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ANGLeS Challenge "Meet a NASA Engineer" #1 — Jerry Woodfill (May 8, 2019)

ANNOUNCER: This meeting is being recorded.

ROBERT: OK. OK, so everybody, if you could please mute your mics. I see several people. I'm glad to see so many people on board. But we do need everyone mute except for Jerry so that we can hear from him. We greatly appreciate Jerry being available for it. He was an Apollo engineer and worked on key aspects of it.

And so he's going to tell us a little bit about what it is to be like as a system engineer. You guys are working on your own projects, it's great. And you know that things break, you fail sometimes. And so here is an opportunity for you to understand what it is to be like engineers when you actually have humans that you're responsible for. So Jerry, can you take it over please?

JERRY: Yeah, good afternoon to everyone. I'm actually at Johnson Space Center. It had been called the Manned Spacecraft Center. I came into work here 54 years ago. So I'm in my 54 year here. And when I came out of college, I went to Rice University on a basketball scholarship. And as a result of taking electrical engineering at Rice University, NASA hired me.

And my first position at NASA was to be with the Apollo program. That is, this was in 1965, and at that time, the Gemini program. That was a program where we had two astronauts that would orbit Earth and practice the kinds of things that would be used to go to the moon. And so when I came on board, most of the engineers were still working on Gemini.

But I was one of the first engineers that actually worked on Apollo. And they assigned me the alarm systems, the warning systems for both the mother ship, the command module that would go to the moon, and then the lunar lander that would take men to the lunar surface. So in that capacity, I was responsible for alerting astronauts any time there'd been a malfunction on board, either the mother ship or on the lunar lander.

It was my job to meet with the astronauts, as well as all the engineers that were responsible for the various systems that would operate these craft, to warn the astronauts, as well as flight control, if they had a difficulty. To do so, I had to come up with some kinds of criteria and the criteria were that if it was a--

[INTERPOSING VOICES]

ROBERT: Jerry-- can I just stop you for a minute. There are several people with open mics, so if you're making funny faces, please don't. So everybody mute their mics. So I see Nikki is not muted. OK, keep going, Jerry. Thanks, everybody for muting your mics.

JERRY: So my responsibility was to alert the astronauts, either in the command ship, or in the lunar lander if they had any kind of a difficulty. And so to do so, if it was something that was threatening the crew, then a yellow alarm light would come on in the cockpit. And if it was a real serious problem, that

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was called a warning, and a red light would come on. See that would be the master line right there, that would come on in the cockpit.

And then at the time, the alarm came on, they'd also hear this. See if you can hear this. Let's see. [ALARM] You hear that? That was the tone that the astronauts would hear in their headsets. As well as they would see these red, amber alarm lights come on. And then there'd be an indication on their panel what particular system was causing a problem.

And so have many of you have seen the movie Apollo 13? I'm sure you have. Well, in the movie Apollo 13, if you've seen it, the master alarm comes on, and Tom Hanks goes, Houston, we've got a problem. So what happened on that-- this is what I heard in my headset. This is what I heard.

- OK, we have a problem here.

- This is Houston, say it again, please.

- [INAUDIBLE] we've got a problem. [INAUDIBLE].

You hear that? With the caution and warning there, that's Fred Hayes, an astronaut on Apollo 13. He heard the tone, he saw the alarm light. And he saw one of the individual lights come on, and said that the main bus, that's the electrical power bus in the command ship, had dropped down below the threshold that turned on the alarm. That was Apollo 13. But we're going to talk mostly about Apollo 11 today.

And so, in Apollo 11, people think, well Apollo 11, it was really easy to go to the moon compared to Apollo 13. No, that was not the case. The same kind of difficulties that threatened the lives of the crew of Apollo 13 also threatened Armstrong, and Aldrin, and Collins on their route to the moon. Many different things happened that actually could have killed the Apollo 11 crew. And I'll talk about some of those things as I share with you.

So this is the challenge. This is the challenge. Here I am, a young engineer, 23 years old, and I'm responsible for the-- exactly for that whole endeavor, to make sure that they come home to safety. Now, listen to this. President Kennedy said this. He said this on May 25th of 1961, before Congress. Now here's what he said. Listen to what he said.

- I believe that this nation should commit itself to achieving the goal before this decade is out of landing a man on the moon and returning home safely to the Earth.

JERRY: OK, did you hear him say returning him safely to the Earth? I didn't know it at the time, I was a student at Rice University, a sophomore. I was playing basketball on the varsity. And I was going to be the guy that actually was assigned that responsibility directly to return him safety to the Earth. Because they had to know if they had a problem.

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And they had to take action to solve their problems. If they didn't solve the problem, too bad for them. They wouldn't get back to Earth. And so, in that capacity, when I hired on with NASA, I was assigned to deal with all those issues that could take the lives of the Apollo crews. And so if you do that, you're going to be a person of interest to the astronauts.

They wanted to know about you. Could you actually do a good job? Now, that's where it's important-- we talk about STEM-- S-T-E-M. When I was at Rice University, we said STEM. I said, well, that's a plant, that's the stem of a plant. Well, no, it's come to mean Science, Technology, Engineering, and Mathematics studies. So at that time, I was an engineer.

And I always make this point. You know, everybody knows Neil Armstrong and the 12 astronauts who walked on the moon. I can name them-- Armstrong, Aldrin, Conrad, Bean, Shepherd, Mixer, There's 12 of those guys. And we can name the flight controllers. We can name them like, Gene Kranz, or Glenn Lenny, or we can say Christopher Kraft and all those guys. But nobody ever heard about me, you know?

Because there's thousands of engineers, but just a few astronauts that walked on the moon. But believe me, the job that the engineers did was every bit as important as any astronaut that actually walked on the moon. Because the ship has to be designed right, correctly. It has to be tested. It has to be reliable. And so that was my job, to actually make sure that that system would solve and save their lives.

And so things happened on Apollo 11 that people aren't generally aware of. For example, when they were coming down to land on the moon, they were going to land on the moon, and they're coming down, and my alarm system begins to ring alarms as they're coming down to land on the moon. And it's called the program alarm.

And this was a situation where the computer was getting a little bit confused. It was trying to monitor the command module up overhead. And it was trying to judge where it was. And then, also, it was looking down to the lunar surface with this landing radar, and both those radars were confusing the computer.

Now, had a very smart group of flight controllers not have gone over that particular alarm previously, they would have aborted. But two fight controllers-- a friend of mine, Steve Bales, and then Jack Garmond-- I knew both of those gentlemen-- they knew. They had, just two weeks before they landed, they had come up with that thing in a simulation and decided if that ever happened, well, if that happened, it was really not a legitimate alarm.

It's like a boy caught crying-- you know the old adage or the old proverb about the boy crying wolf and so forth, and he keeps crying wolf. Well, it's really not a problem. That was a wolf crying boy, and so they just pressed on, and Eagle came down.

OK, so, that was called what they call a nuisance alarm-- a nuisance alarm. Now, nuisance alarms can be very bad. It would be like driving up a mountain and something happens with your automobile that turns on the oil light, but there's really no problem. And so you should press on. But you know, if you're

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going up a mountain, and you see some kind of a thing come on, that's going to make you want to stop and give up.

So these nuisance alarms were things that I had to deal with all the time. And they were very much a problem, because they could be agents of death really. Because say you're coming down to land at Tranquility Base, and all of a sudden an alarm starts coming on, and the astronaut gets overwhelmed with confusion. And he makes the wrong decision. And because of that, he flips the wrong switch.

And actually, it leads to actually aborting the mission, or worse yet, even losing their lives. And that happened, by the way, on Apollo 10. Apollo 10 wasn't actually going to land on the moon. They were simply going to go down near the lunar surface to see what it would be like when Neil Armstrong and Buzz Aldrin came there just a month later on Apollo 11.

And what had happened was Gene Cernan and Stafford, for flying the lunar lander, they called that Snoopy. You ever hear that? Snoopy. And then they called the command ship this for Apollo 10. It was called Charlie Brown. And so Snoopy is coming down and what happened, they flipped the wrong switch and they got on the wrong guidance system.

And so the lunar lander on Apollo 10 starts to just rotate. And it rotates around eight times in 15 seconds. And so what happens is, boy, it was a very big problem. And so what happened, Stafford just turns off the guidance system altogether and takes over on manual control. And they came within two seconds of actually crashing into the moon.

Now that'll spoil your day if you have a nuisance alarm that confuses you and you hit the wrong switch, like happened on Apollo 10. So you see how important it was to deal with what we called nuisance alarms. And so, I'm always trying to eliminate those nuisance alarms.

And for Apollo 11-- I like to tell this story. Now remember, I'm an engineer, you've never heard of me. But listen to this, students. STEM-- S-T-E-M-- Science-- like you, Robert. You're a great scientist. I've seen your background and everything. Man, you'd really blow me away if you look-- go to Robert's background. You've never seen a guy that's done more.

So here I am, an engineer-- S-T-E-M-- Scientist, Technology, Engineer, and Mathematician. There's no A in there for Astronaut, is there? There's no F for Flight Controller. But there is an for E for Engineer. These are the people that actually design and make it work. So it's very important.

It's like God created us, and something like that, you know. But then we're given our bodies, or we're given the space ship as an astronaut to use it. So it better be designed and created right. So here's the thing I want to share with you. And everybody, distribute this YouTube widely, because I want everybody to know about the thing that I did to avoid a nuisance alarm.

We found out, as I visited with all the different managers of the different systems to find out how best to tell the astronauts what was working and what wasn't working, one of the things I discovered was that the landing radar, when we're coming down toward Tranquility Base, when it gets on the lunar

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surface, the temperature-- the temperature of the moon while they were getting out of the spacecraft, the temperature is descending.

It's getting colder, and colder, and colder. And my landing radar is located right under this descent stage. And it's pretty warm after they land, because the engine has heated the area up. But after they're sitting there, it's getting colder, and colder, and colder. And then what happens is, I have a little thermal sensor in that landing radar. And when it gets beneath a certain temperature, all of a sudden it rings an alarm, a master alarm.

Now the astronauts, Aldrin and Armstrong, they're outside. See this, this is the lander. My grandson knocked off my legs on my lunar lander. But anyway, they're out here, and they're getting ready. And here, they're going to collect some moon rocks, and they're planning to plant the American flag. And they're planning to talk to President Nixon. And all of a sudden, my alarm, because of the cold temperature, rings.

My alarm goes off. They hear the alarm. Now, what they'd have to do is they say, no, we can't plant the flag, we can't talk to President Nixon, we can't collect moon rocks. We're going to have to go back and get inside the lunar lander Eagle and find out what turned on the alarm. Well, I discovered that-- I was the one that discovered that. And so I fixed the problem, and I believe I saved the moon walk-- the moon walk.

OK, so you're watching the guy right here that saved Neil Armstrong, Buzz Aldrin, not only collecting rocks, planting the flag, but talking to President Nixon. Now not too many people know that story. So believe me, share this video widely so that everybody knows. My name is Jerry Woodfill-- W-O-O-D-F-I-L-L. OK.

So here we go. We'll continue on. Now, I'm going to talk for a little bit and tell you about some of these things that happened on Apollo-- Apollo 11. And here's some things. This is interesting. I went back and looked at your challenge. I looked on the internet. I read all through the PDF file of everything you-- by the way, I want to compliment you guys. Whoever put together this channel, it's a wonderful job you did. It's just fantastic.

[INAUDIBLE]

It's fantastic to see how clever you guys were to use the idea of bringing-- what do you call it? I'm getting this term-- I call it a drone.

[INAUDIBLE]

Your definition of it is called a UAV, a UAV, that is an Un-crewed Aerial Vehicle. I don't play much with drones, with UAVs, but I know what they are. And we had a drone that actually trained-- this drone trained Neil Armstrong to land on the moon. And it's going to be like the drone you folks are using in your particular challenge.

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Now, his drone would actually train Neil Armstrong and all the Apollo astronauts on a how to descend and land on the moon surface. And so, they're actually in the lunar lander. And of course you're going to do that kind of thing with your UAV, and you're going to drop what you're going to drop down there, some kind of an equivalent moon car or something that you're going to have. And then you're going to-- as a Lego kit, you're going to build it or something.

Well, Neil Armstrong's drone, his UAV, it had a problem. He was out here at our Ellington Field. And he ran out of orientation control fuel. And so what happened was the thing starts to go to and it's going to crash into Ellington Field. And so it has an escape mechanism where he can jettison his escape and get out. And so his drone goes, and it crashes into the runway, into fire. It starts burning up and everything.

So he's in a parachute. And he's coming down towards this particular fire. And Armstrong's going to lose his life because of this training accident. He's going to actually die in a fire. But at that time, this is one of the providential things that happened. As he's coming down and he's going to fall into the fire, suddenly a wind blows, blows out of Houston, and blows him right past it. So his life is saved.

Well, I like to say that's one of the things that saved Apollo 11, because it saved Neil Armstrong. And Neil Armstrong's piloting, if you actually see any of these movies on Apollo 11, you see how Neil, he's approaching Tranquility Base-- he's approaching Tranquility Base in a lunar lander, and all at once, he looks out, and he sees that there's a boulder field and a crater right there in the direction that the lander is being brought by automatic control.

So he takes over. I like to show this. I speak to a lot of students. Now, this is the thing, when I share with students-- oh, boy-- you see this? This is a hand controller. This thing is worth more than probably three or four years of my salary. Right now, I keep it locked in my desk.

But this controller right here is what Neil Armstrong, Buzz-- they use them to fly, these kind of controllers. So he takes the controller and he sees-- actually, I used the wrong controller. I wouldn't have survived. I had the wrong controller in my hand. So he's using this controller. You can pitch down, you can yawl up. You can rotate the lunar lander.

And so, by the way, this controller was used to train the Apollo astronauts. It's one from our simulator. So he's going to land at Tranquility Base. But he has to fly over this football sized crater to save his life and save by Buzz Aldrin's life. So that's one of the things that saved Apollo 11, is the piloting skills of Neil Armstrong. And they were acquired using this thing.

And you guys, when you do your challenge, now, somebody in your group is going to have to be the one that actually flies that particular-- what do you call it-- UAV, into a part. OK, so somebody is going to be the UAV pilot.

Now, this is the thing. I looked at all-- I went through all your PDF, for all the explanation of things you guys are doing. So remember, I'm the caution and warning engineer for the lunar lander and the command ship. Now, I didn't see on your list of people that are in your team members, you have no caution and warning officer. Now you need to have one.

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Here's the reason why. I read I read all the cautionary things about using the UAV. You need to have on each team a-- well, call it a drone caution warning officer, or call it a UAV caution and warning officer. And I've got a job description for him or her.

And this is going to be a team member. And you're going to list the safety rules. And that caution warning is going to explain to the whole team the rules on how to use that UAV in a safe way. Now, that's what I had to do. I had to come up with ways to make sure the astronauts were safe.

And then you have-- now, when you launch-- when this thing launches at Cape Kennedy, you see this thing up here? Well, this is called the launch escape system. Now, that's a way that if there's a difficulty with any one of these stages here, this thing takes the command module, the very top capsule, away, and then brings it in a parachute down on the Atlantic Ocean.

OK, so now, I don't know how you guys are going to do this. But I think the UAVs, most of them, they're designed with some kind of a kill switch or something, just like a helicopter, if it's failing, it will bring it back down to the floor of the gymnasium or wherever you're testing it.

Well, there's another thing you might do. See a range safety officer, they have a way of actually-- I'd better not say that. They can explode the whole thing so it doesn't hurt anybody. I don't think you'll have anything-- but you might have with your UAV, you can throw a net over it so it won't hurt anybody or something. Or you get a baseball bat, not a solid one, but one made out of plastic or something, and knock your UAV out so it doesn't hurt anybody. But those are just some thoughts I had. You know, I can get kind of off the wall sometimes when I talk. Anyway, those are some of my ideas.

Another thing I would like to say about the lunar lander. Now, I began in the beginning, as far as Apollo. And so, one of the things that I was doing, when we designed this thing-- see, this is a lunar lander, it's for two guys. But when we designed it, it's started out that any kind of an automobile, or an aircraft, or a plane, you want to be seated to fly it. You want be seated there, and you can look out the cockpit. And you wanted seated there.

Well, had Neil Armstrong sat in a seat on that Eagle lunar lander, likely he would have not made it. Because when you're in a seat, you're looking at a viewing window. And how are you-- here I'm back in this seat, I can't really see the details of Tranquility Base. But if I'm real close to the window, I can look down and see it very easily.

I have a neighbor that lives down the street. I used to work for him. He's retired now. And he was at the manufacturer of lunar landers, and he said, he looked at this thing, and they saw these seats they had a little mockup of it. And the astronaut would be sitting way back here, and here's the window up here.

He says why are we doing that. Why aren't we just standing up. We could stand up and fly this thing. And if I'm standing up and flying the lunar lander, I can get right close to the window and see exactly where that boulder field is. And so my neighbor came up with the idea of taking out the seats out of the lunar lander and just flying it standing up. Now, that's very unusual, but that was a wonderful idea.

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My point is this, you can come up with an idea that nobody has thought about before. And it can make all the difference in the world for what is going on. And you had that idea. Now Pete was like, well, I could of thought that, I could have thought of that. I said, well why didn't you then. But my neighbor thought about-- guess what, he got a $25 award.

ROBERT: Wonderful.

JERRY: He's also the guy, by the way, responsible for saving the Apollo 13 crew. I like to share this when I give talks. Have you all seen the movie Apollo 13? If you did, you know the main scene in that movie that really everybody remembers is when the astronauts are going to die because they don't have enough filters, round filters on the lunar lander. See they had to use that lunar lander, remember that, as a rescue ship.

And we watched them-- if there's anybody that hasn't seen the movie, you actually got to go home and see that movie tonight. In fact, it's so good a movie, that I bought-- I have 102 copies of VHS tape at home. So in the movie-- in the movie, they have around filters in the lunar lander. And they have to make them work in the square-- they have to-- somehow, the round filters, there are not enough of them.

So they have to come up with a way of making the round filter-- oh, you should start-- what happened here? What happened? I lost out, guys. What's happening?

ROBERT: We can still see you.

JERRY: OK, I can't see you, but that's fine. OK, so, they have enough square filters. This ship uses square filters. There are 24 of these, enough for two weeks in space. And the rescue ship, the lander, only has I think five or six of these round ones. This is a little oil can that I use to make my demonstration.

Now if you could somehow make these square filters fit into the round barrel for the round filters, you can save their lives. Well, my friend, way back in the Gemini days, my friend, my neighbor down the street, there was a problem in Gemini. Gemini's for two men. The cabin was very confining, very small.

So my friends said, well-- they were wanting to do something with all the trash. You know you eat things, and you unpack things for experiments, and everything. You get all that trash in the Gemini capsule. So the people said, well, why don't we build some kind of a mechanical trash masher, you know like you have in your kitchen, where you smash things down.

And he says this. He says, don't do that. You don't have to build a million dollar compressor, trash compactor. All you have to do is, the astronaut can get all those things, put them on his chest, and then take his arms, and just pull real tight like this and smash it down. Now that's a great compressor, trash masher.

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Well, they say, well, OK, so you do that. Well, what are you going to do with it? Here's what you do with it. He said, take that trash, after you have compressed it with your arms, and then use duct tape, and tape it around that trash and just stow it away. So they put duct tape on every single manned mission after that Gemini. My friend suggested that down the street.

So guess what, when Apollo 13 has that problem with the square filters, they come up with this idea. Why not take bags that they used for moon rocks or shoot parts, these plastic bags that were on board, and take that square filter that they have plenty of, and put them at the mouth of those bags. And then, take-- and then take a hose-- they have these hoses on board.

And you take these hoses. These hoses-- this is my hose. I got it at Toys R Us. And so what you do is, you take that hose, which the cabin atmosphere circulates through that hose, and then you can cut a slit in the corner of the bag, put that slit in the corner of the bag. Now there's a fan that's sucking air around the cabin and through the bag. And if you put that square filter at the mouth of the bag, and it goes like this, you'd be sucking air through that hole.

But the problem is this, it's going to leak, it's going to leak. Aha-- now, this is where my friend saved Apollo 13's astronauts. All you have to do is take duct tape and make that seal tight. And so duct tape saved the Apollo 13 crew. So that's the story that you've heard here.

And when I give these talks, I give them to-- I give 60 or 70 talks a year. And I wish I could see you guys. It'd be great if I could. The talks are good. And so I'm talking about things that saved Apollo 11. And at the close, if you guys have questions, you can ask me some other things.

ROBERT: Yeah, that's what we're going to do now, Jerry. If you want to see everyone, I think if you click down the bottom, bring your cursor down, you will be able to see everyone.

JERRY: Now I can.

ROBERT: If you have a team that would like a question, just type in the chat room that you want to ask a question. But I have a few already. And the kids can chat in, and then we'll ask them one at a time as they come through. But Alana Ally from Holbrook High in Holbrook, Arizona, wanted to know-- what was the hardest part of your part for the mission to the moon?

JERRY: Well, the hardest part, I've already told you, is the nuisance alarms. These were problems that I never knew exactly when they're going to occur. And if one happened and the astronaut said, we've had a master alarm. And I've read some of the transcript, and they didn't speak well of it. In fact, I read the transcript from Apollo 10, and there were some pretty raw words that came forth when my master alarm started ringing.

And so right away they say, well, Jerry, what caused the master alarm? Now, this was a day of antiquity, when it came to electronics. This is way back in the '70s, early '60s. It was a time when digital electronics were just in their infancy.

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In fact, my textbook at Rice University in circuits was with vacuum tubes. And the latter part of the text-- well, actually I had transistors. This was a new thing.

Now we're a few what they call IC's, integrated circuits, and there was a counter in my alarm system electronics. But for the most part, it was all analog. So here was the problem I had. When they said, well, Jerry, what caused the alarm? And I would say, well-- see here's the panel, here's the alarm panel-- here it is right here. Here's the panel. And it come on.

And see that master alarm, that thing would latch up. When one of these particular sensors that turned on this light would latch that thing up, it would flare. And it would stay latched up. The only problem was like in your home, when your air conditioner comes on and sometimes the lights dim, and then the air conditioner compressor gets up to speed, and the lights get bright again.

Well, that particular kind of a problem would turn on one of these just momentarily. But this would stay on. So they said, Jerry, what made this thing come on? Now, I had a problem. Because if I didn't have the astronaut say, like Fred Hayes did, on Apollo 13, we had a main bus be under volt, that's one of these lights here.

By the way the movie, Apollo 13 has some problems. The movie Apollo 13 has this light on. That's the caution and warning power supply. It did not-- it did not fail. But the movie made a mistake. They have it failing. But anyway, that was the problem.

They said, Jerry, what caused the alarm? So, if it didn't stay on, I'd have to go into the bowels of the data room and get all of these data strip-outs, these inputs, and have to find one particular moment that that particular thing came on that turned the master on. That was not easy to do. That was probably, for me, the hardest thing to do.

Now on Apollo 13, when I heard in my head set-- Houston we've had a problem, and I saw the measurements, and the telemetry. We have this console that shows all the status of everything. And I saw the thing come on, I said, uh-oh, I've got a terrible problem.

I said all these, what we call these nuisance alarms-- I had six different nuisance alarms on at the same time. I had AC bus alarm, fuel cell alarm. I had main bus B. It was terrible. I had so many alarms on at one time.

And so my thought was, my alarm system is really causing me problems now. I'm in big trouble. What am I going to do? So, I'm listening. And all of a sudden, Jim Lovell says, oh, we see something venting, we see something venting.

Now he's looking back behind the point. He's seeing this gas coming out. Oh, I say, oh, if there's something venting, there's something really wrong. It's not my alarm system. And it wasn't. So that was one of the moments where I had a difficulty, because of my particular job, my particular job, OK?

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ROBERT: We have lots of questions. I see-- let's do some live questions. So, Kira from [INAUDIBLE], you want to ask your question? You want to unmute and then ask your question?

STUDENT: What was the-- I forgot what it was.

ROBERT: How hard is it to work there at NASA, and have you ever not liked working there? Thank you, Kira.

JERRY: Well, I've liked it a lot. I mean 54 years, obviously, if I didn't like it, I wouldn't stay around 50-plus years. And so, because of that, I've had so many different kinds of-- I'm just telling you about the first seven years of my employment here. But every time that something would end, there'd be another program that would begin, start again. I've done 26 different projects, and all of them are very stimulating.

They ranged from things like solid state electronics to come up with techniques to make what we call thermo sensors, using the physics. I've done jobs where we use lasers, flying over polluted rivers that actually transmit a laser beam into the river and then the return will show you if you had any pollutants. I've done so many different things over my career. And there's always a new project. That's what's wonderful about working for NASA.

There's always something new. And so I want to encourage you guys, whatever job you get-- I have a grandson, and he's just beginning-- he's probably going to go to Texas Tech, and he wants to go into chemical engineering. Now, here's the thing I want to make. The point is that yes, you need to know the background, and the basics, and all the laws of physics, or chemistry, or those kind of things.

But the other thing is, you need to be able to take those basics and then use them and apply them in a way that's innovative, come up with solutions that nobody ever thought before. Always look for those kinds of things. One of the reasons that Americans got on the moon before the Soviets did was some guy at Langley Research Center, he came up with the idea of not using just one vehicle with one huge rocket, he used the idea of lunar orbit rendezvous.

That is, he said, why take one rocket and all the way down to the moon's surface and then launch it. Why not divide it into two vehicles, a command ship to go to the moon, and then a lander to actually go down. And that idea was likely why we were able to beat the Russians to the moon. Because they came up with the idea of a huge rocket. Their rockets were huge, Nova class, 12 million pounds of thrust. Ours were 7 and 1/2.

But using that covered technique, their rocket was so big and had so many engines around the periphery, that one of them misfired. And July 4th, I think, of 1969, or sometime, just at the time we were actually going to the moon, their's blew up, because of the complexity of trying to take this huge rocket. So use clever things, come up with innovations. That's my point here.

ROBERT: Wonderful. Charlotte Johnson, you went unmute and then ask your question? So as Charlotte unmutes, the question was, what is the part of Apollo 11 that you are most proud of?

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JERRY: I told you I already, didn't I. When I saved the moon rock.

ROBERT: There you go, easy one.

JERRY: I call it the moon rock. I guess the moon rock-- the moon walk.

ROBERT: Jeremy of Idaho, you want ask your question? I'm not sure. OK, Jeremy wanted to know why was the lunar module the shape it was, octagonal.

JERRY: Well, this is interesting. This is the most unusual space vehicle you'll see. They said it looked like a spider. And it has four legs like a spider would have and so forth. But remember, it never operates in an atmosphere. So it doesn't have to be streamlined at all.

You can hang anything out, any way you want to, these antennas and everything. Unlike this craft here. This comes back through the atmosphere. So you can't do that kind of thing. But this thing can have any shape you want to have it, because it doesn't operate in an atmosphere.

ROBERT: I'm going to-- so, Quincy, you got a-- what was the most stressful part about working at NASA on a daily basis?

JERRY: Well, see NASA is like any company or anything. You have deadlines. You have to get something done in a certain prescribed time. The other issue is you've got to make it cost within a budget. So sometimes I speak to our business office and so forth-- in fact, they had me give kind of a talk like this to them. And I appreciate everything they did.

Because we hadn't of had the kind of people that were able that work with budgets and work with the companies that actually build it-- now NASA, we oversee a lot. We do a lot of hands-on stuff, but it took 400,000 people to get to the moon. And so there were machinists, and there were technicians, and computer scientists. There's all of these-- it's a big team.

And so, that team includes so many different kinds of work, from business, and even legal things and others, and scientists like yourself, Robert, to know what we're going to find on the lunar surface. I didn't know the temperature of the lunar surface at all. But I could go to a scientist and a space geologist, or whatever, who could tell me exactly what the temperature of my lander-- the temperature and the lunar lander's radar would face.

So it takes all of us working together. But the important thing is, we work together. That is, we're not alone. We have to talk to one another. One of the things that made Apollo work is what we call systems engineering. That is, you were assigned your job, but then somebody else had a job. And you had to work together. And you would borrow from them, their knowledge, and you would give them your expertise. So that's important.

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ROBERT: And that's what all the teams are going to have to do, is system engineering, right? You're all working together as a good team.

JERRY: Absolutely.

ROBERT: All right, so here's a really good question from Julie Ford. She has two parts. One is, has NASA improved the duct tape strength? And how many rolls of duct tape did Apollo 11 carry?

JERRY: Hey, that's a good one. I always like to use these questions because when I get them when you're in class and the professor doesn't actually know the answer, he said I'm going to give that to you to come back to the class and share with us. So that's your-- you bring it to me, and your duck. Robert, when it comes in, you give it. I think it was one roll. I think it was one roll. And what was the other-- the one roll of duct tape and is it any better? Yes.

ROBERT: It's a lot thinner and lighter now, right?

JERRY: I'm not a duct tape expert, but I know how to use it. I use it at home all the time. Hey, let me recommend this to you guys, though, on your teams. You need to have some available. You know, there might be just the time in your competition when that duct tape save the day, like it did for the Apollo 13 astronauts. So I would suggest, though, that you don't get a whole roll. Just snip off small pieces of it so you can directly apply it if there's some malfunction in one of your rovers.

ROBERT: And I still use duct tape regularly on my NASA experiments too.

JERRY: Well, wonderful.

ROBERT: So Victoria Martinez wanted to know what science in elementary school helped you understand what you needed in order to [INAUDIBLE] the astronauts. So what did you learn in elementary school that helped you all the way through?

JERRY: Well, I played basketball in elementary school in fifth grade. If there are any 5th graders out there-- I wanted to be an NBA player. And so I started in fifth grade. Between fifth grade and 12th grade, senior, that's your group, I put in 8,000 hours, practicing every night, shooting jump shots, every kind of free throws, and everything. I was averaging 10 points a game. And I wanted to get a college basketball scholarship.

We went up against the finest team in Indiana, number one team in the state. And they put the toughest defensive man at state to guard me. I guarded him. I ate his lunch. I made 20 points against this guy. And based on that one ballgame, I got a full basketball scholarship to Rice University. What a miracle.

But I knew that basketball was not going to be necessarily my future. So every night, I practiced, practiced, practiced, but then I'd go in, I'd study, study, study. So I combined the practice and the study. And I enjoyed science fair. You know, science fair in that day was a big deal. But you know LEGO League

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is much bigger now, you see. But in my day, it was science fair. So you tried to come up with some innovative kind of a thing.

In my senior year of high school, I won the best of the fair. And I come up with something called a Tesla coil. You know, a Tesla coil is something that you can create, just 115 votes on the wall, into a spark, plus 7 inches long or something. And so I enjoyed doing science. I like physics and things like that. That was just my background. But that could be a different thing for each one of you watching this program. So that's what I like. That was your question. I like physics.

ROBERT: There's a couple of groups-- Tacoma Public Library and Victoria [INAUDIBLE] wanted to get your opinion on whether we'll make it to Mars in 2050, and whether this is something important that we should be doing.

JERRY: Well, you know it's important. For me, you know it is. That's a given for anybody that works, especially on the manned, human side of space exploration. And that's my opinion. I think we can do it. I think-- here's what I did. Way back in the day, 1988, '89, '90, I was in a group called the New Initiatives Office. And what we were supposed to do is take things and come up in new ways of doing things.

One of the new things I thought was, why don't we take all this NASA free stuff that's distributed to educators, and I created a program called the Space Educators Handbook. Google that, Space Educators Handbook. And it's a virtual encyclopedia. It shows you how to go to Mars, how to go to the moon. It's got all kinds of wonderful-- Space Educators Handbook.

In fact, in there is a actual model to construct out of materials on how to make a lunar lander. And there's another particular-- it's got all the materials lists and everything. You might want to look at it. Get some ideas for this particular challenge you're on. And so, the deal was that I knew when I worked on that project that there are certain ways we could accelerate things. We could make them-- we could use robotics for example.

We could actually, instead of sending humans first to Mars or the moon, we could dispatch a robot there and actually build some of the structures, actually factories to produce some of the liquid oxygen or something from the actual compounds there. And so I knew if we used robotics, we could accelerate when we could get there. Now, the state of robotics is much advanced.

By the way, I work in the robotics division here. You know, we've done some kind of wonderful things with our robots. In fact, here's one of our latest designs right here.

ROBERT: I love it. Slinky's are important in science, I'll tell you.

JERRY: So I think we can do it, based on all the advances and technologies that we didn't have way back in 1965. We've got so many more technologies that I think we can-- we talk about going to the moon in five years, but remember, it took a little more than that to get there between maybe '64, '65, and when I came on board NASA, to when we landed in '69. And then we had to lose about a year and a half or more because of that terrible Apollo 1 fire that delayed everything. And still, we met President John

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Kennedy's challenge to make it there before 1970. So when you take all these things, and clear it off, I think it can be done, I think it can be done.

ROBERT: The Texicans wanted to know, and you got to be a little bit most precise, because we talked about basketball and your career at Rice, but they wanted to know if you were a sixth grader again, what would you advise a sixth grader to do today to become an engineer like you?

JERRY: Well, I told you right away, do what you're doing. If you're working in this particular challenge, you're doing exactly what you should be doing. And take in these kinds of things, these robotic contests and Lego League. You're doing the same kind of things in a more complex way than I ever did when I was a graduate engineer.

I saw, I looked at your whole project, your whole plan and what you are challenged to do. And so believe me, if you're into this program, you're doing the right thing as a sixth grader. And just do it and take on these kinds of challenges. And you know, that's what robotics is. And what this is, is taking the whole complex of engineering and science, and pulling them together to produce something that works.

ROBERT: I totally agree. Now this one goes-- this is from [INAUDIBLE], but it's relevant to all your team members, because when you do the challenge, you might feel a little bit anxious. So the question was how did you stay calm during an emergency? Or did you stay calm in an emergency?

JERRY: Well, it's like this. If you're playing college basketball or any kind of a sport, you're so engrossed in what you're doing, you're not thinking about fear. You're just acting out of what you practice and know to do. You know how to shoot a jump shot or a free throw, you know how your alarm system works. You've gone through scenarios in your mind of what would you do if this happened.

So you're so involved in solving the problem that you don't get nervous. It's second nature to you. And so if you know your job, and what you're doing, and you've practiced it, fear is not going to overcome you. By the way, how much time we've got left? I want to do one thing before we close.

ROBERT: We've only got about another 10 minutes.

JERRY: OK, well, let's have some more questions then I want to close with one thing.

ROBERT: When you want to close, in five minutes? Or you want to just--

JERRY: It's up to you.

ROBERT: OK, it's up to the other kids, but they can let us know. Sanje N. said, what is the newest project you're working on right now?

JERRY: OK, so here's the deal. We're just stepped into the idea of going back to the moon in five years. So that's just ramping up with all of us here. We're looking at what we did way back 50 years ago and

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how we can adapt that to what is in the present. So that's one of the things, from my perspective, I'm contributing.

That is, I want to be able to share my background, my experience, with the young engineers, like some of you students will be if you're already in 12th grade. Some of you may become interns, or co-ops at some company, or something like that. And you will actually be stepping into the same kind of a career that I have had and have.

And so that's what I'm trying to do, is take my knowledge and my background and help the next generation. See, I've been here for 54 years. So I want to be able to share something. That's why do these things. That's why I'm speaking to you guys, try to encourage you to go beyond what I've ever done.

ROBERT: And that's what I'm doing too. So we appreciate your input.

JERRY: [INAUDIBLE] Robert.

ROBERT: So Miranda wanted to know why is food freezer dried to go into space? And what is the largest rocket you've ever worked on?

JERRY: OK, remember, there's a rocket engineer and then there's a spacecraft engineer. I'm the spacecraft warning system engineer. And so what is the largest one I've worked on-- well, I guess, I don't work on rockets. I work on all the technology that controls rockets or monitor performance.

So I guess I-- let me tell you this. You guys, as you begin to know what Apollo 11 was like 50 years ago, begin to study the different things. Now, there are the boosters. These are called boosters that actually send the rocket to the moon. These are called spacecraft, that actually carry the astronauts to the moon. And those things, this is Marshall Space Flight Center.

These are things, the Johnson Space Center, crew [INAUDIBLE]. So I don't really work on rockets other than trying to understand how they work. So I can come up with ways of alerting the astronauts if they're not working correctly through the alarm system.

ROBERT: OK, so, Christopher Nick Hudson says, from Wisconsin says, please tell him thank you for giving his time for this talk. Just wonderful to hear all these stories from him. And somebody said that-- [INAUDIBLE] also said, this is really cool. There are 73 more questions that I can't get through. I'm really sorry about that. There are going to be more lectures in the coming weeks, and try and get them to us, and we'll see what we can do.

And I apologize we can't get to everybody. I might do one last question. There are now 78 comments so I'm getting drowned here, sorry. I'll try somebody who I haven't-- so Savannah Foxworth said great handbook for all educators. So that was great. Let's see, Paige is saying, I'll send you a link to the lunar module and the educators handbook and we'll send it out to everyone.

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Did you want to-- you said you had something to say in the last few minutes, and I apologize that we can't get to all the questions, but really enthusiastic and I'd love to see it. Jerry, you were going to conclude.

JERRY: OK, as I said, I speak 60, 100 times a year, to nursery school students, to senior citizens about my age. And so it's all kinds of venues, all kinds of backgrounds, and knowledge, and education, and everything. Most of my talks, actually, all my talks are mostly motivational. And Rice made me a-- not a distinguished-- I am a notable alumni, basically because of what I did for the alarm system on Apollo 11 and then motivational talks I give.

So at the conclusion of all my talks, I wear this wristband each day to work. One side says, if you can read it, failure is not an option. The other side says, if you can read it, I have the right stuff. And so in order to share these with the people that I speak to, I have a little pledge that I give and ask all those that listen to me to take the pledge with me.

ROBERT: OK, so everybody un-mic then, if you want to un-mic to take the pledge with Jerry.

JERRY: OK, here's what I say. OK, you put your hand over your heart. We're going to take the pledge together. And I'm going to make you an honorary Apollo flight controller. You see that? But you have to do the pledge with me. OK, here we go. Hands over the heart, now, honorary flight controllers and I'll lead you.

I will do my best.

STUDENT: I will do my best.

JERRY: To achieve success in my goal.

STUDENT: To achieve success in my goal.

JERRY: Neither fear.

STUDENT: Neither fear.

JERRY: Failure.

STUDENT: Failure.

JERRY: Or frustration.

STUDENT: Or frustration.

JERRY: Can overcome me.

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STUDENT: Can overcome me.

JERRY: I am unstoppable.

STUDENT: I am unstoppable.

JERRY: Unmovable.

STUDENT: Unmovable.

JERRY: And unshakable.

STUDENT: Unshakable.

JERRY: Failure is not an option.

STUDENT: Failure is not an option.

JERRY: I have the right stuff.

STUDENT: I have the right stuff.

JERRY: And y'all got it. Now you're all honorary Apollo flight controllers, congratulations. [INAUDIBLE]. I sent you the PowerPoint. And the last screen on that PowerPoint has this on it. So if you send that out, they can print it out. And I signed it. And they can put their name here, because they took the pledge.

ROBERT: OK, I'll do that and make sure that happens. And thank you all for attending. And it's great to see so many youth participating in this. It really warms my heart. And we're going to keep going at it. So thank you, everyone. And we'll send you a thank you. And we'll adjourn this meeting. So thank you everyone.

STUDENT: Thank you.

JERRY: We all close with God Speed.

STUDENT: Thank you.

STUDENT: Bye.

STUDENT: That was great.

STUDENT: Bye.

JERRY: Bye-bye guys.

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ROBERT: Thank you, Jerry, appreciate it.

JERRY: OK, I'm signing off now.

ROBERT: All right.

STUDENT: Thank you, Jerry.

STUDENT: Thanks, Jerry.

STUDENT: We love you.

STUDENT: Bye.

ROBERT: I'm going to kill you all now, goodbye.

STUDENT: Bye.

STUDENT: He's going to kill us all. He's going to kill us!

STUDENT: [INAUDIBLE] just keep shifting between cameras for some reason.

STUDENT: People are slowly dying.

STUDENT: This is sad.

STUDENT: We're over it.

STUDENT: Yeah, we're all slowly being removed from the chat.

STUDENT: [INAUDIBLE] chat room. Ah!

STUDENT: Hey, [INAUDIBLE]. Hey, [INAUDIBLE].

STUDENT: What's up, bro?