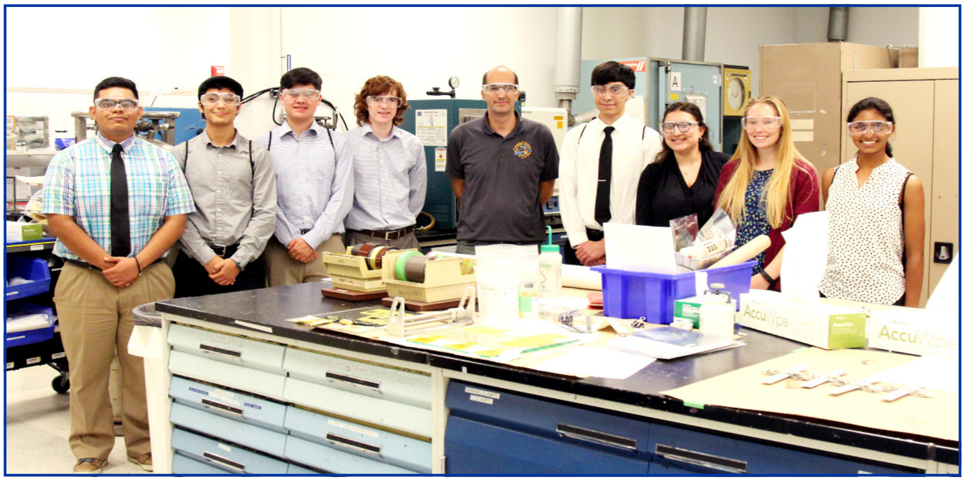
Then Bob led us out of the faring building to our next destination while pointing out a building that housed a huge 33ft deep pool that was used to test submarines. Bob also surprised us by mentioning that parts of the movies 'Waterworld' and 'Star Trek 6' had been filmed there! The next building was mercifully air-conditioned as the heat had only increased with the day. As we entered the building, all the interns trampled in over the sticky mats at the doors to see the CST-100 Capsule forward heat shields. As we watched a couple technicians at work, Bob specifically pointed out several expensive laser projectors in the room. He explained that the projectors were special in that they acted like sensors with the ability to recognize the object they are "looking" at and project an outline onto the part displaying the next element's rightful place on the part.

The next thing we saw was a "small" autoclave. With a 15 foot diameter and 40 foot length, this autoclave is actually considered to be on the smaller side. It had recently gone under repair when the pneumatic cylinder on the door failed several months ago. The autoclave reaches pressures of 100-200 PSI (pounds per square inch), and during calibration, the operator opened the door when there was still one PSI remaining and the force of the pressure exiting the autoclave broke the pneumatic cylinder. The autoclave must receive regular maintenance on the door seal because if it were to fail with 100 plus PSI inside, the door would fly clean off, out the door, and through multiple buildings, clearing everything in its way.

With that in mind, the two intern groups from El Segundo and Huntington Beach smiled somewhat uneasily for a group photo of the Space Hardware tour.

MATERIALS & PROCESSES LAB EXPERIENCE

By Aaron Dominguez, Bosco Tech High School



Miguel Contreras-Aguirre, Aaron Dominguez, Christopher Valdivia, Lucas Schaberg, Peter Babilo (Lab Manager), Henry Rosas, Sabrina Kardashian, Stephanie Paris, and Hetal Shah

Before I had the opportunity to tour the Boeing El Segundo Materials and Processing (M&P) lab, I had been intensely set on discovering the relevance of my own training at Bosco Tech in respects to Boeing's facilities. Prior to the internship, I had spent three years at Bosco learning the practical applications and the theory of mechanical properties of materials and as such, I was eager to see what Boeing had to offer. Fortunately, Boeing exceeded my expectations tenfold.

At the entrance to the M&P Lab, there was state of the art radiography equipment which could only be operated by a licensed employee who, unfortunately, I did not have the pleasure to meet due to his absence. Like the radiography equipment, the rest of the lab was filled with computerized equipment that boasted increased accuracy compared to all of the equipment I was familiar with. Inside the lab, Rockwell Hardness testers, a scanning electron microscope (SEM), and all different assortments of machines were maintained and kept in peak condition. It is an incredible resource for any company to have access to a M&P lab, let alone maintain one of their own. From my own experience maintaining highly sensitive and dangerous equipment such as a SEMs, I understand that repairing high-end equipment can be incredibly costly on top of being heavily regulated. When one of Bosco's SEMs needed maintenance, it required the expertise of a veteran in the field as well as his willingness to do it for free, a job that typically would pay extremely well.

One area where I felt I had a great deal of familiarity with was the metallography room. Grinding stations lined the wall with cabinets containing lubricants and liquid abrasive agents. Polishing naps and 600 grit abrasives were set up on grinding wheels where epoxy encapsulated samples would be worked by hand. On the other side of the room, sectioning equipment equipped with diamond wafering blades rested on a counter, shiny like a new car. If there was any moment during my time interning at Boeing where I knew with certainty that I felt at home, it would be when I stood in that room. There in that room, samples are cut to a desired size set in a two part solution that hardens when it is then carefully worked on the wheels. By using sequentially finer abrasives, the unwanted surface of the part is removed in order to approach the pure material that is desired. After it's polished to an incredibly fine surface, it is etched, a process for removing the final layer of a sample that requires a great deal of chemical knowledge and the facilities to produce any chemical etch required. Without fail, Boeing has both of these things in abundance.

In the chemistry lab just across the room, I saw an inventory of glassware that far outclassed any high school lab I had been in. Alongside etches, the team that works in the lab produces its own custom paints used for their exceptional properties. We were shown the whitest paint ever made which was used on space satellites for reflecting light, allowing for a passively controlled temperature. Just like a chemical etch, each variety of paint is unique in the same way a glove is made to fit a specific need for a very exclusive job. Using the equipment in the lab is a job that requires a solution to a problem not yet known. To create a paint or etch that satisfies every unique job that comes your way is nothing short of an art. As a young engineer, it excites me to know that not all problems have solutions readily available and that I will have to make my own.

CERAMICS TRAINING

By Benjamin Tait, Redondo Union High School

Everyone knows about ceramics. They're simple. We all own ceramic plates and pots, and frankly, they are pretty simple in design—just stick some clay in an oven, right? But if you mention ceramics in the context of the Space Shuttle, you know that things are going to be just a bit more complicated. A lot of people have a general understanding of what the Space Shuttle is, but not a lot of people know what goes in to making it. Obviously it has some sort of heat shield—there is a distinct layer of black on the bottom--but how exactly does that simple layer of black protect from temperatures in the thousands of degrees Fahrenheit? The answer, amazingly enough, is ceramics. To be specific, ceramic tiles—over twenty-five thousand of them.

Bob French shares the history and evolution of ceramics over the life of the Space Shuttle program

These ceramics aren't like ceramics in the classic sense. Instead of clay, they are made up of tens of thousands of tiny glass fibers that have been stirred together and then baked and cured into a rigid tile. But the magic isn't in what is there, it's in what isn't. The reason these tiles can resist so much heat is because of their incredibly low density; some are up to 90% air—and air happens to be one of the poorest thermal conductors there is. In our session, however, we didn't have to just take Mr. Bob French's word for it. With a propane tank in one hand and a tile in the other, Mr. French spewed flames onto one side of the tile while holding onto the other like it was a stone-cold rock.

From then on, Mr. French talked about both the tiles and the logistics of the space shuttle itself—one of the places where heat resistant tiles come in pretty handy. We really got to see the scientific process in action through the evolution of tiles over time. At first it was tiles that could resist heat well but were weak and prone to breaking. Then it was tiles infused with aluminum that were much stronger but then couldn't resist the heat. Through try after try and test after test, in the early 2000's Boeing finally came up with its own unique tile. The Boeing Rigid Insulation (BRI) tile is 5 to 10 times stronger than any tile before it yet didn't require any sacrifices in thermal conductivity—a real breakthrough that dramatically improved the final years of the Shuttle Program and will continue through Boeing's upcoming Commercial Crew program.

While the bottom of the Space Shuttle is the main part that faces the hotter-than-molten-lava temperatures, what about the rest of the Shuttle? You may think that the body of the shuttle is something different—it's that signature white color—but looks can be deceiving! While it may not be in the same final form, the body of the Space Shuttle is still made up of glass fiber ceramics—but this time woven into

thermal blankets. These blankets are a great middle ground in terms of thermal protection. They can't reach as high temperatures, but they are tough and much less fragile than the tiles.

All in all, this session was a great opportunity to shine a different light on both the material and the spacecraft we all thought we knew so much about. It turns out there a whole lot more to ceramics than meets the eye.

BUILDING A HELICAL ANTENNA

By Hetal Shah, Redondo Union High School

Hetal Shah using adhesive to attach the support structures to the ground plate of the antenna

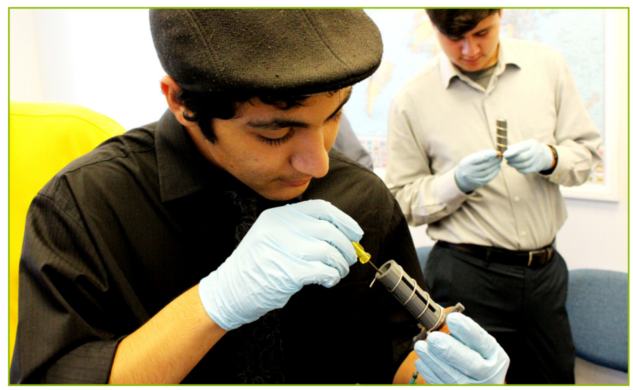
Engineering. If that means being good at math and science then there are so many people who are engineers. Engineering is literally in the acronym STEM. But there is a huge part that is left out. Engineers are artistic, creative, and social. I discovered this while working with the antenna group on the twelfth floor of S12 with my fellow interns: Noah Bernstein, Aaron Dominguez, and Chris Valdivia.

My mentors, Robert Alexovich, Martin Bieti, James Farrell, Mario Pavlovic, and Catherine Thomas, wanted me and the other interns to each build a helical antenna. I thought that these expectations were crazy. How was I, a high school student with no experience, going to build a working antenna? I also had to build a support structure using a CAD tool, something I've never used before.

The first step was to do some more research. I looked up terms that were related to antenna such as frequency, return loss, and decibels. After becoming a little more familiar with antenna, I was given the parameters to design our own model: frequency of 4 GHz, return loss of less than -12dB, gain of 10dB, and an axial ration of less than 3dB. The other interns and I decided to approach this project in a different way. Instead of making our own individual designs, we were going to make one central design for the coil and change the support structure design to see how that affected the signal. We used an RF calculator to help create a design.

We were given the CAD tool Space-Claim to design our support structure. Learning to use a CAD tool was difficult but the other interns were able to help me. Noah created the baseline design for the support structure. We used his design and improved upon it to see if the testing would yield better results. For example, Chris decided to make his antenna turn in the opposite direction to Noah's, giving it a different polarity. I decided to make cutouts in the structure to allow more RF signal to pass through.

Once our designs were finalized, the four of us presented our designs, cost analysis, and antenna requirements to our mentors. They also gave us some insight on how a professional meeting should be structured and planned out. Once we received approval from our mentors, the 3D printing process began. It took a couple of tries for me to get the structures printed out properly, but the mistakes were fixed. The next step was to build the antenna. Using a two part adhesive, I glued our support structure to the ground plate. Later, I soldered the wire to the pin of the RF connector. The only thing left to do was test my hard work.



Aaron Dominguez and Christopher Valdivia adjust their support structures

We performed a preliminary test and made slight adjustments to the positioning on the wire. Some of the coils on my antenna had to be pressed to be more circular. I learned that the coil closest to the ground plate had the most drastic effect on the signal strength. Any slight adjustment could fluctuate the return loss by two dB, which was a lot considering my antennas has a return loss of about -12 dB. One Boeing employee told us that the closer you could get the last coil to the ground plate without touching it, the more optimal the return loss would be. Using popsicle sticks and tweezers, I

Aaron Dominguez and Hetal Shah test gain of their antennas

continued

positioned the wire to get the best return loss. A few days later, I performed the final testing of my antenna. I tested not only the return loss but also the gain. I used a horn, another type of antenna, to calculate the gain of each of our antenna. At first, one intern held the horn while another pointed an antenna at it. Eventually the mentors created a structure to hold the horn using a tripod, bubble wrap, and zip-ties, engineers at their best. The return loss graphs were saved on a floppy disk.

Designing and building an antenna was one of the most unique experiences of my life. Being able to build a piece of hardware and test it using real equipment was an opportunity that very few high school students get. I learned that even building a simple antenna with only three necessary parts (the connector, ground-plate, and wire) requires so many theories, equations, and variables. Using the different equipment involved in testing was also a remarkable experience. From picking up the heavy horn to calibrating the PNA (Precision Network Analyzer), I got more insight into engineering than I could have imagined. The experience at Boeing was not just an internship; it was a chance to show yourself how much you are capable of.

BECOMING BLUE

By Nadia Owen, Mira Costa High School

Miguel Contreras-Aguirre, Carol Nguyen, Nadia Owen and Eleazar Lontoc

When you think of Boeing and the aerospace industry, you think of planes, military equipment, and satellites, designed and built through mechanical, electrical, and software engineering. At least, that's what I thought until this internship. The processes and work that go into making a satellite are much more intricate and require the work of so many more engineering fields of discipline than you expect. I learned all of this and much more through working in the survivability and contamination group with my mentor, Carol Nguyen, Tech Fellow/Survivability and Vulnerability Engineer, and all of her colleagues. Through working with Carol and her colleagues I was able to gain real work experience, specifically in the survivability and contamination fields and attend many of their meetings.

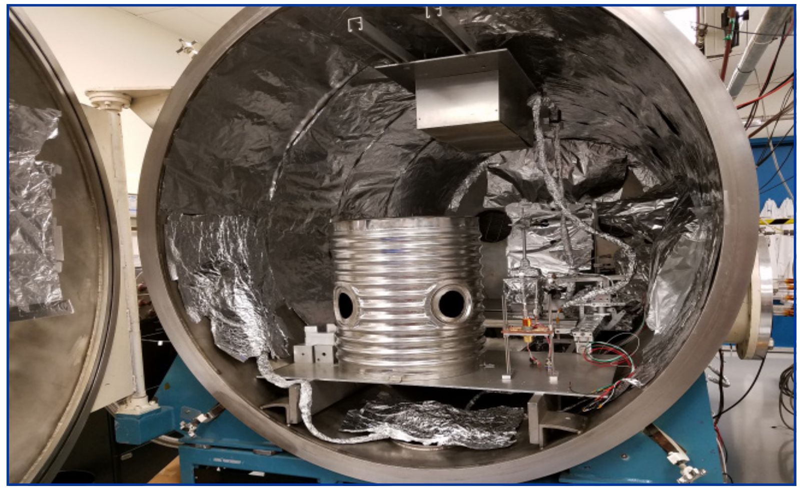
My first assignment was to design and build a simplified ASTM E 1559 test set up which tests outgassing of materials in a vacuum simulating a space environment. Outgassing is when particles evaporate off surfaces in space. When satellites are sent to space, the materials they are built from need to have extremely low outgassing rates to ensure that the satellite can survive for the 10 ot15 years it is running its mission without breaking down because of constant loss of material. There are two main machines that can test particle outgassing: the ASTM E 1559 and ASTM E 595. The E 1559 is more precise, whereas the E 595 allows the user to identify which substance is being outgassed. Since the El Segundo Boeing facility does not have an E 1559, every time someone wants to test a material, it has to be shipped to a different facility which takes time and money. By having me build a simplified E 1559, some of the testing could be done here, benefitting everyone. In order to create this machine, I first had to do a lot of research and reading to learn about the machine, what it does, and its predecessors. From there, I had to create a bill of materials and then get those subsequent materials as well as coordinate with the people whose vacuum I needed to borrow. This required me to reach out to a lot of people and gave me a real sense

continued

of what it's like working in a large company. You have to communicate and work with other people to create the best outcome for the project you are working on. Reaching out to so many people really expanded my comfort zone when it came to asking for help and working with new people, as I'm usually the quiet and reserved type. When it came time to assemble the test set up, I had to experiment with many different fittings and adapters to connect all the parts together as well as create my own wires and cables through soldering and crimping. Creating my own cables was really an "ah ha" moment for me, because starting out I had zero knowledge of electrical engineering or even what soldering was. However, I worked hard to figure everything

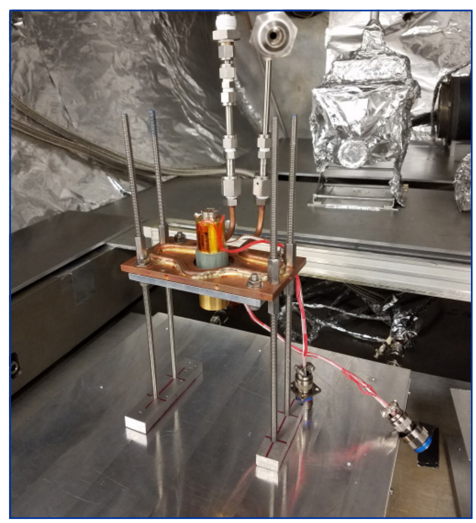
Bell jar that forms the cold shroud allowing the outgassing particiles to collect on the QCM and be recorded

out and talk to people and all of my cables ended up working! This taught me that I am capable of creating things I have no experience with and experimenting which is a valuable skill in the aerospace and engineering industry. Once everything was connected, I had to place the set up in the vacuum and plug in the cables and liquid nitrogen lines, and then my set up was complete. Coming into this, I had never expected to get to do so much hands on work and for my test setup to be used by other Boeing employees, but it was. I was able to take over work from my mentor and her colleagues that would save the company time, resources, and money.



Bell jar and QCM side-by-side in the vacuum that the simplified ASTM 1559 test takes place

At the same time, I began the completely different task of evaluating a new software system and running simulations on it to compare to results from a lab. Based on my evaluation, the software and my research could be used by Boeing for preliminary sputtering testing of materials. This software was The Stopping and Range of Ions in Matter (SRIM). It has the ability to run tests for ion sputtering yields and damage. Ion sputtering is when inert gas ions bombard the surface of a material at extremely fast rates. This can cause the material to be broken down over time or the ions to embed themselves into the material also causing damage. In space vehicles, the effects of ion sputtering are being seen more and more with the switch from traditional liquid fuel to a Xenon Ion Propulsion System (XIPS) for rocket thrusters. XIPS uses Xenon ion gas which is 10 times lighter and more efficient than liquid fuel, saving space and weight on a satellite. My task was to learn the SRIM software and run multiple simulations with different elements and compounds to look at sputter yield and damage in relation to the Xenon ion. This required me to also research sputtering and then learn the new software. From there, I had to determine which settings matched my needs and the lab results I was given. After calculating and graphing the results, I compared the curves to the curves I was given. This allowed me to analyze that singular elemental targets were more accurate compared to compounds. In the future, if this software is used, preliminary ion sputtering testing can be done on a computer, making things much



The QCM attached to a cooling plate and stand that places it the required distance away from the material being tested for outgassing

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easier. This project embodied real work experience in that you have to be flexible and learn new things. In addition, you have to spend the time to analyze results to try to understand as much as you can and then apply them to the bigger project you are working on.

Working at Boeing this summer has really given me a chance to see what real work is like and all the hard work that goes into each project, especially the satellites. I saw how the survivability group I was working in is just as integral as the electrical or payload or flight groups to launching a successful satellite. This internship expectations, especially in terms of all the knowledge I gained and projects I got to work. It pushed me to challenge myself in new activities and also reaffirmed my passion for chemistry and result analysis. I got to visit the Materials and Processes lab where I watched some of the chemists run Ion Chromatography tests, got to participate in hands on trainings, and analyze different results with my SRIM simulations, all of which I greatly enjoyed. I'm grateful to everyone who helped me along the way and I will always cherish my time here.

QCM Controller which receives all the data from the QCM in the test and transfers and graphs the information on a computer

ADVICE FROM AIRMEN

Wesley Park, Palos Verdes High School

Stacey Surace and Wesley Park at Mission Control Center

An Airman--a person enlisted in the air force. Even though half the time I don't know what I want for dinner, I know that someday I want to be an airman. With that in mind, I walked through the hallways of Boeing seeking out airmen and airwomen. One of the many lessons I learned during my time at Boeing is that it is almost always beneficial to reach out and talk to the professionals I find myself surrounded by. This article is a compilation of some of the advice from former and current members of the Air Force that I met through Boeing.

One of the first airmen I met at Boeing was Henry "Mac" McClintock, a member of the Computer Operations Team in the Mission Control Center. When Mac was in his twenties, he met an elderly man who, despite his success, told Mac that he would give up all his wealth just to be young again. The old man's one regret was being afraid, and Mac's advice to me was very much the same. He said to not be afraid and really take advantage of every opportunity available. Ask every question you have because beyond that fear, you will find success. You cannot make the most of something if you let fear stop you.

Colette De La Barre, Director of Engineering for Autonomous Systems, was a Professor at the Air Force Academy. The Academy is the third best public school in the nation, with a plethora of NCAA sports that are all division one. In addition to academics and athletics, cadets receive military training. As you can imagine, due to the rigor on all fronts, the attrition rate at the Academy is around twenty percent. Colette watched many young cadets struggle and sometimes fail at the Academy. The advice from the former Airwoman is this: "Be happy with the decisions you make because they are yours no matter how difficult it gets." Her statement has two meanings: make decisions you will be happy about and do not second guess yourself, regardless of the results of your decision.

Steven Turechek, currently a systems engineer, stressed the importance of opportunities. The former Major attended the Air Force Academy and

continued

ADVICE FROM AIRMAN
continued

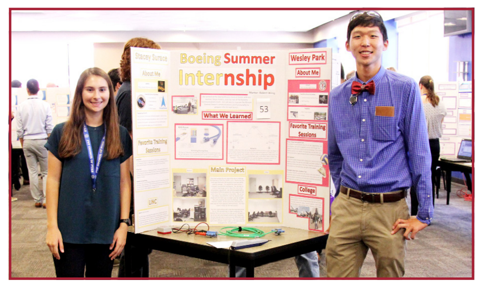
Brigadier General Philip Garrent visits with the interns

The advice given to me was from the perspective of airmen and airwomen, but they apply to all aspects of life, not just the military. Whether it be in the aerospace industry or through social interactions, the information from these wise veterans and officers holds true. After speaking with all of them, my advice to those in the same position as I am is to always seek the guidance of others. It is difficult to achieve anything using just your own intuition, but the invaluable input of others makes those dreams obtainable. I am just a seventeen year old with an opportunity and a dream, but with the help of those who are more experienced than I am, maybe someday I will be an airmen.

graduated in 1985. As an aspiring Air Force Academy Cadet myself, I was told to never forget that for every opportunity that comes my way, someone else is not as lucky. Out of the applicant pool, many candidates are denied acceptance even though they are qualified. That's simply the way it goes. Therefore, in every opportunity one should strive to make the most of it, not only for personal betterment, but for the sake of those who were less fortunate.

Colonel McKenzie said that when new officers are assigned to him, he gives them the incredibly important task of running the snack bar. This task is not to haze those under him, but rather to test their diligence. He told me that if he cannot trust them to run a snack bar, he cannot trust them to run a multi-million dollar satellite.

Brigadier General Philip Garrant, Vice Commander of the Space and Missile Systems Center, held a Q&A session on July 12th. During the session, he covered many topics including his own background and the announcement of the Space Force. When asked about his success, the General responded "blossom where planted." This common saying in the military means to do the best job you possibly can do, no matter what that job may be. Whether you start at the very bottom or are put through great adversity, be sure to make the best of it. In a world with so many external factors, one of the only things you can control is your own resilience.



Stacy Surace and Wesley Park during poster session

Jason Morales, Wesley Park and Skyler Winig during LINC kick-off meeting

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MAKING CHANGE HAPPEN...IN A DOCUMENT

By Matthew Chan, Da Vinci High School

Matthew Chan with mentor Dr. Chahriar Assad

Typically, when most individuals think of engineers, they usually think of us as people who spend all their time in laboratories, giant testing chambers, and hangars, doing lots of hands-on tasks in order to build very complex machines and products. And while that is very much true, that is not the complete picture. And just like most people, I believed in this typical view of engineering: lots of hands-on work. And when I was fortunate enough to receive the opportunity to work for the Boeing Company this summer, I was exposed to a completely different side of engineering: Documentation and great amounts of paper work. Although I felt disappointed at first, my mentor Dr. Chahriar Assad always stressed the importance and weight of my task.

"This is what *real* engineering is like," he said, "when you start rising higher up in the company, there's less time to do really fun hands-on lab work and you end up spending more time in meetings and reading and writing documents. The work that you are doing is real work that is going to help the Boeing Company tremendously."

At first, things started a bit slowly. It took time to schedule meetings with other engineers, who have very busy schedules, and trying to find times when both of us were free was a bit challenging. However, once all the meetings started, the pace of the whole internship picked up. There were meetings every day, and very quickly, I began to understand the very complex nature of my task. I was tasked to streamline the documentation process for the qualification of space units, assemblies, parts, etc. And these meetings allowed me to understand the relationship of how all involved documents worked together, and what people within Boeing wanted to change. But if there is one thing that I have learned from this internship, it is this: Even the smallest of changes can take a very long time in large corporations. There are many checks and balances in place, with good cause. However, if someone wants to accomplish something, it can be very difficult to satisfy everyone. And so this is how most of my weeks were spent at Boeing. I had to understand the "players" of the game and what they wanted, and decide the best way to satisfy all parties involved in order for my changes to be accepted. Through this process of working through checks and balances, I greatly improved my soft skills and became much more comfortable working and talking with high-level individuals within the company. And all that I had learned during my time at Boeing, as well as throughout my time in high school, prepared me for the most important meeting in my internship, in which all my work and learning had built up to for the past five weeks.

As part of the checks and balances system, I was required to bring my proposed changes to a council, in which it would be determined whether or not my revisions would be accepted and published. And this council is composed of executive members of the Boeing Company, such as Dr. Sargent. This was the big moment. When I was called, I stood up, and walked toward the board, where my slideshow was being projected. This was not anything new to me, as I had done this countless times at Da Vinci Science High School, a school built upon project-based learning and presentations. I smoothly ran through both of my presentations, and at the

continued

MAKING A CHANGE HAPPEN...IN A DOCUMENT

continued

end of the meeting in front of the other council members, Dr. Sargent made a remark about how well I presented, and how calm, collected, and clear I was. In addition, when Dr. Sargent was assigning my mentor, Dr. Chahriar Assad, a follow-up task, he suggested to Dr. Assad that I be tasked with that assignment. And this validated the one idea that I had heard the most from engineers. That if one works hard, it will pay off and the opportunities to do more high-level work will come his or her way, and that is how one makes a lasting impression on others.

Now, my internship did not consist of just that singular task. There were many training sessions made available to interns to help peak their interest in the different disciplines/fields of school's FRC program, Team 4201. There, I do lots of hands-on mechanical related work, and this composites training really grabbed my interest and fascination right away, due to the interactive nature of it.

Yet, it wasn't just these training sessions that helped shape my view of college and engineering. There is also a program called LINC, in which interns are grouped randomly with one or two engineers and throughout the course of the internship, interns are able to ask their mentors anything and everything they want. And it feels much more genuine and relatable when these discussions are happening in smaller groups, where everyone gets the chance to really know each other and become very good friends. On top of this friendly and open aspect of LINC, groups can choose to partake in a challenge, created by Boeing engineers and LINC mentors. Together, these LINC groups work with their mentors and fellow peers to create pitches that could be potential solutions to the challenge. And these challenges are aimed at real-world space problems. Problems that future engineers, such as the interns today, will have to solve in the near future. So these challenges really cultivate and foster these ideas which can improve our world greatly in the years to come.

Patrick Jackson, Hana Meroth, Matthew Chan pictured with LINC mentor Jereme Barnett-Woods

Throughout it all, with all the different aspects of the internship, I learned a great deal. And the lessons that I learned weren't what I was expecting. I walked into the internship believing that I would leave Boeing (for now) with lots of technical experience and information. And while that was true to some extent, that was not the entire case. Instead, this internship taught me many people skills, what it felt like to work for a large corporation, how to follow through with an idea and actually make it happen, and how I should view and approach college. While this was all very important, I walked away with something much more valuable that I can apply to any aspect of my life: the desire to want to learn more about everything. That, by far, was the most important takeaway from this internship.

Commendation for Matthew Chan

The original task that he already completed was an engineering task that included rewriting Boeing PROs, understanding the details involved, engaging the stakeholders, getting their approvals, and taking the final updated PRO to the Enterprise Process Council (EPC). He presented and defended his changes to the current Qualification process to the EPC all on his own. His changes have already been accepted by the counsel, and now the new PRO will soon become part of everyday Boeing process. Thus, I wanted to take this moment and bring his achievement to your kind attention. This task that was assigned to him, would generally be assigned to a level III engineer at the minimum.

—Chahriar Assad

TEAM DESIGN CHALLENGE

By Henry Rosas, Bosco Tech High School

Team UAV members Benjamin Tait, Christopher Valdivia, Skylar Winig and Logan Hayes present their award winning concept. Not pictured: Jack Bernardo

Many of the training sessions that took place during the course of the summer internship allowed the interns to work in a hands on environment in order to experience what it is like to be an employee at Boeing. The Team Design Challenge was precisely that: a chance for interns to showcase their presentation and brainstorming skills while innovating new ways to overcome real life scenarios in the engineering industry.

Broken up into six teams, each group was tasked with solving a hypothetical scenario as a newly formed Boeing team. From developing a secure cyber security network to creating a versatile air vehicle to provide aid during national disasters, these scenarios each included specific requirements that needed to be met. The interns were then instructed to create an original model of their solution from the various items scattered across each table in only thirty minutes. At the session's conclusion, they would be judged by a panel engineers who would evaluate them on their project's program management, finance, logistics, technical feasibility, and overall presentation.

As the timer started, signaling the beginning of the thirty minutes, the interns raced to their tables to begin piecing together exactly what their product and/or service would look like. Some groups started off by assigning roles to each member so as to streamline the creative process, while others jumped right into brainstorming what they needed to accomplish in the given time. However, all of the groups were cohesive in their decision to creatively make a product out of the items given to them.

The items on the table consisted of pipe cleaners, coin wrappers, construction paper, and an assortment of office supplies. One group, working on developing an AirCam Communication Device, used the folders and construction paper provided to them to model a phone-like device that would only activate when the caller's face was scanned. Another group, working on building a biofuel commercial airplane, used styrofoam strips to model the sound dampening pads that would surround the engine of the plane to allow for a quieter flight.

Even as the time limit grew nearer and nearer, the interns stayed focused on their goal of solving the problem presented to them. Presentation ideas were tossed around as the clock ticked on and interns solidified the concepts that they had just a few minutes ago created. Each aspect was to be taken into account, from the logistical practicality of the project to the creativity needed to make a spacecraft out of rubber bands and paper.

Finally, the time to present had come. One by one, each group gathered in the center of the room to present their design to the judges. With poise and confidence, the groups displayed their technical knowledge to the judges as well as their ability to think on the spot when asked specific questions. Like the real world of compressed schedules and limited resources, the six teams thoughtfully articulated their unique designs. Teams were expected to present their innovative solutions in a three minute pitch followed by a two minute question and answer period.

continued

TEAM DESIGN CHALLENGE

continued

Unmanned Aerial Vehicle (UAV): Christopher Valdivia, Skylar Winig, Benjamin Tait, Logan Hayes. Not pictured: Jack Bernardo

Cyber Security: Paola Prieto, Chloe Stonecipher, Max Shultz, Wesley Park, Patrick Jackson

Satellite Delivery System: Kody Bird, Jeffrey Shen, Aaron Dominguez, Jessica Reyes

797-11: Henry Rosas, Stacy Surace, Jiajer (Joseph) Ho, Sarah McKenzie, Joshua Maros

AirCam Communications Device: Saahil Parikh, Matthew Ramos, Robert Peltekov. Not pictured: Andrew Mills, Victor Velasco

Versatile Air Vehicle: Olivia Jo Bradley, RJ Wakefield, Lauren Kong. Not pictured: Noah Bernstein

LINC INNOVATION CHALLENGE

By Olivia Jo Bradley, Peninsula High School

Lindsay Crossan (LINC lead) and Jamal Madni (LINC founder) presents 2018 LINC Innovation Challenge recipients: Lauren Kong, Hana Meroth, Patrick Jackson and Matthew Chan

What is the future of satellites and space? That is a question that so many engineers ponder every day. This prompt was given to groups of interns by Jamal Madni, a program manager and business development lead who started the LINC program. Its goal is to facilitate discussions and relationships between experienced professionals and students who are looking into similar careers.

Nisha Chatwani, Charlotte Collins, Lucas Schaberg and Joy Uehara present during LINC Finals

To prepare, groups of interns met with mentors to use their imagination and knowledge to find the answer. LINC teams had to answer questions such as “What technological leaps will be made in your lifetime?”, “What will enable and empower this change? Socially? Economically?” and “What is Boeing’s role in the future of space? Explore? Connect? Defend? Inspire?” Teams researched and talked to engineers throughout Boeing to form their idea for the future of satellites.

Groups gathered together to present their ideas to a board of Boeing employees with a picture pitch, “Shark Tank” style. Students proposed moon solar farms, ways to remove space debris, stations to repair satellites, asteroid mining communications network, and commercial interactive camera satellites, just to name a few. A handful of these proposals moved on to the finals, where students pitched their vision of the future of satellites to Chahrair Assad, Danny Howard, and Hanish Patel. Students learned how to give an engaging presentation in a professional setting, with ideas backed by research.

“I learned so much by working with others in a professional setting and creating a professional pitch.” said Charlotte Collins, from Flintridge Sacred Heart Academy, whose team made it into the finals.

> “I found that brainstorming for the LINC Innovation Challenge was one of the highlights of my internship. It was so much fun to throw these wild ideas around and then put in the time and research to transform a crazy idea into something more feasible. I am grateful that this platform was provided to help our disruptive ideas come to fruition.”
>
> —April Lee
> Palos Verdes High School

In the end, the winning team was LADSAT, a satellite that used high energy lasers to deorbit space debris in LEO orbits, created by Matthew Chan, Patrick Jackson, Lauren Kong, and Hana Meroth.

Mentor Mike Czarnecki (second from left) meets with his LINC group of Max Shultz, Logan Hayes, Marta Maynes and Emma Hall during LINC Kick-Off Meeting

GRADUATION CEREMONY

At the conclusion of their seven weeks immersing themselves in the El Segundo Engineering Summer High School Internship Program, 58 interns celebrated their accomplishments and relived their experience at the graduation ceremony on August 3, 2018. Dr. William Sargent, Chief Engineer and Executive Sponsor for the program, welcomed several participating high school coordinators and administrators and shared the importance the interns are to the future of the aerospace industry. Dr. Sargent personally thanked the 39 mentors who volunteered their time and reiterated how valued this program is to the future of the Boeing Company in keeping the engineering talent pipeline full and sustainable.

Joining Dr. Sargent was guest speaker Chris Brown, Director of Space Electronics, who recognized and presented a medal and certificate of completion to each intern. He beams, "When I had conversations on Wednesday at the poster session, you were right there with me, technically. You knew your stuff and you presented yourself so well. You were confident, you knew how to address questions. So whatever you've done to learn how to present and be confident, keep doing it. That's what's going to get you through life; get you hired on your next job. So whoever taught you that whether it's yourself, or your parents, keep doing it."

Pat Sandoval, Program Manager for the Engineering High School Internship Program continued with the awards presenting both Best Overall Presentation and Best Technical Presentation awards to Bosco Tech's Joshua Maros where interns showed their work at the poster session which took place on August 1, 2018.

A special recognition, the Outstanding Performance award, was given to those interns who went above and beyond their assignment and tasks in support of the engineering high school internship program. In addition, recognized by leadership for their technical contributions The Outstanding Performance award for 2018 recipients were: Henry Rosas, Wesley Park, Victor Velaso, Sabrina Kardashian, Allyson Doyle, Logan Hayes and Matthew Chan.

> "When I saw your presentations, I was blown away. Every one of you are so impressive. You should thank your administrators and teachers who helped you get to this point. Then, your parents who put you on this path. You are on an incredible path."
>
> —Chris Brown
> Director, Space Electronics

Joshua Maros wins both Best Overall Presentation and Best Technical Presentation at the Poster Session

Guest speaker Chris Brown

Outstanding Performance recipients

continued

GRADUATION CEREMONY

Continued

Bosco Tech

California Academy of Math and Science

Da Vinci

El Segundo

Hawthorne

Mira Costa

Palos Verdes

Peninsula

Port of Los Angeles

Redondo Beach

Sacred Heart

South Torrance

Windward

PARTICIPATING HIGH SCHOOLS

CALIFORNIA ACADEMY OF MATHEMATICS AND SCIENCE

Jiajer “Joseph” Ho
Sanchita Kedia
Jason Morales

DON BOSCO TECHNICAL INSTITUTE

Aaron Dominguez
Devyn Espino-Canche
Patrick Jackson
Joshua Maros
Henry Rosas
Christopher Valdivia

DA VINCI

Eric Banuelos
Matthew Chan
Johnathyn Garcia
Emma Hall
Joy Uehara

EL SEGUNDO

Thomas Piibe
Matt Ramos
Maximilian “Max” Shultz
Chloe Stonecipher

HAWTHORNE

Tony Lee-Taylor III
Paola Prieto
Jessica Reyes
Victor Velasco

MIRA COSTA

Nisha Chatwani
Allyson Doyle
Nadia Owen
Wyatt Saltzman
Andrew Slater

PALOS VERDES

Noah Bernstein
April Lee
Hana Meroth
Wesley Park
Alexandria Pheiffer

PENINSULA

Olivia Jo Bradley
Lauren Kong
Jocelyn Ma (HB)
Saahil Parikh
Robert Peltekov
Stacey Surace
Robert Wakefield-Carl
Skylar Winig

PORT OF LOS ANGELES

Sarah McKenzie
Gabriela Murrieta

REDONDO UNION

Kody Bird
Henry Graven
Logan Hayes
Hetal Shah
Benjamin Tait

SACRED HEART

Charlotte Collins
Marta Maynes
Teresa Wang

SOUTH TORRANCE

Ariel Ben-Avides
Mohammed (Khalid) Mihlar
Andrew Mills
Stephanie Paris
Jeffrey Shen

WINDWARD

John Bernardo
Miguel Contreras-Aguirre
Sabrina Kardashian
Lucas Schaberg

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