Bons Episode #016: Former Astronaut and SDSU Alumna Ellen Ochoa Shares Her Story (Encore)

Announcer:

For this Bonus Episode of Fireside Charla, we share an encore presentation of Former astronaut and Johnson Space Center Director Ellen Ochoa inspired an audience during President's Lecture series, sharing her life's journey, from physics classes at San Diego State University to four Space Shuttle trips into orbit. Enjoy!

President de la Torre:

I am pleased that the university is able to honor Dr. Ellen Ochoa in this special way. On the recommendation of the faculty and on behalf of the Board of Trustees of the California State University, I hereby award you the degree of Doctor of Science with all the honors, rights, and privileges pertaining thereto. Congratulations, Dr. Ochoa. What an exciting day it is for SDSU. It's now my great pleasure to welcome you to today's President's Lecture Series. I'm glad to see so many devoted supporters of the university here today. A great reflection of the partnerships between the university and our community. Our university has been an integral part of San Diego for 122 years and one of the most important purposes of the President's Lecture Series is should hence collaboration between the university and the community. Through these collaborations, we are making discoveries and creating a better future. Through these collaborations, our students are learning how to improve the global society they will lead. Today, we are extremely honored to recognize and welcome back one of those graduates, Dr. Ellen Ochoa, Class of '80 and SDSU's 51st Honorary Doctorate Recipient. Before welcoming Dr. Ochoa to the podium, I'd like to share a significant contribution she recently made to our university with a $100,000 gift to establish the Ellen Ochoa Endowment for the Femineer Program in the College of Engineering. The Femineer program at SDSU is one of only 3 in the nation and works diligently to inspire and empower K-12 females to pursue science, technology, engineering, and mathematics in their education and future careers. The students are taught through project-based learning and are paired with SDSU female engineering mentors. Thank you, Dr. Ochoa for paying it forward and supporting our current and future STEM leaders. I would now like to excuse our stage party as we begin from San Diego State to space.

Dr. Ellen Ochoa:

Wow, what a great little video, thank you so much. Well first I want to start off by thanking President de la Torre, Dean Roberts, the Trustee McGrory, Professor Davis, for the honor and for participating in the ceremony just now. You know, I truly couldn't have imagined it. Thank

you to other university leaders today who are here today and a big welcome to all the students and all the supporters of San Diego State who have joined us this afternoon. You know, it's just amazing to be chosen for an Honorary Degree by my Alma Mater and when I certainly couldn't have imagined when I was a student here. And I also wanna thank the Gordon and Betty Moore Foundation because it's through the foundation that I was able to designate the gift for the Femineer Program.

I am on the Board of Trustees of the Moore Foundation and they allow Trustees to designate recipients for a gift. So it's actually the foundation's funds and I am very grateful to them that through them I was able to support such a wonderful program as the Femineer Program. I was really fortunate to grow up just a few miles away in La Mesa High School. I am a graduate of Grossmont High School. Go Foothillers! Any Foothillers here? Just to tell you a little bit more about my background, I think a lot of you know my dad's parents were from Mexico. They were married, had some of their first kids in Mexico. But by the time my dad was born, he was the youngest of 12, they had moved to southern California to the Anaheim area. My mom's from Oklahoma, but they had met in California. My dad was able to go to college because he got an appointment to the Naval Academy so his family wasn't required to pay for his college education and that was obviously very important to him.

Now, my parents divorce while I was in high school, and while they were both big supporters of education, certainly my mom is one who had just a huge impact on my life. She attended San Diego State really the whole time my four brothers and sisters and I were growing up here and she would literally come on campus for one class a semester, semester after semester, year after year. And for a long time it really wasn't in support of a degree, it was because she was interested in so many different things, and she was very grateful that there was a local university here where she could go off and do that and still raise our whole family. And I think that's something that I and all of my siblings really took away from that education was important, but it was also just really interesting. And the ability to be able to learn a variety of different things is something that serves us well our entire life. She did, by the way, eventually, you know, collect enough credits and made it into a degree and graduated two years after I did. So she has a degree from San Diego State as well.

And I should also mention that my sister, two of my brothers, and two of my nieces also have degrees from San Diego State. Thank you. So perhaps like many of you in the audience, this university has been, of course hugely important to my family and to many of your families as well. At Grossmont High School, I enjoyed my literature classes, my math classes, I was in the Concert band and the Marching band, but for some reason I had just decided that I wasn't interested in science, so I hardly took any science. I did not take Chemistry or Physics, and even though I was the top math student at my high school, nobody ever really mentioned to me like, "Well maybe you should study, you know science or engineering or something that uses math." And so I came to San Diego State knowing that I had a whole wide variety of departments and subjects that I could choose from. And as I said I was interested in music. I was also thinking about business. But I had the ability to take a lot of different classes while I

was here. And I was very fortunate also at that time that actually the state supported it so well that we didn't actually even have tuition and I got a scholarship from San Diego State that actually covered my books and parking and things like that.

So I was able to come here very affordably which, as I mentioned my mom was also in school here, my sister was in school here, my brother was in college and so, being able to do that was incredibly important to us. But as I came here one of things that I followed up on was taking more math classes. So I had taken the first semester of Calculus in high school and then I was able, I went on and took the next couple of semesters in the first couple years that I was here. By the kinda the time I got towards the end of the Calculus series, I thought, you know, I should ask other students in the class you know why they're in here. And of course they were in there because they were in general some kind of engineering major or physics major. I was like well I was just in here for fun, you know, trying to, you know, cus I liked it. So, you know, I was still kinda trying to decide what I wanted to do, and I thought, well I should go off and talk to, you know, go explore some of these other departments a little bit.

So I went to talk to a professor in the Electrical Engineering department at the time, who was this student advisor and told him you know I was interested in learning more about the department. And you know, you have to remember this was 1976 or 1977 and he was clearly not interested in having me in his department. He said, "Well, you know coursework is really difficult, and you know we did have a woman come through here once." And then you know he started picking components up off his desk, "You know you'll have to work with these." And to be honest, I really had no idea what they were. And you know really didn't tell me anything that was relevant to me actually learning about Electrical Engineering. Well I went to the physics department and had quite a different experience.

I had taken one physics for non majors class and so I was actually talking to that professor and first of all he said, "Well you did very well in my class. Tell me a little bit about what math background you've had." And so I said, "I'm finishing up the Calculus series and I have the top grade in the class." And he goes, "That's fantastic." He said, "Because you know math and calculus in particular is the language of physics. So if you started into the Physics series for majors next semester, you know you'd be able to concentrate on the concepts that we're teaching whereas most of the people in that class will be taking calculus and physics concurrently and they'll be trying to learn the language and the concepts at the same time." And he said, "You know, I think you'd probably do very well." And then the other thing that he talked to me about was what kind of things do people do with physics degrees, different areas that you can go into, different kinds of jobs that you can have.

And that was incredibly important because I didn't know any scientists, I didn't know any engineers. I honestly had just no concept of what it is that you did with a physics degree, which is probably one of the reasons I hadn't thought about it prior to that. So, I think you can tell that the kinds of conversations that professors and advisors have with students are incredibly powerful and it probably doesn't surprise you that I thought, "Well I'll give physics a try." I

actually never made it back to the engineering department till today. But, so, you know I transferred to physics and really had a good experience there. And one of the things that we did in physics before you graduate is in senior year you have a senior project, a research project. So it gives you a chance to do some research and also to explorary in a little more depth. Through one of my math classes, I was a math minor in Fourier Transforms. I got very interested in learning a little bit more about Fourier Optics and how lenses can take Fourier Transforms and how you can build optical systems to extract information from images. So I ended up doing my senior project in that area with a fairly new professor here in the Physics department. But he joined us up here just a few minutes ago, Professor Jeff Davis, and he's still teaching here introducing students to optics.

So that's really how I got my start. And then, you know as you see there's bulletin boards in all of the department offices around here and through notices that I saw on the physics department bulletin boards, I got some different summer jobs where I had a chance to do some research. One was actually in a biochemistry lab in UCSD and a Fellowship Through the American Heart Association. So it wasn't quite in physics, but it was a chance to do research in an actual laboratory. And then I spent two summers working at Los Alamos National Lab again through, you know, a sign I saw on the bulletin board in the physics department about that opportunity. And those were great introductions to research and I decided I wanted to go on in research and sort of go down the path of being a research engineer.

So, I went off to Stanford for graduate school. There's a very well known professor there that actually wrote the textbook on Fourier Optics so he became my thesis advisor. And I really had a wonderful experience at Stanford as well. Oh, one more thing I needed to mention about San Diego State was my great experience two years as a Marching Aztec and five years in the Wind Ensemble.

So I was telling somebody earlier at lunch that, you know they were like, "What did you do for like stress relief while you were in school?" And I said, "Well I think I had four solid semesters where I was taking four physics classes, a physics lab, and Wind Ensemble and it was really nice to get to Wind Ensemble. Just needed that different part of me you know to sort of deal with everything. So off at Stanford, I also had the chance to play music there, which was one of the reasons I picked Stanford.

But the end of my first year there, is when the Space Shuttle flew for the very first time, and of course that was a very different kind of spacecraft that had ever flown before. And it could do a variety of different things: it could launch satellites, it could retrieve them, it coule help build structures in space. But a big part of what it was gonna be used for was as a laboratory to do science and engineering research in space. And since I was on track to become a research engineer, to me, you know the thought of being able to do research in a unique laboratory, experiments you couldn't do anywhere else because of either you were in a microgravity environment or you were above the Earth's atmosphere or you had access to almost a complete vacuum, you know was just very exciting.

But still, you know I was really just starting into my Ph.D. program and wasn't giving that much thought into what I was going to do afterwards. But a couple years later when I was about halfway through, Sally Ride flew in space, first American woman, and that was a huge deal. In fact, a few years earlier when NASA had selected the first group of astronauts to train specifically for this space shuttle, which was under development then, that was the class that included the first six women and also the first minority astronauts and I was here at San Diego State at the time and those were just huge milestones because these were careers that just weren't open to women before that. It didn't matter you know what you did or what you studied or how hard you worked, they weren't open to women, and now they finally were.

So I made the decision that as soon as I finished up my Ph.D., I would apply to NASA. So I did, I got my doctorate, applied to NASA, figured I'd never hear from them again and went off to work for Sandia National Labs in Livermore, California, which is a department of energy labs. You know, as a research staff member in the area that I was in, or the building that I was in, which included a few different research areas, there were sixty members of the professional research staff and I was the only woman there, which, you know, the odds weren't too exciting but they have gotten better throughout the years.

A couple years later, I was contacted by NASA actually to come interview at the Johnson Space Center, so that was my very first opportunity to be at any NASA center and particularly the one where human space flight took place. Had the chance to talk to astronauts for the first time, to really find out more about what the career was like because really you know what you see on the news but you don't really have a good idea of what it's like. Got to see a lot of the training facilities and got a very very thorough medical evaluation. So I wasn't selected during that selection, that was the 1987 Class, but I could also see some areas where I could get experience that might help me as I'd try again. One of those was, I really didn't have any operational experience.

You know, I was a researcher, I worked in a lab, you know, I wrote technical papers, went to conferences, and those were all very good backgrounds, but didn't really have any experience, you know in a real time environment. So I went off and got my pilot's license and also decided I wanted to work for NASA even if I was never selected as an astronaut. So I moved to NASA Ames Research Center, which is also in the Bay area in California and had the chance first to be a member of a research group there and just a few months later, to head up a research group of about thirty five people that were all working in some area of high performance computing, potentially for space missions.

So three years later, NASA had their next astronaut selection and I was called again to interview, and that was the year that I was selected in 1990. So along with twenty two other people, I went off to Johnson Space Center in Houston, Texas. And the first year we basically all trained together kinda as a class, and a lot of it was a lot like school. And I had spent ten years in college, so I was really good at school. And you know we got a big stack of workbooks to read through about all the different shuttle systems. And we had lectures, and then we were

working one of one with trainers to understand more about in detail about the shuttle procedures, the cockpit, you know, when you use which switches, you know, how you recovered from malfunctions, and there were about 2,000 switches, including circuit breakers in the space shuttle flight deck and mid deck.

So it wasn't just like ten. But there were other parts of the training that were, you know, very different than anything I'd ever done before: learning to fly in a high performance jet, learning how to eject out of an aircraft, how you would land under a parachute, actually getting to be picked up out of the water by a Coast Guard helicopter. So I mean I hadn't even been a Girl Scout. So those were things that were pretty far outside of my experience, not to mention comfort zone. But the nice thing was once you made it through the selection process, NASA actually wants you to succeed as an astronaut, they want you to learn the skills that you need and be able to demonstrate them. So people were very helpful, including my astronaut classmates, a lot of whom were from the military.

We were about half military, half civilian. And so it was a very interesting, fun, and challenging experience overall. And then after that first year, we spent a second year doing part time training and getting more specialized. So one of the things I started training on was the robotic arm. And then we were assigned jobs that supported the ongoing shuttle mission. And then at the end of my second year or so, I was assigned to my first mission. And my first two missions were really kind of exactly what I was thinking about when I first thought about wanting to be an astronaut and applying for the program, because it was an opportunity to do research in space that couldn't be done on the ground. And we were specifically studying the earth's atmosphere and the problem of the Ozone hole and Ozone depletion. And so, we had a suite of instruments in the payload bay that were measuring many different constituents in the atmosphere. And we were using the sun as the light source.

So, every time we did a sunrise or a sunset as the sun sort of came up through the atmosphere disappeared behind it, that was the light source for many of these instruments that would allow them to collect information and understand what kind of constituents were in the atmosphere. And of course, a lot of what we were particularly looking at was byproducts of chlorofluorocarbons from aerosols that people were using. And, of course, this was at the time when the U.S. and many other countries were cutting back on the use of aerosols because they signed a protocol understanding that this was really harming our upper atmosphere and destroying the upper atmosphere, the stratospheric ozone.

That's like the good kind of ozone that you really want to have there because it prevents damaging ultraviolet rays from damaging humans and other things on Earth. So, we were able to contribute to that and also measure the amount of light coming from the sun in many different wavelengths. And particularly the ultraviolent because that is the wavelength that provides the energy for the chemical reactions that both create and destroy ozone. So, it was really exciting and gratifying to be on those two flights. My third and fourth flights, a few years later, were now part of assembling the International Space Station. So, during the time I was flying on my first

couple of flights, the U.S. and particularly NASA joined up with the Russian Space Agency, Roscosmos, to develop an international space agency. NASA had already been involved in developing a space station, which we were calling at that time, Space Station Freedom.

And we were working with the European Space Agency, the Japanese Space Agency, and the Canadian Space Agency. Well now, we had kind of changed. We were asked to particularly form this partnership with Russia, because this was shortly after the end of the Cold War, and both countries were looking for opportunities for their scientists and engineers to work together on a peaceful collaboration. And that became the International Space Station Program. And actually, one of my roles in the office was to lead the astronaut office support to the space station program at this time.

This was actually even before any part of it was built, although it started to be built during these years. And one of my jobs was to actually negotiate with members of the Russian Space Agency and their contractors on, you know, how were we going to select crews? How were we going to train them? Where are we going to train them? What language? Who was going to decide on the curriculum? How were we going to operate in space? What, you know, what language were we going to speak? So it was an incredibly interesting time and something I had really never thought about being a part of earlier on when I was interested in the astronaut program. And then I was fortunate enough to be on two flights that were part of the assembly of the International Space Station.

So, one of them was the very first shuttle mission to dock with the station. The second shuttle overall involved with the assembly. So at that time it was just two pieces, one Russian, one American that were put together. It was about 40 feet long. Nobody was living on board because we didn't have a habitation module yet. So, our crew which was multinational and included a Russian cosmonaut and a Canadian astronaut, went up to bring a number of supplies to leave inside the station as well as some on the outside, in preparation for the first crews that would be living up there. And then I got to go back three years later. Now the space station is inhabited. We completed kind of what we called Phase I of the assembly. So we had the U.S. laboratory on board. So, we were able to do experiments. We had one large solar array up there, so we were able to power the lab.

We had an airlock so we could stage space walks from the station, not just from the shuttle. And so, there were a lot of things that we could do but we had quite a bit of assembly to go. And in particular, we needed to be able to accommodate another full laboratory module from the European Space Agency and yet a third one from the Japanese Space Agency. And we needed to be able to power all of these laboratories. So, we needed to bring up three more large solar arrays, and by large, they're actually 240 feet long. And so, we needed to build out a big truss structure. It's about 350 feet long in total so we can hang these solar arrays off of it and complete the International Space Station. And our job on this mission was to bring up the very first piece of that truss structure. And in just a few minutes, I will be showing a video from that flight that gives you an idea of how we did that. But before I show it, I'll just continue on that, not

only was I able to participate in these two missions, but I had the opportunity really throughout the rest of my career at NASA, to in one way or another, support the International Space Station Program. I also worked as the lead person of the astronauts who work in Mission Control, who are the ones who actually speak to crews on orbit. And so, we had to figure out how to transition from supporting in Mission Control just when the shuttle flight was up. So, maybe ten or twelve days, every few weeks, to 24/7 operations. And our first crews arrived at this space station in November of 2000 and we've inhabited it ever since. So, if you think about people who are freshman or even second-year students here at San Diego State, every moment of their lives there have been people in space. So, we really are a spacefaring country, and we have learned, excuse me, so much about living and working in space by being there. You know, next month it will be nineteen continuous years that we've had people in space.

And after those jobs, I was offered some management and leadership positions at Johnson Space Center, including eventually becoming the director of Johnson Space Center. And of course, Johnson Space Center is the home of the International Space Station Program office. So, everything that happens on the station really is run through Johnson Space Center, home of the astronauts, home of Mission Control. We're responsible for human health and performance in space.

We have a large engineering group that supports not only the station, but development of future vehicles, including the Orion spacecraft and many more people, all of whom are really focused on human space flight. So, a big part of my job was making sure that everybody, you know, was focused on our mission of human space flight, that we kept our crews safe and productive in orbit, and that we were looking forward to what was coming next in human space exploration in addition to taking care of the whole team there. So, it was, you know, such a huge privilege to be able to, I don't really think of leading them, I think of serving the people at Johnson Space Center because they're so talented, so dedicated, really passionate. So, mostly you just try to get them what they need, stay out of their way, and they will get the job done. So, with that I would like to go ahead and show the video, if we can start it. I'm going to narrate it. And again, most of it is focused on this flight that I was talking to you about. But there's also this footage at the end of what the station looks like today. So, this is our crew. This was in 2002. STS-110. As you know, all the shuttle missions were numbered, so that was our mission. And we're getting ready to launch here. I was the flight engineer on this mission so I was kind of the one in the center there in the second row.

So, my job is to work with the commander and pilot during the dynamic phases of flight during launch, during landing, during rendezvous with the space station. We kind of work as a team, particularly if there are any problems. We have to work through them with the procedures that we have and working with the ground. So, the shuttle's a combination of solid rockets, the white rockets on either side of the main tank, and then the main tank holds liquid fuel, liquid hydrogen, liquid oxygen and fuels the main engines that you see here, the three main engines.

So, the solid rocket boosters burn for about the first two minutes and they provide about 70% of the thrust during those first two minutes, but then they're all out of fuel. They separate away, go into the ocean and were refurbished for future flights and we get the rest of the way into orbit on the liquid engines. And then we spend about the first day and a half rendezvousing with the International Space Station. So, you saw a burn there where you have to kind of hold on when you burn the engines so that you don't go flying through the cabin. But the commander here, Mike Bloomfield, the pilot Steve Frick, and I, again, are working together during this rendezvous phase. Here's what we looked like from the space station's perspective. And you can see that big piece of the truss structure really takes up the whole payload bay. We referred to it as S0. And then this is what the station looked like to us as we were coming up to it. We're gonna attach to that silver ball as kind of in the upper center of the view there. And here's what it looks like looking out the F flight deck of the shuttle windows just before contact. We're coming up to the space station.

So the space station's the upper part. The ring is attached to the shuttle there and we make contact. We spend about 10 minutes pulling the two vehicles together and then about two hours doing a leak check. And our commander was very happy with his flying skills. And then we open the hatch and that's the commander of the space station, Cosmonaut Yury Onufriyenko. So, those are the two commanders. And we had the chance, there were two other people living on board this station, actually members of my astronaut class. So, it was great to see them. They'd been on board about four months. So, I think they were happy to see some new faces. You know, a week later, I think they were just so happy to see us leave. You know, it's kinda like when your relatives come for the holidays. So, we started transferring supplies. You can do it between your knees, not just in your hands when you're floating. And then the next morning was, we really started into the major part of our mission. And I'm operating the robot arm along with another astronaut. And so we were using the station's robot arm to pull S0 up out of the payload bay and get it ready to attach to the station. This is what the robotics workstation looks like. It's in the middle of the U.S. laboratory at this point. It got moved later. And you can see, actually there's no windows that you can look out and actually see what you're doing. So, you have to try to find some camera views that give you an idea of what all the different joints of the arms are doing. And then you have to not be distracted by, oh that's the Nile River back there and the Gulf of Aqaba. It's really important not to be distracted by that.

But here's the final part. We're moving S0 really onto the top, the zenith part of the station. And then that claw on the right's going to attach around a rod and that will be the very first part of the connection. And that's Astronaut Dan Bursch. He was actually the one that had the controls of the arm when we did that final attachment there. And then so, over the next week as we were attached to the station, our crew did a series of forced spacewalks. And we used the robot arm during all of these. So, I was inside operating the robot arm and we always had a crew member attached to the arm. So, moving them around. And what we had to do was form the final structural attachment of S0 to the station, so we added cable trays, we bolted down some struts, and they had a ton of different kinds of cable connections to make in order to power all the equipment on the truss to allow us to send commands to all the equipment and to get telemetry

back. So, just a whole lot of different connections that were made in order to really bring the truss piece to life. Here you can see a drill be used to bolt down the struts, actually. There's actually a person on the end of the arm there holding a piece of equipment that looks like a v. Just kind of giving you a different perspective.

They had a really good view of the Earth as we were moving them around, of course. And then this is what it looks like inside the station at the end of a spacewalk when you bring the crewmembers in and you're about to get them unsuited. Now this is on the shuttle side, remember the shuttle's attached to the station. It was rodeo time in Houston, so we brought up a Houston barbecue and invited the station crewmembers over and kind of had a nice evening. Another astronaut, Rex Walheim, he's showing off his two little boys doing a video conference with home. Astronaut Steve Smith shows you what liquid does when you let it loose in the cabin in microgravity, of course the surface tension takes over and forms that big sphere. And then at the end of the week we completed all of our tasks and so we were gonna get ready to undock, so we're closing up the hatches in preparation for that. And then again, the commander and the pilot, Steve Frick and me are working on the undock. This is the target that the pilot uses to back away and tries to stay in the right corridor. And so our job was to back away about 400 feet, wait for sunrise, and then do a complete flyaround of the station, taking pictures the whole time so that we'd have very good photo documentation of the station for future assembly missions.

So, you saw there, maybe, how quickly sunrise happened when you're going 17,500 miles an hour. It just takes a couple seconds. And again, here's a view of us from the station, and you can see our payload bay was empty. This is what the station looked like to us when we were about halfway through that flyaround. Some of the cameras and laser-ranging devices we're using during this part. And this was probably our final good view of the station, and that rectangle in the middle is what we had just added to the station. So after that, we did a burn and moved much farther away from the station. We spent a day checking out all the systems that are needed for re-entry. And then this is the final morning of flight. We're closing the payload bay doors, we're getting in our seats for the landing.

First, we get in these special suits that we use just for launch and landing, which can help protect you in certain kinds of emergencies. And now here's the very final part of re-entry. We've already come through the atmosphere, and we're over Florida, and if you can see the heads up display there, we're going about 290 nauts passing through about 13,000 feet here. And now you can see the runway of Kennedy Space Center, the shuttle landing facility. And then this is really the very final part, as we're coming in over the runway when we hit about 200 feet, we actually flare up.

And remember, we have no engines running, so there's no power at all. We're really a big glider, kind of closer to a rock in terms of how aerodynamic we are. So we're dropping very, very rapidly, which is why that pull-up is so important. But the point is, we are going to land and so we want to land on the runway. And we want to land at approximately the right speed, which is a

little over 200 nauts. And so, our commander again, Mike Bloomfield did a great job. And we used these drag chutes to help protect the tires and brakes during the rollout. Fortunately, we do have a three mile long runway there, which helps make the rollout successful. So that was the 11 day mission of the STS-110. Thank you. So, this is what the station looks like today. This is an actual photograph of the station in orbit. It's about a million pounds. You can see how long the truss structure is now. You can see the four solar rays that I talked about and the many more modules that are up there, laboratory modules and storage modules. So, there's just a whole wide variety of research going on. Some of it is on the outside. This is the Alpha Magnetic Spectrometer, which collects cosmic rays to understand more about dark matter and dark energy in the universe.

This is the inside of the U.S. Laboratory and it just gives you an idea of some of the different science facilities that allow us to do just a whole wide range of different types of research. This is Astronaut Peggy Whitson. She is working with stem cells, which are being turned essentially into cardiac cells to understand more about how they work together to contract as heart muscle. Astronaut Kate Rubins. She was the very first one to use a DNA sequencer that we sent up to station. And you can imagine how important that will be on long duration missions to Mars, for example, where we can measure astronaut health as well as the health of spacecraft itself. This is Astronaut Kjell Lindgren. He's working with a flame experiment. And flames look quite different in space than on Earth as you see here.

And they also have two different regimes in which they combust. Sort of a high temperature one, and then again in a low temperature one. So, something that you actually don't see on Earth that we have the chance to investigate. Astronaut Scott Kelly is working with the freezer that we have where we collect samples, primarily biological samples, that we want to return to Earth that are part of some of the experiments that we are involved in. Joe Acaba is working with the capillary flow, understanding how fluids move in microgravity environments, which are really important for satellites and fuel for satellites. Some other types of experiments, a lot of universities' students have written algorithms for this experiment called, "Spheres," which we can then test out, which allows them to understand how objects can move in space. We have a 3D printer. I think this was the first generation one. I think we now have the third generation 3D printer.

Again, something you can imagine how important that would be on a two or three year mission to Mars. We have a number of experiments looking at the Earth that are on the outside of this station. That one in particular was looking at wind direction on the surface of the ocean. But we have many more others as well. We've deployed, I don't know, well over a hundred cubesats for companies, for laboratories, universities, even one elementary school that developed a cubesat. And NASA itself is a customer of the International Space Station. And so we're trying to understand more about long duration space flight. We flew this module from Bigelow Aerospace using technology licensed from Johnson Space Center to understand about expandable modules. We've also been growing plants, primarily lettuce, but also flowers. We can learn more about plant physiology, but also we want to understand how to provide fresh food for long

duration missions. The astronauts themselves are subjects for a lot of these experiments and it is really important for them to exercise a couple hours a day to preserve their bone mass and muscle mass. A few years ago, Scott Kelly and Cosmonaut Mikhail Kornieko spent just about a year in space, 340 days actually. And again, this was trying to learn more about human health and performance in space and what happens over time. So they're still actually analyzing a lot of the data, but there's a number of papers out about that.

All astronauts, whether on the ground or in space participate in educational activities. And so there's down links going on quite frequently with schools across the countries, and of course, around the world, as well. And I mentioned that there's a number of experiments on the outside that are studying the Earth and astronauts are contributing to that as well by taking their own photography. And you can actually follow the astronauts on social media, on Twitter, Facebook, Instagram.

They're sending down photos everyday of the Earth as well as of experiments that they're involved with on the International Space Station. So, if you're not following any of that, I would encourage you to do so. We have commercial partners, where we buy services to develop cargo. You just saw this SpaceX Dragon. This is the Northrop Grunman Cygnus vehicle. So for the last few years, they've been sending up supplies. And another company, Sierra Nevada, is developing this Dream Chaser, which I think is planning to fly in 2021 to deliver cargo. And then we have two companies which are developing services to send our astronauts. So this is a simulation. This is the Boehing capsule that's being developed, the Boehing Starliner. And then SpaceX is developing the Crew Dragon. And we hope to see test flights with our astronauts by either at the end of this year or sometime in the first part of next year. So, definitely something to be looking forward to. Really an exciting time to be in aerospace because of so many different companies that are contributing. Meanwhile, NASA's moving on beyond lower orbit. Johnson Space Center is involved in the Orion Program, which is this spacecraft right here. And another center's developing that heavy lift launch vehicle that you just saw there, SLS. And the two will fly together for the first time in 2021, and then hopefully just a year or two after that, the first mission with crew on board. So, looking forward to going out beyond lower orbit, initially to the moon and onto Mars. And with that, I want to thank you very much for your attention today. It's been my pleasure.

Dr. Jeffrey Roberts:

Thank you, Dr. Ochoa for your inspiring presentation. I would now like to open the floor to questions from the audience. You will see two microphone stands located in the aisles, and please line up between one another and we will take as many questions as we can for 15 minutes. So, don't be shy, high school students, especially! Grade school students! Okay. Stand on up. In the red there, tell us your name please.

Volunteer Speaker:

Giovanni.

Dr. Jeffrey Roberts:

Hi there. What would you like to ask?

Volunteer Speaker:

How do you think you are changing the world for women?

Dr. Ellen Ochoa:

Well, I kind of described to me how important it was for me to see Sally Ride and some of the other first women astronauts. And what it really gave me was sort of the courage and the inspiration to think about doing something really exciting and challenging with my life. And so, I hope that me being here and the many other opportunities that I have to talk to students, that I'll have the same effect on students as they think about their future. And they realize really almost anything is possible. I mean, I really could not have imagined this career even when I was a student here at San Diego State.

Volunteer Speaker:

Thank you.

Dr. Jeffrey Roberts:

Thank you. Young gentlemen there in the white.

Volunteer Speaker:

Hi, thank you. I was wondering, so what preventative measures did you do for the ISS to prevent like deterioration over time, because I think I read up about the Mir Space Station. And that was only in orbit for like nine years or something because of different bacteria and extremophiles and I was wondering, since you're such a big part in making the new space station, like what kind of ways did you do to prevent that?

Dr. Ellen Ochoa:

So there's a variety of things and there's different things that contribute to, you know, the space station sort of getting old, if you wanna speak. Certainly, a big part of keeping it going and keeping the astronauts healthy is having clean air and clean water. So, we have systems inside that scrub carbon dioxide out of the air that provide oxygen. And also provide clean water for the

crew. And we actually even have a system, you know, that recycles not only water, but moisture out of the air. Recycles urine, so what the astronauts joke is, you know, we turn yesterday's coffee into tomorrow's coffee.

Volunteer Speaker:

There you go.

Dr. Ellen Ochoa:

So, but it works very well and in fact, you know, it's actually used in communities here on the Earth. Particularly in more remote or rural communities where maybe they don't have access to clean water and they're using some of the technology and systems that have been developed for the International Space Station Program. And then you'll also have to worry about, just on the larger scale, structural issues and loads because we have spacecraft either docking or undocking on the average of every three weeks. And that all puts loads on the station. So, we have a lot of really smart structural engineers that try to understand, you know, the loads that the station undergoes and tries to make sure it's safe to continue operations. And they think there's many many more years of operations that's possible. Of course, we need to continue to be funded to operate it as well.

Volunteer Speaker:

Thank you.

Dr. Jeffrey Roberts:

We'll go to the other side, please.

Volunteer Speaker:

How does it feel to be a woman and be the director of NASA, when most of your employees are men?

Dr. Ellen Ochoa:

Well, so first of all, about a third of our employees are women, so the ratios have gotten a lot better. And even when you look at the people who are in science and engineering positions, at least a couple of years ago, it was about 28% or so. So, not quite three out of every ten, but we do pretty well, but we still want to continue to diversify our workforce in just the same way that we're trying to get more women to study science and engineering and math in high school and in college. But you know what? I never felt, by the time I became director, first of all, a lot of people knew me. You know, I was at Johnson Space Center for a number of years. So, I don't

know that they looked at me so much as a woman, but more as like, oh well that's Ellen. We know what she's done. A lot of the work that I accomplished either as an astronaut or in other leadership positions before I became director, I think it gave people an idea of what kind of a leader that I would be. And so I really didn't have issues with being a director of the center, even though a majority of the people there were men. And I think I mentioned earlier, that, you know, we just have such a dedicated workforce. People are really passionate about supporting human space exploration and they're there because they want to accomplish missions. And as long as they were convinced that that's why I was there too, you know, it was easy to lead them.

Dr. Jeffrey Roberts:

Thank you. Please.

Volunteer Speaker:

So what are the psychological effects of going into space and how do you feel when you return to Earth?

Dr. Ellen Ochoa:

Well first of all, let me just say that, you know, my longest mission was eleven days. And right now, we have people, the average stay on the station is six months and occasionally people stay even several months beyond that. So, my experience is going to be different than somebody that has spent six months. But I didn't think there were a lot of psychological aspects. To me, you know, I prepared for this mission, I trained with my crew, and now I was up there working really hard with my crew to carry it off. And you stay very busy and you know, you're really, it's really a mental job. You know, you're focusing really every moment of every day on all the procedures that you're doing because you want to make sure that you're doing everything right. And if there's any small issues, and there's always small things that go wrong, you know, where some piece of equipment isn't working quite right and you're trying to work through it. So, I think, you know, in space you're really just very very focused on the job. And so, you know, and I was there with other people, so it wasn't like I was alone, or you know, wondering, you know, kind of what my place in the universe was. It's like I had a job to do and I had a team to do it with and I was really focused on that. And then coming back to Earth, you know, there's definitely some physiological changes. And again, if you come back after six months, they're much more extreme than what I experienced. But, you really do forget how strong gravity is, you know, when you're floating around for a few days. And so, you know, just standing up or walking straight, or leaning over, well actually leaning over's easy, it's not falling over when you start to lean over. That's a little bit hard. So you have to sort of re-adapt to gravity.

Volunteer Speaker:

Thank you.

Dr. Jeffrey Roberts:

Thank you. Do I see a Girl Scout there?

Volunteer Speaker:

Since I am one of the billion Girl Scouts, I want to know, what is it like to be one of the space icons?

Dr. Ellen Ochoa:

Well congratulations on being a Girl Scout. I wasn't one but I will tell you, a large percentage of the women astronauts have been Girl Scouts. And I think a lot of the skills that they'd learn are Girl Scouts are something that have really helped them, you know, throughout their whole lives. So, you know, it really gives you the opportunity to learn some new skills, learn about new subjects, and you know, I mean I don't go around thinking of myself as an icon, you know, on a day to day basis. But like I said in response to an earlier question, I know how important it is to me to see women and underrepresented minorities in jobs that they hadn't been previously been in and that gave me the opportunity to really think about it for myself. And so, I'm just really happy that I can inspire others to do that too.

Dr. Jeffrey Roberts:

Thank you. This side.

Volunteer Speaker:

Are you allowed to like, is it easy to break a leg in space?

Dr. Ellen Ochoa:

Well, so you don't fall down and trip, so it would be harder to get injured that way. But you certainly could get injured in space. And so one of the things we always have to think about is how are we going to provide medical care to our astronauts on orbit? So, for example, every time we had a shuttle flight, two of our crew members were trained on some medical procedures. And, of course, we had the opportunity to talk to doctors on the ground. On one of my missions, I was actually one of the medical doctors, which was a very scary thought for my crew members. So, when people go off for six months on the station now they have quite a bit more medical training than I received for example, for being a medical officer on a shuttle mission. But one of the things we have to think about is when we go to some place as far away as Mars and we're gone for maybe two or three years, how exactly we're going to provide medical care? And so, we actually have a group at Johnson Space Center that their job is to

look at that and they try out some of the training and some of the equipment and some of the techniques on the International Space Station.

Dr. Jeffrey Roberts:

Thank you. This side.

Volunteer Speaker:

My name is Steven, and would you ever, when you're in space, would you ever want to visit the moon or Mars?

Dr. Ellen Ochoa:

Well, sure. I would've loved to have done it. Now the space shuttle was not a vehicle that could go to either the moon or Mars. It was developed specifically to be in orbit around the Earth and to do a variety of tests there. And of course, landing on the moon, you don't need or want wings because there's no atmosphere on the moon. And so wings are for, you know, planets and other bodies that have an atmosphere. So you think of a very different kind of vehicle if you're gonna land on the moon. Now Mars is very tricky because it has an atmosphere but it's much thinner than Earth's. And it's kinda like the exact wrong kind of atmosphere because it's thick enough that it causes extreme heating on the outside of a spacecraft coming in for landing because you're coming in so fast. So you have to figure out how to survive that heating. But it's not really thick enough to slow you down that much. So now you have to figure out how to slow down too. So we have landed, as you may know, rovers on Mars. And it's always kind of dicey whether or not they're going to survive that landing. When we land humans, it's going to be a much bigger, much heavier, kind of spacecraft that's going to need to land. And that's actually one of the big technical challenges of sending people to Mars is how we're going to land them safely.

Dr. Jeffrey Roberts:

Thank you. One more Girl Scout here.

Volunteer Speaker:

Are you able to keep in touch with your family when you're in space?

Dr. Ellen Ochoa:

Yeah! We are. So when I was flying in space, we mainly did it through email. And the folks on the ground in Mission Control, you know, a couple of times a day. So we'd write messages in space, for example, and a couple times a day they would download them, and they could get

them to our families and sort of vice versa. And each time I went into space, I got one either phone call or sort of a video call with my family. Now today on the International Space Station it's quite a bit better. So for example, people can call any phone number on Earth from the International Space Station as long as they're in sight of a communication satellite, which they are almost all of the time. So people can call their families, you know, most of our astronauts have kids. Maybe they're in a big sports event and they're able to call their families and call their sons or daughters after that and check in. And so, they're able to use the phone. And then, I think, once a week they do a video conference with their families. So that's all in addition to also having the email capability. So, it allows them while they're away for that six months to really stay in touch with their family, which is really important to all of the family members.

Dr. Jeffrey Roberts:

Thank you. I don't want to think about the roaming charges, though. On this side.

Volunteer Speaker:

Could you play an instrument on space?

Dr. Ellen Ochoa:

You can, and I did. So I played, as I mentioned I was in music. I played the flute and so on my first shuttle mission, I did get the opportunity to take my flute in space. It was, we were using it as part of an educational film or video that we were developing to show people kind of what we do in space, and the differences of living and working in space from living and working on Earth. So, I got just one opportunity to play my flute in space. In general, shuttle flights were really busy. And so it was kind of difficult to do any hobby music or anything else. Now on the space station, we do let crew members take up a musical instrument or something else that has to do with their hobby. People have taken up art supplies, or quilting supplies, you know, so that they have a little bit of time on the weekends in which they can engage in a hobby that they like to do here on Earth. Because we want to make sure, when you're gone for six months, and you're living and working in the same spot, you need something that makes you feel like you're off duty, and you're having some leisure time. And so people do like to continue to do their hobbies if it's at all possible.

Dr. Jeffrey Roberts:

Thank you. Here.

Volunteer Speaker:

Was training hard?

Dr. Ellen Ochoa:
Well, I tried to describe a little bit of it. A lot of it, as I mentioned, was a lot like school. So, it was like studying. You had to learn new things and you got tested on it. But I thought it was really interesting, so I enjoyed it. And I really enjoyed learning to do things, like operate the robot arm. You know, I think overall the hardest part of preparing for a shuttle mission was just that you were trying to learn so many different things at one time. So, all about the shuttle systems, the robot arm, the science experiments that we were doing, a lot of emergency procedures. And so it was just sort of trying to remember, you know, all the things that you had learned and all the little tips that everybody had given you just before you were about to do a procedure.

Dr. Jeffrey Roberts:

Thank you. I'm afraid we just have time for just one more question. So, please ask your question.

Volunteer Speaker:

Thank you for coming to SDSU, but I just had a quick question. How did it feel to be the first Latina to ever go in space? You're one of Mexican descent. How did that impact your life during the time that you were in space?

Dr. Ellen Ochoa:

Well you know, while I was in space, I don't think it made a difference. I mean I'd been working with my crew for about a year ahead of that mission and we had a job to do. And so, we were just working together as a crew to get that done. Where it really started to make a difference was after I landed, because of course, as I mentioned, all astronauts are involved in educational activities and they go around and talk to schools and school groups, and lots of other kinds of groups. But of course, I got many many invitations, which continue to this day. To particularly talk to groups at schools with a high Hispanic population or programs that are designed to get girls or Hispanics interested in STEM fields. And so that's been a whole extra dimension, I would say to my job, that maybe not every astronaut gets to have. That has really added to my career and to my life, you know, over the last twenty five close to thirty years now.

Volunteer Speaker:

Thank you.

Dr. Jeffrey Roberts:

Thank you very much. And thank you all for such excellent questions. We'll now wrap up this Q&A and move into the next part of the program which we call Rapid Fire. So, during previous President's Lecture Series, we've enjoyed getting to know our speakers by asking a series of

allegedly fun questions, similar to the format, “Inside the Actor’s Studio,” for those of you familiar with the show. So to get us started, I would like to introduce our Rapid Fire host, Ms. Daisy Galliana. Daisy. Daisy is a College of Engineering alumna and is the regional technical manager in the oil and gas organization for Latin America at Solar Turbines Incorporated. Solar Turbines supports SDSU’s Mathematics Science Engineering Advancement program or MESA for short, and thank you. It’s important and the Solar Turbine Center for Industrial Training and Engineering Research, CITER partnership. Daisy has been a long champion of the MESA program and has recently made a gift to name the MESA Collaborative Annex in the Engineering building. Thank you. Now please join me in welcoming Daisy Galliana.

Daisy Galliana:

Thank you. So we will start. What profession other than yours would you like to attempt?

Dr. Ellen Ochoa:

Flutist. That’s what I originally thought I might do.

Daisy Galliana:

That’s good. What is your favorite San Diego State memory?

Dr. Ellen Ochoa:

Wow. You know, I was here five years, so there’s a lot of memories. But I’ll tell you, this one is a musical, too. So, when I was in the Wind Ensemble, probably the most famous American composer living at the time, Aaron Copeland, came to San Diego State and he actually conducted us in the Wind Ensemble. So, you know, when I tell other musicians that they’re like, “You were conducted by Aaron Copeland?” That was very memorable.

Daisy Galliana:

That’s good. What is the best piece of advice you’ve ever received?

Dr. Ellen Ochoa:

Well again, so many things to choose from. Probably one of the most memorable pieces, I’ll answer that question. Is so, when I first got into the astronaut office, I think maybe when I was assigned to flight, you know, one of the veteran astronauts told me, “Well don’t worry, there’s only two ways you can mess up as an astronaut. One, failing to follow the procedures exactly as written. And two, following the procedures exactly as written. So, at the time I didn’t think that was very helpful. But I think I eventually understood what he was trying to tell which is you have

to not only understand the procedures, but what led to them and in what cases you might actually have to choose something to do a little different.

Daisy Galliana:

Great. Good advice. Tell us about a book you recently enjoyed.

Dr. Ellen Ochoa:

Well I do like reading memoirs. And so, there's a couple I read this year that probably a lot of other people have read. So one is, "Becoming," by Michelle Obama. I thought that was excellent. And then I re-read and this was put out for the 50th anniversary of Apollo. The book by Michael Collins, who was on the Apollo 11 flight, "Carrying the Fire." And so, if you're interested in a space book, I think that's an excellent one to read. And then I've also of course had the opportunity to meet Michael Collins. I was actually on a panel with him earlier this year at the JFK Library. And he is, in addition to being very talented, he's got a great dry sense of humor. And some of that comes out in the book too.

Daisy Galliana:

That's good. Tell us about a person who has influenced you the most.

Dr. Ellen Ochoa:

Well, I kind of mentioned this earlier, but I would have to say my mom. Because you know, I just, she was a person who, you know wanted the best for her kids and tried to give us all kinds of different experiences. And as I mentioned, she was just very interested in learning and education in general. And I think that's led to, you know, all of my brothers and sisters and me having careers that we have enjoyed.

Daisy Galliana:

That's good. Good example. In five words or less, what do you want your legacy to be?

Dr. Ellen Ochoa:

Well you know, I don't spend a lot of time thinking about my legacy. But, you know, I think it boils down to inspired others to become more.

Daisy Galliana:

Nice. I like it. Well, thank you Dr. Ochoa for allowing us to get to know you better. I'd now like to welcome President de la Torre to the stage to conclude our program. Thank you.

Dr. Ellen Ochoa:

Thank you, Daisy.

President de la Torre:

I'd like to thank Dr. Ochoa again for joining us today and for sharing your inspiring story. We're so fortunate to have you as a role model for the young men and women pursuing their STEM careers. It is now my great honor to present you with SDSU's Presidential medallion. Please join me at the podium. Before concluding our program, we have one more final surprise. Dr. Ochoa is not only one of the most notable alumni, but she is undoubtedly considered to be our most famous SDSU Marching Band alum. In fact, here she is as a Marching Aztec. Dr. Ochoa, we have some friends who have wanted to drop by and say hello.

Marching Band:

Let's go State! S-D-S-U. S-D-S-U Aztecs Fight! S-D-S-U. S-D-S-U Aztecs Fight!

President de la Torre:

What a perfect way to end our program. Thank you again to Dr. Ochoa and thank you to everyone for joining us for the President's Lecture Series.