

DISCOVERY 30TH ANNIVERSARY ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

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INTERVIEWED BY ERIK M. CONWAY
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CONWAY: Okay, great. Finally glad to meet up with you, Leon. It's been a while.

ALKALI: Yes, it has.

CONWAY: What I wanted to do today is talk about two roles you've had. We started this request with VITAL [Ventilator Intervention Technology Accessible Locally, for COVID-19 patients], but I also want to talk to you about GRAIL [Gravity Recovery And Interior Laboratory], because I understand you were the GRAIL proposal manager.

ALKALI: Proposal manager and Capture Lead.

CONWAY: I think nowadays those are separate things, but once upon a time, they weren't.

ALKALI: Exactly.

CONWAY: So, first off, let's talk about the ventilator project briefly. So the first question is, how did you get involved?

ALKALI: Sure. So what happened is the pandemic, the COVID pandemic, started to really become more, let's say, evident in the United States, around the world, and in the news. There was a moment where it became pretty alarming in the public media that there was a dire shortage of ventilators, so this kind of emerged mainly from news coming out of Italy. At the time, Italy was hit very hard, and I'm talking about early March 2020. So Italy was hit very hard and there were stories being told or reports being made that the frontline healthcare workers in Italy had to make almost like godlike choices to whom to give ventilators, based on how many children they have or what their family situation is and so on. This kind of sent shockwaves throughout the world, that a nurse has to decide between one person or another to whom to offer lifesaving ventilators and making life/death decisions, which was pretty shocking to anybody who would be listening to that.

So, roughly around that time frame, in early March, I get an email from Dave Van Buren, and he sent me an email, something to the effect of, "Hey, Leon, I hear from others that this whole area of medical stuff is something at JPL [NASA's Jet Propulsion Laboratory, Pasadena, California] that you've been championing. I think JPL should do something about this in the U.S. I think we can come up with a quick way to allow everybody to go to Costco or Home Depot and assemble their own ventilator and, therefore, save lives."

So it really came through an email from David Van Buren in, I would say, around second week of March. So that's the first I heard of anything, and I reached out to my boss, Dave Gallagher, right away, texted him, and I said, "There's something that we might be able to do here. I think we should proceed." And he responded favorably. That was like a Friday or the weekend.

And on Monday, March 16th, we had our first meeting at JPL with a local doctor, Mike Gurevich; “Dr. M” we called him—from the Huntington Memorial Hospital, and we had our first lesson on how ventilators work. Ventilators 101.

CONWAY: Wow. That’s pretty fast. How did you find Dr. M?

ALKALI: He actually reached out to us. I believe it was David Van Buren who reached out to him to find out what’s going on. . . the doctor from Huntington was working in the ICU [Intensive Care Unit]. He is a respiratory doctor, was treating COVID patients in the ICU, and either he knew David Van Buren or David reached out to him to see if he would be willing to join our team, or vice versa. I don’t remember the details. They did not really plan for that way, but I think Dr. Gurevich also had a similar vision, you know, maybe engineers can put together something quickly, and JPL is a hotbed of engineers, so there was some kind of matchmaking going on there behind the scenes, and they got together.

CONWAY: Wonderful. You mentioned you’d been championing medical stuff at JPL. Tell me a little bit about that.

ALKALI: Yeah. So this is a nice, I think, story. I’ve been at JPL for—I retired recently after thirty-two years, and I had many initiatives at JPL. In my last five years at JPL, I was dealing with strategic planning, strategic partnerships at JPL, and I created something called the Blue Sky Studies Program. The Blue Sky Studies Program was a funded program at JPL from investment, to stimulate ideas that are not necessarily the mainstream ideas at JPL. It’s not your

next lander on Mars or next orbit around Jupiter or Europa. It was really intended to stimulate not-your-mainstream ideas, looking at the future of the laboratory, being creative and disruptive and so on.

One thing we created some seven, eight years ago is a Medical Engineering Forum. This was a group, an informal group at JPL, of people who all had some additional collaboration or effort or research that has ties to medical engineering. So, I created this forum with also another colleague of mine at JPL, Dr. Shouleh Nikzad, and with Dr. Rao Surampudi, and for seven, eight years, we've been stimulating, networking a dedicated group at JPL *just* in the field of medical engineering. The theory was that there's a lot of synergy and overlap between the engineering work at JPL and medical engineering solutions for healthcare. We did not anticipate a ventilator. That was not foreshadowed in any way. But there were many others areas of mutual interest such as in robotics, in precision metrology, in a number of different areas where JPL technologies can benefit healthcare. So that was put in place seven, eight years ago, and that was known in the JPL community that we had that effort.

So once this came up with David Van Buren, I believe he reached out to his division manager, and his division manager said, "You know, you should reach out to Leon. He's got some network of people at JPL. See if he can help." And that's really what happened.

CONWAY: So, then ventilator is not completely unprecedented, because you had already spent some effort cultivating people interested in that kind of thing at JPL.

ALKALI: Hundred percent, hundred percent. There is a—I would call it, let's say, an interested network of people at JPL, some who have joint faculty positions, who are passionate about

medical engineering and healthcare. It could be at Cedars[-Sinai Hospital, Los Angeles], it could be at City of Hope [Hospital], it could be at Children's Hospital. There are a number of people at JPL who have dual, let's say, interests, not only in space exploration but in medical engineering. This is not new.

I would guess there's close to 100 people at JPL who have various degrees of involvement in the field of medical engineering. That was uncovered when we had our first workshop at JPL on this topic. This would be 2014, where we held a workshop, invited people from outside, and then a whole bunch of people at JPL came over and said, "You know, I have an adjunct position here. I work with such-and-such." So, this was one of the revelations that we made at JPL, and that's kind of what reaffirms the Blue Sky Program as being an interesting and a valid thing to champion, because you never know until you ask these questions.

CONWAY: So it's another case where JPL has a core of over-talented people with lots of ties outside of space exploration you wouldn't think of. [laughs]

ALKALI: Absolutely, and, you know, there's a lot of, let's say, altruism built into JPLers. They want to do good. They know their technology can do good, and there are straightforward ways of licensing technologies. But then people also like to collaborate. They have joint research programs, they spend time, they do various collaborations with other medical institutions. And then JPL does have microbiologists, JPL does do Planetary Protection, so we do have a valid technological overlap with bioengineering. And, by the way, Caltech [California Institute of Technology] is huge in this area. Caltech has lots of work in bioengineering, so it's not totally out of the comfort zone at all.

CONWAY: So, let's see. So, let's go back to more specifics about VITAL. That was great. Thank you. Tell me what did your role become during the ventilator project?

ALKALI: So, in the immediate hours and days of the ventilator project, Dave Gallagher, as the Associate Director, was immediately put in charge of overseeing the overall effort, reporting directly to Lt. Gen. Larry James [Deputy Director of JPL] and Mike Watkins [JPL Director], and also Roger Gibbs was appointed the Project Manager. And I, being from the JPL Medical Engineering Forum and working for Dave Gallagher as the Manager of JPL Strategic Partnerships, I was immediately taking responsibility for all external strategic relationships, partnerships, and also being part of Roger Gibbs' inner circle for project management. So, I was his right-hand man as assistant to Roger Gibbs. Immediately, my role was to reach out to the FDA [U.S. Food and Drug Administration], to hospitals, to NASA Headquarters, and external legacy ventilator developers, like Medtronic, and other national laboratories, other government agencies, like the Department of Homeland Security, Human and Health Services, and all the other U.S. government agencies. So, there was a whole slew of activities dealing with external interfaces that really benefited from my experience.

CONWAY: What did those connections contribute?

ALKALI: I'll give you an example. Within our first week of working, we pivoted the whole strategy from designing something that you can go to Home Depot and buy and post on the Internet and have everybody assemble. We realized that that was a nice dream, but not practical,

and actually would maybe bring more liability to JPL than anything else, and the reason we came to that conclusion is we called a few hospitals, including Huntington, and I talked to the director there and I asked, “If we design and build something quickly, would you use it without FDA approval?”

And they said, “No, we would absolutely not. We have a responsibility to the patients and to everybody to make sure that we don’t do more damage than good.” So, the answer was simply no, they will not use a device without FDA approval.

Within days, we pivoted from a nice dream to what is more realistic, and what can we realistically do. So, we immediately decided within the first few days that this will not going to be a toolkit that you can download off the internet and wish everybody good luck. This has to be done right, and if it’s going to carry JPL’s name or NASA’s name, by association it’s got to be done so that it can be cleared by U.S. regulatory authorities.

FDA immediately was the number-one contact. Within the first days, I reached out to the FDA, and within hours, I got Dr. James Lee, the director of the U.S. regulatory division for ventilators and other respiratory devices. This was pretty unique, you know. You don’t just cold-call the head of the FDA for all ventilators in the United States and get them onboard. So, within hours, I got a hold of James Lee. He was super excited, and he said, “Leon, I would like to be on your team. Let me know how I can help you guys at JPL.” So that was a breakthrough. That was a make it or break it kind of a moment. So that’s the kind of work I did.

CONWAY: How did you find him? I can’t even imagine the phone calls I’d have to make to find the right guy in Washington or wherever that is.

ALKALI: I did what everybody did; I went on the Internet and found their website for respiratory approval, and looked at the bottom and saw the director. I sent him an email, saying, you know, “I’m just a rocket scientist, and we don’t know anything about ventilators, but we think we can help.” And he called me right back.

CONWAY: Wow. He also was taking a bit of a chance there, then.

ALKALI: He was, but I also have to give credit to, you know, our email address is jpl.nasa.gov, so it’s not just any Gmail address. He most probably took a little bit—and my signature is “JPL fellow and doctor,” whatever. I’m putting a little bit more credit to where we’re coming from as a laboratory than just him taking chances on just anybody. So I think that helped a lot. I’m pretty sure the team would credit that moment with being a breakthrough.

CONWAY: So we’ve talked about getting FDA onboard and also Huntington. Talk about your work with industry. You mentioned Medtronic in Minneapolis, I think they are. But tell me about that. How did you seek them out and get them to work with you?

ALKALI: So this is where my experience comes to play. Before I start talking too much about me and myself, I just want to make sure that you understand that there was a very small core team. Roger Gibbs and I and Rob Manning and David Van Buren were kind of the core leadership team from day one, so I want to make sure that that’s recorded and named upfront. Roger Gibbs and I talked multiple times a day, and divide-and-conquered, and same with Rob Manning and David Van Buren, so we really were a tightknit group. Roger was focused on building the core

team. Mike Johnson was the chief engineer. Rob Manning is the Laboratory chief engineer. So we kind of huddled at least twice a day, first thing in the morning and then later in the afternoon, and then we were moving *extremely* quickly, but we were kind of dividing the efforts.

So the way I reached out to Medtronic is that I knew that Caltech had an excellent working relationship with Medtronic. Medtronic is actually on the Caltech whatever it is, corporate partnerships list and so on, and the CEO of Medtronic has a close relationship with Caltech as well. So I knew that much from my prior medical forum activities. So rather than calling Medtronic, I called Caltech and I said, “Caltech, I need your help. I want you to put me in touch with the CEO of Medtronic.”

And just to be a little bit more kind of amusing, the person I talked to at Caltech said, “Wonderful. Yes, we have a relationship with Medtronic. I’ll get back to you next week.”

And I said, “You didn’t hear me? I want an answer in less than three hours.”

And they said, “Wow! I’m not sure we can do that.”

I said, “Yes, you can. We’re dealing with ventilators, we’re dealing with lives. This is not going to happen a week from now. This is going to happen in the next three hours. Please do what you can.”

And in the next three hours, I get in touch with the CEO of Medtronic. He assigns his person to the team, and from day one, we had Medtronic as a partner. And to give them credit, they did not ask anything in return. They offered all their IP. They just wanted to help do the right thing. They participated in all our reviews. They threw their team as advisors to us without asking for anything in return or not knowing that they will get anything. So they were a partner from the beginning. So that’s kind of, again, what I brought in that sense in terms of partnerships, what helped a lot.

CONWAY: You've mentioned Caltech is big in medical engineering. How did—sorry. I'm struggling a little bit to formulate the question I want to ask. Is this the only contact you had with Caltech? Did they have other roles in the ventilator project besides [making this connection]?

ALKALI: They absolutely did. They absolutely did. You know, the whole ventilator project moved *extremely* fast, so think of it. We started March 16. That was the date the project started. By the end of April, we had FDA approval. From the first meeting where nobody knew anything about ventilators, until April 30th, we had FDA approval for Emergency Use Authorization. In fact, we were showcasing our ventilator in the White House. So that is, even today, when you think about it, incredulous that in a matter of less than two months, you go from a whiteboard to FDA approval. And beyond that, what we did was to license this technology all over the world, and that's where Caltech came into play.

We realized—again, this was one of my roles; Roger really left it up to me—what are we going to do with this? We design it, we build it, we get FDA approval. Then what? What do we do with this? We're not going to manufacture. We're not going to set up a shop at JPL and build a thousand of these. How do we get this into hospitals? So there's multiple ways to do this. You can team up with industry, and that's kind of how the White House was doing things, and Human Health Services and Department of Homeland Security. They would team up with GE [General Electric] or they would team up with GM [General Motors] or with—and these were sometimes forced marriages, sometimes joint kind of efforts, but it was kind of mandated.

So we had two options. We could have done an RFP [request for proposal] and say, “Hey, we’re going to pick a manufacturer,” a Lockheed Martin or a whoever to manufacture this. And we thought that was not the right way to go, not the best way to go.

What we did is we offered a free license to the world, with full support of JPL, full documentation of everything, software, hardware, everything. So this is where I worked with Caltech. I said, “Caltech, you have a Technology Transfer Office, Dan Broderick and others. Let’s put together a rapid transfer case.” And Caltech had never done anything like that before. We had two workshops, we had a process place, we had proposals to review, ten-page proposals. All this had to be thought through carefully, and then we went through a rapid process of distributing information, and we had hundreds and hundreds of proposals. We down-selected. We went and assigned license agreements with companies in Nigeria, in Australia, in Canada, in Mexico, in Japan, South Korea, Malaysia, Armenia, Turkey, Egypt, UAE [United Arab Emirates]. The list went on and on and on. So we were very, very excited about it. And in the U.S. And as of today, these ventilators are being distributed primarily in India and Brazil. So that was another role that Caltech played.

CONWAY: Great. We haven’t talked about the design goals. You started out with, “we wanted something you could build from Costco parts” and then had to change for regulatory reasons, which makes perfect sense, but what were other design goals for the device and for the process?

ALKALI: This is something that JPL does extremely well, and this is where I’d say compared to just any other place, including other laboratories, national laboratories, JPL just is a powerhouse of engineering, and the talent that we put together on this project was just amazing. In other

words, once you define the requirements for what you want to build, our machinery takes over. Our processes take over. So Brett Kennedy on our team was in charge of requirements. Stacey Boland on our team was in charge of defining the medical healthcare interface and usability requirements. So once we do a spec sheet saying whatever we're building, call it VITAL, call it whatever you want, it needs to meet these requirements, and those requirements were reviewed by the doctors, by our partners at Mount Sinai Hospital in New York City, and other places, and they said, "Yes, this is the flow. This is the requirement." Once we knew those, our engineers can build the system that will meet those requirements.

And another requirement that we have to deal with, we had as a rule, we knew that if we infringe on the supply chain of the legacy ventilators, we would be in trouble. Here we are building something new and we're taking away supply from Medtronic? That would be a disaster. So we have to source all the parts from non-existing supply chains. That means from the automotive industry, from other science instruments, from other medical applications. And we did that very successfully. We found supply chains that were not at all in the medical business, but met all the requirements. So that was really done well, so that was part of the requirements.

CONWAY: So was that JPL procurement that found those things? Did your engineers find it? Who did that work?

ALKALI: Yeah, we worked with JPL engineers, first of all, and we also got some outside consultants. We hired, actually, an outside supply chain consulting company that does that for a living. So it was basically, most of what we did, we relied on our knowledge and processes at

JPL, but wherever it didn't fit, we reached out to our partners at Medtronic, other places, consultants, and so on.

CONWAY: One last question before we move on to GRAIL. Tell me who the other key players were. You've mentioned a number of people, but who else have you not told me about yet?

ALKALI: Well, certainly Michelle Easter was a key player. She worked with Mike Johnson. Mike Johnson was the chief engineer. Sarah Hovsepian was another key player. Arbi Karapatian was in charge of ventilator production, supply chain analysis and more. You have to realize we had at some point over 100 people involved from JPL, and most of them I never met before and still to this day haven't met. So the people—like I mentioned, David Van Buren, Roger Gibbs, and Rob Manning, we worked together before and I knew them and so on, but certainly there were many, many others involved and certainly would love to give credit to all of them as being key contributors to the team and so on.

CONWAY: Right. The mandatory work from home has to have made that job much more difficult. As you say, you wound up never meeting any of the people doing it.

ALKALI: Yeah. You know, for a while during this first thirty, forty days, I know Roger Gibbs and I were reporting to Dave Gallagher and the JPL Executive Council twice a week, twice a week, because Mike Watkins and Larry James and Dave Gallagher were worried, you know. One, are we credible? Are we just wasting everybody's time, or can we actually do something useful? And, two, all of this was going to cost JPL. We tried very hard to get this money that JPL

invested reimbursed by NASA. That did not happen. At some point, JPL basically assumed the risk and said, “This is just good for JPL to do, regardless of whether we get reimbursed by NASA or not.” Obviously, something like this is not well defined in the prime contract. But at some point, to JPL’s credit, JPL said, “This is good for the nation, it’s good for JPL. It shows the fighting spirit in the presence of an ultimate national security threat.” So for JPL to rise above, let’s say, the legal or the politics or money was just really commendable, and it was recognized by the NASA Administrator, recognized by the White House, by the press, the media. So it was a brave decision by JPL. JPL could have easily said, “This is not funded.” It was pretty expensive for JPL to do, and it was absorbed in the overhead of JPL.

CONWAY: Essentially the investment budget.

ALKALI: The investment budget. Dave Gallagher, again, I’ve mentioned his name many times, but he trusted us. He backed us up many times when there was some concern.

Then we had a disengagement plan. The fact that we licensed this out to the world was a way to get out of it in a way that we can then empower the world, but not continue the process indefinitely.

So certainly I want to mention Stacey Boland, Chris Yahnker. Chris was in charge of the FDA approval process, really brilliant. Stacey Boland was magnificent. Michelle Easter, I mentioned as well. Arbi Karapetian was in charge of the supply chain and manufacturing. And each one of them had teams. So, just a great, great group of people.

CONWAY: Fantastic. Thank you. Now we have to jump backwards in the past like almost twenty years, so we can talk about GRAIL.

ALKALI: Twenty years? Oh, my god.

CONWAY: Well, ventilators, 2020, right? And GRAIL was—

ALKALI: GRAIL was launched in 2011.

CONWAY: 2011, awarded in 2006. So it's not twenty years.

ALKALI: 2007, GRAIL was awarded, so in 2005, the step one was part of the—so 2005, so it's like sixteen years, yeah.

CONWAY: Yeah. So tell me what your task was at that time. What was your job description in the 2004, 2005, 2006 time frame?

ALKALI: So at that point, I had transitioned from a prior career in technology development and technology programs into a new area. Really it's the area that I think I made significant enough contributions to JPL that I was elected a fellow, after winning both GRAIL and InSight [Interior Exploration using Seismic Investigations, Geodesy and Heat Transport], a mission later on.

Before I stepped into the GRAIL proposal, I was transitioning from technology into mission formulation, and I was put in touch with Professor Maria Zuber from MIT

[Massachusetts Institute of Technology, Cambridge], who's now the—I believe she's today a vice president for research at MIT. She reached out to JPL, to Charles Elachi at the time, saying that she wants to do a mission to the Moon. Now, this is early 2000. The irony of it then was that she first reached out to Goddard, Goddard Space Flight Center, the director, and Goddard basically said, “The Moon is not in our strategic view. Why don't you go to JPL.” And it was kind of like, you know, “Leave us alone. We're not into the Moon. Go and talk to JPL.”

She reached out to Charles Elachi, and Charles didn't turn her down, but said, “Sure, we'll help you out.”

So one thing led to another, and I was given an opportunity to interview with Maria Zuber. My interview was—maybe there's a trend here. It's kind of like my reaching out to the FDA. I told Maria, “I've never done this before, but I've won many DARPA [Defense Advanced Research Projects Agency] and other technology programs. I know how to write proposals. I've never done anything of this scale, but I'm super excited to work with you.”

And her response immediately was, “You're my man. I want you.” And that was it. There's something in that, I guess, style of being upfront about what you know and what you don't know, and showing enthusiasm to work hard and be creative. So that's what happened with Maria Zuber.

The GRAIL proposal came out very kind of serendipitously. At that time when there was a Discovery call from NASA, JPL had already planned in its pipeline ten proposals out of JPL, ten proposals to submit, and then at the time—he's now retired—Gregg Vane at JPL was leading the Program Office for Planetary, and he knew that I was interested in lunar stuff, and he reached out to me and said, “Leon, we don't have any proposals to the Moon. I know you're working

with Maria Zuber. We'd like to get a proposal. I don't know what it is, but let's do it at the Moon."

The first batch of JPL proposals were already launched through the process at JPL and already working with formed teams, and I felt really bad because I did not have a team, did not have anything, so I actually reached out to a few people, Alex Konopliv, Mike Lozano, and actually Mike Watkins at the time. A few of us put together literally back-of-the-envelope kind of a drawing of a mission like GRAIL at the Moon.

I basically came back to Gregg Vane after a week, and I said, "I think we can do this kind of a mission." And I was in. I was into the portfolio of companies, and I was the last one in, but the only one that came out. [laughs]

CONWAY: GRAIL's very like GRACE was, which, of course, explains, at least partly explains Mike Watkins' interest.

ALKALI: That's right.

CONWAY: Did you explore that sort of outright at the beginning, "Maybe this is a way to go"?

ALKALI: Absolutely, 100 percent. I actually went to—I'll get his name—close to Gray Davis or—the guy who was the project manager for GRACE.

CONWAY: Ab Davis [Edgar Davis].

ALKALI: Ab Davis. Thank you. Ab Davis. I reached out to him right away, and, you know, for the longest time in our proposal we called it GRACE at the Moon. We did not shy away from the connection. We did not try and make this totally new. It was GRACE at the Moon, and that's what we called it. For lack of a better name, we called it GRACE at the Moon.

But the real challenge was, is there enough science in gravity at the Moon? That was a huge issue. Can you do a Discovery mission on one measurement? Usually you have three, four instruments. This is going to be one measurement: gravity. Can you do GRACE at the Moon? On Earth you have GPS, you have a whole bunch of things going on at Earth that you don't have at the Moon. So the whole transposition of GRACE on Earth to GRACE at the Moon was not trivial. That was exactly—I studied gravity recovery from the early *Science* papers in the sixties, to how it was implemented on GRACE. I met with Ab Davis, I met with the whole team there, and they were still operating, doing well. So that was a huge source of information.

CONWAY: And also, I'd imagine, confidence, because it worked, and by the time you were writing that proposal, everybody knew that.

ALKALI: That's right. And, in fact, it turns out in some way it's much harder to do on Earth, because on Earth you have atmosphere and you have to have additional instruments onboard the GRACE spacecraft to measure the disturbance from the atmosphere. So you have to compensate, get rid of that noise, which you don't have at the Moon, but on the Moon you don't have GPS. So how do you create the capabilities, especially when you go behind the Moon, how do you keep track of each spacecraft and figure that into your model for recovering the gravity? So there were a lot of small miracles that had to happen at the Moon to make that a credible mission.

CONWAY: Just sketch for me what those solutions were. Were they purely modeling or was there some other way of determining positions on the far side?

ALKALI: Absolutely. So, first, we had to create our own kind of a GPS. So there's an S-band and an X-band communication between Earth and the Moon, certainly when they're in sight of Earth, and then there has to be precision tracking, bidirectional precision tracking from each spacecraft when they're not in communication with Earth. There is precision Doppler, everything going on while you're in sight of the Earth, and then when you're behind the Moon, they keep very close track of each other behind the Moon, and you have to extrapolate that, you have to understand the uncertainties of it, and so on. All that was modeled *extremely*—I mean to such confidence that it can actually be done, and so on. So that was all—clearly there are ultra-stable oscillators onboard, there's a lot of other features. The instrument was based on GRACE, and the Ka-band interlink measuring the distance between the spacecraft to a nanometer, so, very, very precise.

When we got selected in the finals of the competition, we had to demonstrate to the review board that this will work. We took them to an anechoic chamber up on the hill of JPL and we had an actual display of a prototype of one side of the instrument and then the GRACE space equipment on the other side, and we showed that we could measure the distance precisely, and we had the board jump up and down on the slab of the anechoic chamber and we showed the vibrations on a monitor as they all jumped up and down, indicating that we can show those kind of changes in the distance. I mean, that was just—let's call it—that just nailed it.

CONWAY: How did you get the money for that? That's actually something that Dave [Lehman] told me about, too, because he thought it was very important to winning. But how did you get the money for that demonstration?

ALKALI: So JPL does have investment budgets for proposals, and then JPL does, I would say, get creative in ways that we can put aside some investment budget in infrastructure that is multipurpose use within JPL. So we took some hardware from GRACE, spare hardware from GRACE. We were able to build some new prototype. So we kind of begged, borrowed, and plundered from wherever we could to hodgepodge a demo with what we had. You know, when you do a proposal, you get creative, you're innovative, and you borrow things, hardware from wherever, spare parts here and there, and you demonstrate the key technology. So it was very creative and innovative.

CONWAY: Tell me about assembling that step one proposal. You already told me that Gregg Vane was part of your supporters, but tell me about the process of pulling together the people that do it.

ALKALI: So I would mention Gregg Vane and Greg Garner. Greg Garner was also key to helping out with this. The nice thing about both Gregs, Gregg Vane and Greg Garner, is I personally, as a lead for this proposal or lead for the strategy, I work best when I'm kind of allowed to operate on my own.

CONWAY: Independently?

ALKALI: Independently, and then get help when I ask for help. So I would have weekly meetings with Greg Garner and I would say, “Greg, this is where I need help. I’m not sure about this. I’m not sure about that. I really need somebody here from a staffing point of view,” and it would be very targeted. And Greg would get on it and help me out. So I worked best when I was free to do what I do best, and then not micromanage. I guess that’s what I would say. And that’s really how it worked best.

I worked with David Smith from Goddard, Maria Zuber from MIT, obviously Dave Lehman in step two. And I remember handing Dave Lehman in the cafeteria the step one proposal, saying, “Dave, you’re it. We won the step one. Now we’re going to work together with you.” [laughs]

And I remember also a joke or a casual remark from Tom Gavin in the cafeteria when it was announced that GRAIL won the step—the only one out of JPL out of the eleven that won from step one to step two. There were three selected, one from Goddard, APL [Johns Hopkins University Applied Physics Laboratory], and JPL. So Tom Gavin saw me in the cafeteria walking with the step one proposal, laughing and saying, “Leon, what kind of a trouble did you get us in?”

Gavin was instrumental in getting Dave Lehman onboard as a project manager, and Dave Lehman and I got along beautifully. Dave Lehman is just a wonderful human being. He also let me do what I do best, and he just kind of made sure that he could implement whatever is promised in step two. To his credit and to the formulation & implementation teams credit, GRAIL came on schedule and on budget. The flight system manager and later Dave’s deputy was Tom Hoffman who later also became project manager. Tom Hoffman and I worked together

on InSight as well. So there was just good chemistry here between my role and Tom Hoffman, Dave Lehman, Maria Zuber, Dave Smith, Mike Watkins. They let me do my job, and that's not an easy thing at JPL, because, typically, project managers are kind of czars in their own world and they don't often let a project capture lead do what they do well. So I was fortunate in GRAIL and InSight that I was allowed to do that.

CONWAY: I would think for step one, it seems to me, as an outsider, anyway, that there's almost more going on with having to assemble the science story than the rest of it. Is that right?

ALKALI: That's absolutely true. What's challenging in step one, and I believe this is where I've maybe excelled compared to other proposals, at JPL there's a kind of a subculture for years that proposal writing is a salesman's job, and project managers would often look down on that. What I wanted to do in my style and my approach to capture leadership and proposal management is kind of bring those two worlds closer together and bring the appreciation from a project management for this skill and this artform, and in a way, as a capture lead, you have to be a project manager, too, even though I've never been a project manager, but you can over sell something without knowing that it can be built. So, you know, I've tried very hard in that sense to bring the two together and to bring ownership from a project implementation point of view early on, but also an appreciation that as a project manager, if you're going to build it, you've got to win it first.

So there is an element of pushing back and forth, so both GRAIL and InSight, and I would say especially InSight, had a major leap from step one to step two, because in step one, it's mainly science, as you said, but then a lot of things get hidden or overlooked. "Yeah, we'll

just deal with it in step two. We'll deal with it later." Well, those are traps. Those are things that you want to avoid. InSight had a lot of that in step one. "Well, we don't know how we're going to do it, but we'll deal with it later." So that's kind of a lesson learned. You have to almost see the step two in step one and not overly paint yourself into a situation where you can't get out, and that is something that is a lesson learned that I've been through.

CONWAY: You have to have a sense for what's actually possible, even in step one.

ALKALI: That's right, and more than that, you need to build in the right safety net or margins or, like, contingency in step one, because if you win step one, you get into step two and you have to change your science requirements. That's bad news. That means you didn't plan it right, and that could be a kiss of death. And that's happened before. So you have to make sure that those Level 1 requirements in step one are immutable and you didn't paint yourself into a position that you can't get out of.

CONWAY: And did you find that Maria and Dave Smith understood that, or did you have to tell them that?

ALKALI: We had to tell them that, definitely. Definitely we had to tell them, and this is nothing negative against them. I think it's more intrinsic to scientists and PIs; they want more science. And for GRAIL, there was clearly a concern. Is NASA going to award a 350-million-dollar mission to a one-measurement Discovery mission, two spacecraft, one measurement? That really hasn't been done before, you know. If you look at all the Discovery missions, they have cameras,

they have magnetometers, they have this, they have a bunch of instruments, and then it's a matter of, well, do you have one instrument too many? Well, you can descope. But if you have one measurement, there's nothing to descope, right? That's it. So that was not clear.

On the day what we were selected, I was in San Francisco with Dave Lehman and Maria, and when we went for a drink afterwards at a local brewery in San Francisco, Alan Stern, who made the selection, joined us. I was a bit nervous, you know. He was the AA, Associate Administrator for Science. And he was just glowing. He was just so proud and so happy with the selection, and he told us that NASA did three independent cost reviews of GRAIL, and all three validated our cost methodology, and he thought that that was so unique. And I was very proud of that.

Fast-forward in 2011 and so on, GRAIL came, I think, actually under budget, launched on the date that was planned in step one. That doesn't happen very often, and certainly something we should all be proud of.

CONWAY: Yes. Well, it's one of the few Discovery program missions that actually conformed, I think, to the intent of the program back in 1993, which was low-risk, cost-capped science. If you only have one instrument, your risk is pretty low.

ALKALI: That's right. It's really the cost of science, right? And you have to get it right. If you get over-ambitious, you know, your cost grows. So I kind of think of it we found the low-hanging fruit in terms of great science at the right cost. When we were trying to brand the mission, I forbid anybody from saying "cheap." I said, "This is not cheap. This is a lot of money for great science, and we need to give NASA a great deal." And that's how they saw it, a great deal, great

science, and the science went way beyond what we had in mind, not just discovering the core, but detecting lava tubes and dikes and many, many things on the Moon that was never planned, and upgraded the gravity maps for navigation at the Moon, and just many, many additional good things that happened from this mission.

CONWAY: So my famous last question, because we're about out of time, is what haven't we talked about about GRAIL that we should have?

ALKALI: Well, I always want to make sure that the team is recognized. I mentioned a number of names. There was also Bill Klipstein, Sami Asmar, Charles Dunn, and many others who played a major role, and a bunch of people who just did a phenomenal job. I also want to mention Lockheed Martin, my good friend Stu Spath, who recently retired. So Lockheed Martin played a tremendous role in building the spacecraft, both spacecraft, for GRAIL and for InSight.

That whole selection of the spacecraft was a masterpiece, masterpiece. I could lecture on that for hours. We did an RFI [request for information] and then an RFP [request for proposal], and it was a cutthroat competition between Astrium in Germany that built the GRACE flight system, and Lockheed Martin, and ultimately the decision came to Charles Elachi, but it was a neck-and-neck kind of a competition between the two providers, and ultimately Charles picked Lockheed Martin, which was a great, great decision.

But, again, just to give you another very, very quick story. When we looked at how this mission would be implemented, back in the first days of planning, we picked a spacecraft that was available, and it was by a company called Spectrum Astro, which Stan Dubyn used to lead at that time. When we opened it up for bidding, they called us and apologized. They called me and

apologized to me that they're not going to bid on the RFI because they simply don't know how to do it. They said they don't have the in-house expertise, because we specified very, very detailed requirements for the spacecraft capabilities, pointing accuracy and much more. And it was the hardest thing for me not to tell them that we know they can do it, because we've used their spacecraft as a proof that it can be done at low cost. But it just showed the difference between JPL and other organizations. There you go.

CONWAY: Okay. We're out of time anyway, but thanks for that story. [laughs]

ALKALI: Yeah, I finished the story, but that was just an interesting story on the differences between JPL and the rest of the community. We knew they can do it, we used their data, and they were not sure how to do it. But anyway.

CONWAY: Or they couldn't figure out how to make money doing it, because it may have been very difficult for them.

ALKALI: It was technically challenging for them.

CONWAY: Yes, I understand that pointing accuracy would have had to have been phenomenal in order for that to work.

ALKALI: Pointing accuracy, thermal control, navigation at the Moon, a lot of challenges at the time, and Lockheed Martin did a great job.

CONWAY: Thanks for your time, Leon. You'll get a transcript in a few weeks to review and edit.

Okay?

ALKALI: Thank you so much, Erik.

CONWAY: Thank you. Have a great day.

ALKALI: Bye.

[End of interview]