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Interviewee: Bering, Edgar and Jacobs, Laura
Interview Date: February 27,2014

University of Houston
Oral History of Houston Project
The Mars Rover Celebration

Interviewee:	Edgar A. Bering, III, Ph.D.
Interview Date:	February 27, 2014
Place:	Dr. Bering's office in Science and Research Building One on the University of Houston Main Campus
Interviewer:	Alicia Nichols
Transcriber:	Michelle Kokes

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Abstract:

University of Houston, Main Campus physics and electrical and computer engineering professor Dr. Edgar A. Bering, III, who also serves as the chairman of the Mars Rover Celebration, and the principle investigator for the Mars Rover grant at the University of Houston, discusses the Mars Rover Model Celebration. Also present was Ms. Laura Jacobs, a Ph.D. candidate in educational psychology at the University of Houston, and day-director of the 2014 Mars Rover Celebration event on the University of Houston campus.

Dr. Bering explains the program itself, designed for third, fourth, fifth, sixth, seventh, and eighth graders, that includes a series of 5-E lesson plans and culminates in the students selecting a Mars issue that they would like to study, and creating a mock-up Mars rover to help them answer their question. Dr. Bering details the history of the Mars Rover Celebration at the University of Houston, from about 2002 to the present. Dr. Bering became interested in creating a program for elementary and middle school students after his children studied and created Mars rovers in their elementary school classes as part of the city of Houston's SPARK Park Project, around 1993. Dr. Bering discusses how he adapted the materials used by his children's fourth grade teacher and created the Mars Rover Model Celebration event held on the University of Houston campus to coincide with the 2002 World Space Congress, which was hosted in Houston. Dr. Bering also discusses the importance of space exploration, K-12 education, the education of elementary and middle school teachers, and the importance of educating students in science and engineering. Events like the New Millennium Program (NMP) and the missions of various Mars Rovers (such as *Curiosity*) are also discussed.

UNIVERSITY OF HOUSTON
ORAL HISTORY OF HOUSTON PROJECT

Edgar Andrew Bering, III, Ph.D.
with Laura Jacobs

Interviewed by: **Alicia Nichols**
Date: **February 27, 2014**
Transcribed by: **Michelle Kokes**
Location: **Houston, Texas**

AN: So just to start, I Alicia Nichols am interviewing Dr. Edgar Bering on February 27, 2014 in his office in the Science and Research Building I on the University of Houston Campus; also here is Laura Jacobs.

LJ: Whee! Transcribe that!

AN: So just to start, I'd like to have some basic biographical information, just as kind of background. So, what is your full name?

EB: Edgar Andrew Bering, III.

AN: Okay, what is your date of birth?

EB: January 9, 1946.

AN: And what is your place of birth?

EB: New York City, or as I tend to put it a small island off the coast of New York.

AN: And what is your educational background?

EB: Okay, I did my undergraduate work at Harvard. I got a bachelor's in physics, cum laude, and then I did my graduate work at Berkley. I went straight to the Ph.D. in 1974. And I came here immediately from graduate school and I worked no place else.

AN: Okay and what is your work here at U of H?

EB: Huh?

AN: What do you do here at the university?

EB: I am a physics professor and a professor at electrical engineering, and my smart-ass answer to that question is: as little as possible. I teach classes, I supervise graduate students, I conduct research in a number of areas including: electric space craft propulsion, the physics of the earth's magnetosphere, engaging undergraduates in advanced research, and in the educational efficacy of various outreach curricula.

LJ: i.e. Mars Rover.

EB: Yes.

AN: So, could you explain your position and your work with Mars Rover, specifically?

EB: Okay, this is perhaps best approached from a history standpoint. I am the chairman of the Mars Rover Model Celebration and the principal investigator of the model… Mars Rover Model Celebration grant [Dr. Bering is the principle investigator of the Mars Rover Model Celebration grant]. I am also the sitting national chairman of STEM K-12 outreach; STEM is science, technology, education, and mathematics.

LJ: Engineering.

EB: Engineering and mathematics. Education would be more helpful. The uh…

LJ: For?

EB: For the American Institute of Aeronautics and Astronautics [AIAA], and in that capacity I am also chairman of the Educator Academy Project, which is developing aerospace curricula for the AIAA and promulgating them nationwide, and one of them is Mars Rover. So I wear a multiple multitude of Mars Rover hats. And in all of these capacities I do basically three things. I

run the event here on campus. Actually I don't run the event on campus. Laura runs the event here on campus.

LJ: Thank you!

EB: What I do is kibitz.

LJ: Tell her your real, what you really do.

EB: I make policy decisions.

LJ: Right, and for years you probably did half the stuff that I do.

EB: Yes, I have packed all those packets.

LJ: Yeah, he's done the whole deal.

EB: And the… I am also engaged with curriculum development. And that has involved writing lesson plans, researching the efficacy of the lesson plans. What I do is I set policy, and I keep track of what's going on and I remind people of stuff. I recruit the speakers. I raise money.

LJ: I was going to say that's a big thing. You can't do it without the money.

EB: I'm the community interface.

LJ: He's the man behind the curtain.

EB: Nationally, I also am the chief presenter of the teacher training workshops.

LJ: I was just gonna say he does all the teacher training. So that's a whole other arm of it all. So that teachers will use the Mars Rover curriculum in their classes. He does trainings to teach them about the lessons and the whole curriculum. It's awesome.

EB: I mean when I say that the nation is my beat, I have given these workshops from northern New Hampshire to San Diego.

AN: Could you describe the Mars Rover event itself to me?

EB: Yes. The Mars Rover Model Celebration is the capstone of a curriculum.

AN: Okay.

EB: It's the regional competition amongst kids who have carried out our curriculum, and the teams are selected by the schools. Some schools bring everybody, or try to bring everybody who participates. Other schools like say, Quail Valley Middle School where the whole school participates, they have 600 kids in the program, and they only bring about 50. So they have a cut-down process at the school level. The event, the curriculum, starts with the kids researching Mars. So they start out learning process skills on how to do research. And for a third grader being told, "Okay you can go on the Internet and start looking up stuff about Mars." This incredibly motivating. They are being unleashed for the first time. In the school and academic environment, and as far as their parents officially know, they are being unleashed, and they go nuts. Because this is so liberating. And they get to, and the basis of this research, they get to pick a question that interests them. And they know that this is the objective of this research. They know that going in. More motivation. Because for a ten-year-old, this is the first time in their life they've gotten to choose what they study.

LJ: Right they get to pick their assignment.

EB: They get to pick their assignments. They get to pick what they are studying and even within the context of the surface of Mars, well that's a planet with the surface area of the earth, leaving out the oceans, and so there's plenty of topics and the kids really get motivated because they can take ownership of the question. Okay, then what they do is they figure out: "How do I answer this question?" Some, in a lot of cases this is hard. One of the kids picked, "I want to find a good place for a strip place on Mars." I will be politically correct here and just let you guess the gender of this person. Okay, now imagine picking a good site for a strip mall with a robot spacecraft. Deciding what measurements to make turns out to be very challenging!

LJ: Right, what do I need to know to see if a strip mall will work here?

EB: The easier one was the team of young ladies who wanted to do a spa. And because what they looked for was minerals for the mudpacks.

LJ: That was years ago, or a couple of years ago?

EB: Yeah.

LJ: That's a good one.

EB: And, so …

LJ: So the creativity is pretty boundless…

EB: But the science there is actually pretty obvious; you are doing surface chemistry.

AN: Right, correct.

EB: So they then designed a set of instruments conceptually, to answer their question, then they design that set of instruments somewhat less conceptually, and actually build the model.

AN: Okay, so they are building the rover itself.

EB: They are building a model of the rover itself.

LJ: Like a prototype kind of thing.

EB: Mock-up is the term.

LJ: Okay, mock-up.

EB: And they use what professional art teachers call "stuff."

LJ: You see what I'm working with here?

EB: If they are dealing with high school students they call them "objets trouves."

LJ: Which is?

EB: Trash.

LJ: Oh. I was like, I don't know all my French, even though I should.

EB: Actually, it means found objects. But, practically, we're taking about trash. The models are supposed to be made for no money out of, you know, stuff you find around. There are certain rules like don't steal your baby sister's toys. Um, the uh… But your big sister's toys are fair game.

LJ: Right exactly. So they build the model, they come to the event.

EB: They write a skit.

LJ: Right.

EB: So they can present their model in skit form. Now costumes are optional. A tri-fold is optional. Neither the costumes nor the trifold are judged. The skit is judged solely as a piece of writing, and also as a piece of performance merits. They have to rehearse it well. But the costumes and the trifold are optional, but somehow that word never quite gets through to the kids.

LJ: I was going to say every single …

AN: Every single one of them had a trifold. They were all dressed up.

LJ: Deked out, which I think is cool.

EB: And we tell the teachers, "Show them the rubric!"

LJ: But the teachers want them to do well. "You must have a great skit and practice." But the kids. They are getting, so many, practice of so many good skills with presentation, with you know what I mean, with doing all those good things.

EB: Presentation, writing, art.

LJ: Creativity, and then of course all the science, critical thinking, you know the application.

EB: The engineering design process. I mean this is… I realize this is… the "W" term has become discredited.

LJ: What's the "W" term?

EB: Whole learning.

LJ: Oh.

EB: But this is whole learning done right.

LJ: Okay, next question.

AN: So, um, did you start, you started the Mars Rover? No?

LJ: How was it born, was that kind of what you are asking?

AN: Yeah.

EB: Okay, the Mars Rover curriculum was devised by two people named Thea Cañizo, T-H-E-A, new word, C-A-Ñ-I-Z-O…

LJ: Uh-huh. And?

EB: And Larry Lebofsky at the Planetary Science Institute in Phoenix no, no, in Tucson, in Tucson. But they published an article about this curriculum in 1993 or '94 and then Michelle Viotti at the Jet Propulsion Laboratory [JPL] in California picked it up for what they called the Mars Millennium, which was a project jointly funded by the NSF [National Science Foundation] and the National Endowment for the Arts [NEA] to put together a set of activities and curricula pertaining to Mars for the year 2000. And my kids' fourth grade teacher picked it up. It was picked up by the city of Houston's SPARK Park Project. The SPARK Park Project, in case you don't know, is a project where schools get to turn their playgrounds into public parks and in the process they get their playground substantially re-landscaped and, but as part of it the mayor's office said, "Well, why don't you add some curriculum? Do academic stuff. You're a school." So my kids' fourth grade teacher picked up, I mean the SPARK Park Project adopted the Mars Millennium Project as one of their tools.

LJ: Oh, okay.

EB: Packages of goodies. And my kids fourth grade teacher picked up on the Mars Rover project. Now JPL for political reasons associated with some sort of some hissy fit by the Bush administration dropped the Mars Millennium program in 2001. But by this point my kids' teacher had been running it for three or four years, and both of my kids did it in fourth grade. And in effect I am a soccer parent run amuck.

LJ: So your kids' teacher was using this curriculum with her classes, and their school playground got redone by the SPARK Park thing, and they kind of wove in the curriculum?

EB: Right.

LJ: Okay got ya!

EB: And there was another piece. This was in fourth grade. In fifth grade, the corresponding fifth grade project was design the colonial economy of Mars.

LJ: Oh, okay cool!

EB: And, okay.

LJ: So then you said skip forward a few years.

EB: Skip forward a few years, and, well, my son was in eighth grade. I am on the local organizing committee for the World Space Congress. The World Space Congress was the joint congress of the Committee on Space and Research, COSPAR, and the International Aeronautical Congress. Or Astronautical Congress. Astronautical Congress. Two distinct international meetings, one on science, the other on engineering. I, for my sins, got on the local organizing committee. Partly because the president of COSPAR [Committee on Space Research] was one of my professors and I met him in 2000 Warsaw and he said, "Oh we're coming to Houston in two years," and I said, "Oh that's interesting Gerhard, you know I'm at the University of Houston."

Then he said fighting words. This is one of my professors. At that point in time I'd been here for 26 years.

LJ: Okay.

EB: He said, "There is a University of Houston?" "Alright Gerhard!"

LJ: The gloves are off! Was he messing with you or was it an earnest question?

EB: I don't know. Gerhard is still with us and I've never dared ask.

LJ: Because you don't want to know.

EB: Gerhard is about 85 now. [Gerhard Haerendel]

LJ: Aww, okay.

EB: Anyway…

LJ: So they came a couple years later.

EB: They came a couple years later. I went home and got on the local organizing committee immediately.

LJ: Right.

EB: You know Bill White was the honorary chairman and the actual chairman was a guy that worked for Boeing who's now moved onto some place in North Carolina, his name was Joe Meyer, and my job, I was put on the Education Public Outreach Subcommittee. And at that point they thought their local university partner was going to be Rice, and Rice kept dropping the ball after, after ball, after ball. And I partnered up with a woman named Brenda Boycoe who was at that point the Vice President of Research Special Assistant for Special Projects.

LJ: At Rice? Or over here?

EB: Over here. In, you know, the squirrel factory.

LJ: Oh gotcha. So then how did it end up?

EB: I'm getting there.

LJ: Okay. I'm sorry, I keep interrupting.

EB: My… Brenda and I went to the President, Art Smith, and we got this wonderful memo. "This sounds like a great project, please help these people."

End of recording 1

LJ: That's what the president told you to do?

EB: Yeah, the memo, this was pertaining to the entire World Space Congress. I mean that's unchain the wolves memo. You know, by the time we were finished we'd spent a million dollars.

LJ: I was going to say did you say, "What's our budget?"

EB: No, we were not that stupid.

LJ: You didn't ask for money, you just asked for forgiveness after you spent all the money.

EB: So we went around and we did things like we got the athletic department and the drama department to set up a ticket booth. We had the European Space Agencies' charter planes full of students met at the airport by the band.

LJ: Okay.

EB: We gave a party at their hotel for said students when they arrived. Beer and pizza. We had a cocktail party over in the hotel for the dignitaries from the concert and the grad students all found out about it. There was a mailing list cross-up and so we ended up feeding expensive hors d'oeuvres and good liquor to several hundred European graduate students.

LJ: That's awesome.

EB: And we engaged with, okay, the conference decided they were going to have more K-12 kids engaged than they were going to have professional registrants. Now our target was 13,000

registrations. Which isn't that big as conferences go. But then 9/11 happened, so we only had about 8,000 registrations.

LJ: Oh wow! That's still. Oh, I see so then registrants couldn't come because they couldn't get into the country. Okay gotcha.

AN: Got it.

LJ: I was thinking, okay, people didn't come because they didn't want to fly or they didn't want to whatever, but this is a worldwide thing that was the issue. This is really good history thing!

EB: Yeah, so, alright. We decided to try to get as many K-12 participants as we were having professional participants.

LJ: Oh my God!

EB: This was under the leadership of a woman named Mary Sanchez who at that point was at Johnson Space Center, who is now at Sierra Nevada Corporation. We had, we got 20,000 kids to tour the exhibit hall. We didn't tell the professional exhibitors which was a mistake. They were mad at us.

LJ: The professional exhibitors exhibiting things like what?

EB: Oh, rocket engines.

LJ: Okay all these kids come through, "I want to play with that!" Oh my God that would be such a good documentary!

EB: Yeah, I mean you know, a lot of them were giving out things like, I wonder if I have... [Finds a small alien plush toy in his desk.] This by the way is an official U.S. Air Force alien plush toy. And so a lot of them were actually were giving out swag like this.

LJ: Oh and they were just cleaned out.

EB: And they were cleaned out by the 20,000 kids and they were really not expecting it. You know I had a whole lot of stuff like that.

LJ: Okay, so they lost all their swag to people that aren't going to buy any of their stuff.

EB: There aren't many ten year olds who are in the market for a Delta IV Heavy. [Type of rocket.]

LJ: But you know what, that may have sparked so many kids to become scientists.

EB: Yeah.

LJ: Because they got to see stuff that was really cool.

EB: We were planning to have a space day on campus, and we ended up with 8,000 kids. And there were all sorts of, "Okay well what can we do?" And people were talking about, "Okay we'll have BEST Robotics. We'll have FIRST Robotics." And then somebody said, "You know, LEGO needs to be more involved with Aerospace." So we rolled out first, we had them create and then roll out what is now FIRST LEGO League.

LJ: Okay cool.

EB: And then I said, "You know all of this stuff is expensive, most of this is aimed at high schools and you know I mean FIRST Robotics… La Porte has a $35,000 a year budget for FIRST Robotics." They all looked at me and said, "Yeah that's true." I said, "Can't we do something for Title I schools, in elementary school?" They all looked at each other, and they looked at me and they said, "You know that sounds like a good idea, do you have anything in mind?" And at this point the soccer parent struck.

LJ: You're like, "I got it!"

EB: I said, "Well..." Now I was being a good Calpurnican. I, my impression of the totally rigid bureaucracy of the Texas school system was perhaps overstated. I could not imagine that my children did anything that every child in Texas didn't do.

LJ: Right. You thought everybody did Mars Rover.

EB: So I thought everybody did Mars Rover in fourth grade.

LJ: Oh.

AN: Oh, okay.

EB: So I said, "Okay why don't we get together and have a competition and have a city-wide, you know, face-off of their Mars Rover models?

LJ: What Mars Rover models?

EB: What Mars Rover models? Well in fourth grade my kids did, and I described what they had done, and they all looked at me and said, "Well your kids were extraordinarily fortunate because none of us have ever heard of that!" And I said, "Okay, I just learned something about the Texas school system."

LJ: Yeah.

EB: And I said, "Well we could do that anyway. We could have a …"

LJ: So that sparks you going, "Okay every kid should be able to have this curriculum."

EB: Right, and then somebody asked a really dumb question.

LJ: Which was?

EB: "Well, who is going to train the teachers?" And I said, "You know we give teachers certification as part of our degree program here at the University. That's my day job."

LJ: Right… hello!

EB: Ask me something hard! And they went, "Oh, gee, okay, never mind." We put the program together.

LJ: Did they give you a budget for it?

EB: I had to raise the money. Our first year budget was $5K and it all came from the Provost office.

LJ: Okay.

EB: That was part of this memo, you know. I don't think President Smith realized, but at the end we spent a million dollars. But we had you know, thousands of visitor days and the closing ceremony the President of COSPAR, who the incoming president of COSPAR was somebody that I had gone to Harvard with and still write papers with, a fellow named Lou Lanzerotti, and he gets up and he thanks four organizations in the city of Houston. One of them is the University of Houston, and the others are things like the convention center. And I made sure the president got a recording of that.

LJ: Right. You're like, "Here."

EB: We were very successful in being a really good host. The deans loved the cocktail party full of students. Poor Brenda was tearing her hair out because she hadn't ordered enough food or drink, and the deans got literally hundreds of applications for graduate school from all of these undergraduates. For the European graduate students, the European undergraduate students, this was an exotic new place to go to school.

LJ: Exactly! And that's a big part of U of H's base now, is international students.

AN: International.

EB: And, uh, so…

LJ: And then it just grew and grew.

EB: And from there it grew and grew.

AN: Awesome. So, um, how long has it been that you've been working with Mars Rover?

EB: That was 2002, it's now 2014. It's 12 years.

AN: Okay awesome. Has Mars Rover changed much from its early days?

EB: Yes, first off it's a lot bigger. Second off, we have learned a great deal about how to do it well. We have gone from teams of people with pads of paper and pencils doing scoring to using the University's registration computers and registration scanners. The big iron. So the data processing has improved a lot. The registration process, it used to be emails to me, now we have a whole big deal online system.

LJ: Right.

EB: We have gotten a lot more engagement from the University. When I started, all of the judges and all of the volunteers were from the NASA community. Virtually no university students did anything. Now it's the other way. We have about 500 university students helping us and relatively few NASA volunteers.

AN: Would you like to see those numbers go back up?

EB: I'd like to see the NASA side go back up.

AN: How would you go about trying to do that?

EB: I have no clue. Because if I understood how to do that, I would have done that already.

LJ: Some of it is, I think we can look at, like how do we go about, like this was my first year, so it was like I was learning as I went along. But now we can look at it and go okay, "How can we on the front end expose them more and get them roped in?" I don't know we'll try different things.

EB: I think it's mostly the current state of turmoil and funding uncertainty at NASA. Nobody feels like being…

LJ: Like pulling away from their job to go then do extra stuff.

EB: These are civil servants, they don't work on Saturday.

LJ: What's the difference in the budget now from where it started at?

EB: It started at $5,000 this year it was $38,000.

AN: So what exactly funds Mars Rover?

EB: I'm really not sure. It's kind of… it's smoke and…

LJ: I'm trying really hard not to laugh really loud.

AN: You're fine.

EB: It's smoke and mirrors. We get grants from Marathon Oil and JSC Federal Credit Union. I have some NASA money. I get money from the Provost. We have money from the STEM center from the Texas Space Craft Consortium, and some other STEM center money came in this year, and several of the colleges put in money.

AN: Okay.

LJ: It's kind of a conglomeration.

EB: My current task is to give a "Friends of Mars Rover Cocktail Party" sometime in April.

LJ: And is the purpose of that to try to build awareness, raise money for Mars Rover?

EB: Raise money. I'm looking to have 25 guests each of whom donates $1,000.

AN: Do each of those things go specifically to Mars Rover here at University of Houston or are there other parts that pays for it?

EB: The other parts are different fund streams.

AN: Okay.

EB: I only answer for University of Houston.

AN: Okay, got it, got it.

EB: I also have about $30,000 for the AIAA and about $400,000 from NASA to cover the rest of the country.

LJ: Right.

AN: And you mentioned earlier a Mars Rover grant.

EB: Uh-huh (in the affirmative).

AN: What is that?

EB: I have a research grant from NASA, that $400,000 I just mentioned, which is to do and that is part of the changes that are taking place. We are, we have been funded to write and we have written a thirty-hour fifteen lesson plan 5-E curriculum for Mars Rover as a formal curriculum. We've also been funded as part of that grant to research how that curriculum works, what its impact is on the kids.

AN: And is this curriculum currently being implemented in Texas schools or, um, schools all over?

EB: Okay, we've a couple of schools in Arizona, and a couple of schools in Colorado. The school that did it in Lexington, Massachusetts has stopped. The state of New Hampshire education teacher training college in Plymouth, New Hampshire wants me to train their faculty on how to do this in June, but mostly it is being implemented in Texas. We have there are schools in Boerne and San Antonio. There is a whole big clump of, what do we have? We have forty schools, seventy-five teachers doing it here in Houston.

AN: Okay.

EB: The curriculum is fifteen lesson plans, each averaging two periods. Half of them, sixteen have been approved as NASA education products. The other fourteen I am about to submit as NASA education, for approval for NASA education products. The…

AN: Just to clarify, are these for junior high, or elementary students, or…

EB: Yes.

AN: All across the board?

EB: I have two sets.

AN: Okay.

EB: I have a three-five and a six-eight set of lesson plans.

AN: So the curriculum is kind of all over the country. Are there other, like the Mars Rover event here at U of H, are there other events like that in other states?

EB: We're trying.

AN: Okay.

EB: There's, they have done them a couple of times in San Antonio, and I think they are going to do it this fall in San Antonio. I think they've finally found a place. Venue has been an issue. They have done it once in San Antonio, but then venue became an issue. We wanna have one in Tucson in November. And we'll see.

AN: What are the kinds of projects that students bring to Mars Rover? There's, of course, like the script…

EB: You can, you can answer that better than I. I stood around dealing with problems; you got to walk through and take pictures of them. [Interviewer Alicia Nichols was the main photographer for the 2014 Mars Rover Celebration Event.]

LJ: But, recollection. What are some of the problems that they solve, is that what you are going for?

EB: I'll be candid. I really seldom get to find that out. I mean, I'm, I'm floating dealing with.

AN: You're dealing with overall management.

EB: Issues like the guy who lost his kid.

LJ: Right.

AN: There's different sections, correct, like solar, freestyle?

EB: There's solar, freeform, and radio controlled car. And we tried last year having true robots but that was a failure. Because we wanted them to actually, it was middle school, and we wanted them to build the robot from parts that they got from electronics store and they all showed up with Legos.

AN: Like the LEGO rover…

EB: LEGO Mindstorms. We said, "We told you not to do that."

LJ: Right that's kind of just following directions. That's not really creating something.

EB: Right, yeah. And the teachers, I mean the teachers hadn't told the kids that was the rule. End of part 2

AN: So even though you're not necessarily really looking at the students projects do you think any of the ideas that they've come up with or the questions that they are trying to answer could potentially be actually be applied to current space exploration or current issues?

EB: You bet. You bet! One of the things we have to tell the judges not to do, is stop and take notes. This has been an actual management problem in some years.

AN: That's great!

EB: You come up to a judge and if he is sitting there with his smart phone going, tap, tap, tap. And you say, "Okay sir, can you finish judging and then start stealing intellectual property from ten year olds?"

AN: That's great!

EB: And, you know, if you put it that way they kind of go, "Oops, busted." Yeah, no, we… a couple of years ago when *Opportunity*, no when *Spirit* got stuck. The kids, a lot of the kids had ideas of ways to deal with that. They were really amazing.

LJ: Cool so they got it… their quest was to get it unstuck.

EB: Their quest was to get it unstuck and they had ideas that couldn't be implemented because we didn't have… a helicopter rotor. A lot of the kids come up with pretty pedestrian, you know they want to search for water. They want to go investigate the cliffs here or this crater or that crater. But every so often you have the really exciting ones the, "I want to do a spa."

LJ: Right, right.

EB: The, that one, that one was I think the best of the off the wall ideas because it really involved science to answer it.

LJ: Right, right it wasn't just like, "Let's build a spa!"

AN: There was some backing to it.

LJ: Yeah, that's cool.

AN: That's awesome. So why is it important that we have programs like Mars Rover?

LJ: I'm just making sure this is still going.

EB: The United States has done something that is probably irreversible, and rather hazardous, economically speaking. Um, consider that. [Points to nearby iPad.] That isn't manufactured in the United States.

AN: Right.

EB: It was developed and designed in the United States. But increasingly not by United States engineers. We have… we have gone from being a manufacturing based, well an agriculture-based economy, to a manufacturing-based economy, to… we're now, a product innovation based economy. The, well with you know with patents only lasting seventeen years, that is a knife-edged treadmill, if you will pardon my mixing metaphors. Um, you can fall off easily, and you have to run really fast.

LJ: Right.

EB: And if you fall off or stop running, the economy craters, because, you know, we're surviving on, surviving on the profit that goes to the U.S. owners…

LJ: And of the idea people.

EB: The idea people. Well if you run out of… if you are not producing a competitive number of idea people you are in trouble.

AN: Right.

EB: Per capita China is out producing the United States four to one in engineers. So naked economic reality is we've got to start producing more engineers. Now, we can double that easily, well not that easily. And and you'll notice we have a lot of girls in this program.

AN: Yes, I saw.

EB: We're all so happy about that. My favorite picture is when, I guess it appeared… the four young women with Joan Higginbotham behind them. The uh, they are getting their award; it was about two years ago.

LJ: Oh, I think I know what you are talking about.

EB: And, okay there is an African American young woman. A Muslim young woman in a hijab. A Hispanic young woman. And, oh yeah, a blonde. And standing behind her is a female, an African American female astronaut giving the award and I'm going…

LJ: Awesome!

EB: That's the picture we want to have!

LJ: Right.

EB: I've had, I have stopped having, "How do we improve diversity meetings." Because I'm supposed to have them on this grant. And the first year I had one I said, "Well the best thing I can do is I can show you pictures." And I showed that picture and the woman, the diversity officer who was in the room from the university looked at me and said, "Why are we here?"

LJ: Hello?

EB: "You've done, you've solved the problem never mind."

LJ: It's in process.

EB: "Just continue…. Carry on!"

AN: So what are other ways that we as a community can get students interested in pursuing science and engineering?

EB: Better trained teachers. And the second one is very, very hard to implement. Better-trained parents. If you do that, that's all you need.

LJ: Yeah, really. I mean…

AN: What specifically about training teachers would you do differently so they can, I guess, promote science and engineering?

EB: Make them more comfortable with math.

AN: Uh-huh.

EB: Make them more comfortable with teaching interactively, teaching inquiry based. You know most teachers get taught to maintain ruthless rigid, "You shall not move a finger unless I say, 'Finger move now!'" control of a classroom. This sound familiar?

AN: Yeah, uh-huh.

EB: Particularly if the children are handicapped with Y-chromosomes. Um, this is a terrible thing to do to them!

LJ: Yeah.

EB: You need, they need to roll up their sleeves and get dirty!

LJ: They need to move.

EB: And they need to get dirty on their own time and in their own, following their own little program. And yeah, you guide them and ask questions that get them to learn things by getting dirty, but teachers hate that because it's uncontrolled and it's very hard to evaluate.

AN: Right.

EB: But that's what you've got to do.

AN: Would this require a change in the educational system, or more the, I guess, the teacher education itself?

EB: I'm not sure there is an "or" in that question.

LJ: I was going to say that's an "and."

EB: "Yes," is the answer to that question.

LJ: Yes on all fronts.

AN: Okay.

LJ: Yeah because even if a teacher wants to do inquiry based stuff, they may be under an edict from a principal to do "X, Y, Z."

AN: Right.

LJ: And they may have 30 kids in their classroom. And HISD is guilty of this at the present moment, is that when they don't know, they are not at this point of inquiry at all so they make it very cookie-cutter, very regimented so it's like teacher-proof basically and they can get their test passed.

AN: Because the focus is on test scores?

LJ: Well not just on test scores, but on the way you are going to teach this.

EB: You know, I would love to be allowed to write one of those tests. I mean, because I have done this. I have written evaluation materials that, where the evaluation material is itself inquiry based.

LJ: Right.

EB: Now everybody hates that.

LJ: Yeah.

EB: That is mean.

LJ: Because you can't do that. It would take a lot of money to even score, or to administer an inquiry-based evaluation, and then to have somebody evaluate the evaluation? And that, it, that would take a huge monetary investment on the educational systems of America, and there's no money for that to happen.

EB: I'm not so sure.

LJ: You don't think so?

AN: Would you think there are other programs in the Houston area like Mars Rover?

EB: I'm, I'm really, I'm so focused on what I do, that I really don't know the answer to that question. There are… Future City is sort of like it in some respects but… and there's a Mars

Rover-related curriculum that is written by a woman Sherri Klug Boonstra at Arizona State. And, um.

LJ: But it's really I would say different in terms of, like if you compared it to, Science Fair. [Science Engineering Fair of Houston] Science Fair is, "Here's the rules, go." This is more, there's a curriculum there's, this kind of has more of a focus.

AN: So its focus is kind of unique.

LJ: I would say that's one of the things. Because I was trying to think what else is there that is kind of like it. Science Fair kind of.

EB: We partly tried to fix some of the problems that are wrong with science fair when we designed it.

AN: Okay. And it's kind of like if you took a specific category with science fair and kind of just went with a category almost?

EB: Um, the, the…

LJ: Not even that.

EB: The… the kids start with the data, not a hypothesis.

AN: Okay.

EB: They work in teams, not by themselves. And the budget cap kills the impetus for a helicopter parents.

AN: What's the importance of the teamwork aspect?

EB: It's how real work is done in the real world. It's also brain research. Educational brain research shows that working in teams, you learn more. Working with, starting with the data and developing a question and working interactively to answer the question, you learn more. You take ownership of the question. You care about the answer.

AN: Would you say it's more real to life if you have data and then you have to develop your question from the data? Yes?

EB: Yeah. Yeah. It is much more… I mean, you know, I sit there and whenever I hear an elementary school teacher start talk to me about the scientific method, I sort of melt into my chair. I say, "You realize I've been a working scientist for half a century and I've never used that?" And she goes, "Oh you're kidding me!" "No." "What?"

LJ: Because it starts with the question, right?

EB: I start with the data.

LJ: No, I mean the method starts with the question.

EB: The method starts with the hypothesis, which isn't even close to…

LJ: Which isn't a question, but it is a question.

EB: No it isn't a question. The question comes before the hypothesis. The hypothesis is a postulated answer.

LJ: That's true so it really starts with the answer, instead of inquiring into all possible answers.

AN: So why is space exploration and the exploration of planets in our own solar system, like Mars, something we should still care about, and I guess educate students?

EB: Well, from the standpoint of the educational excitement, you know the only thing that comes close in terms of generating kid excitement is dinosaurs.

AN: True.

EB: And dinosaurs I hate to say…

LJ: Dinosaurs and space are on opposite ends of the spectrum.

EB: Right, dinosaurs are not the future.

LJ: If you can find dinosaurs on another planet, oh my God!

EB: So yeah that. It's just really exciting to kids, and airplanes still are, too. But you know. The… from a more profound intellectual viewpoint, as long as we stick to the earth we only have one planet. That's terrible scientific method. The fact that we have seven others, plus a whole bunch minor planets to look at, with atmospheres of different kinds and different geologies and different chemical makeups, lets us really begin to understand what processes are universal in a planet, and what are the specific? We understand the earth better because we study the other planets. And of course, you know, you wouldn't want the average planetologist loose on the street; you've got to give them something to do.

AN: So besides being exciting for younger students, like elementary and junior high kids, is there anything else kind of important about, I guess knowing these things, or learning about these things.

EB: Like I said, the, the, the comparison, you know it's about… I think part of what we learn from planetary studies is, okay, what was the early history of the solar system? That's one of our objectives, is to understand the history of the solar system over the four and a half billion years it has existed. Understand the processes that have shaped the earth as it is, and where we are going. And, um, the um, the search for planets, and now the examination of the properties of planets in other solar systems. We now know of several thousand, uh, which is a new development in the last five years. All of the sudden you know exoplanet astrology has become a major field. It is interesting to watch an entire discipline appear out of nothing.

LJ: Yeah.

EB: But one of the things that you learn is that one of the processes that shape a solar system that are universal, and what are the particular accidents that produced ours? And what have, what

are the, the, what gave rise to life? Can we find life anywhere else? The answer is certainly we will. But how common is it? And is it going to all be carbon based?

LJ: Right.

End of recording 3

LJ: So it's kind of like, I mean in some respects it sounds like,, you know, akin to things like back when we realized the earth was not flat, it was round. Like we're still capable of within, you know, out and beyond us finding out things that will impact how we evolve or cope.

AN: Does this also have a hand in like development of new ideas and better technology that you kind of….?

EB: Uh, you never know. You know, the process of developing the instruments to do the exploration drives technology pretty hard. That's really the impact on technology., is the instrument development process has had awesome effects. The actual discoveries of new technology by making observations on other planets, not yet, not so much.

LJ: Right.

EB: That might happen, but it hasn't happened yet.

LJ: Right. So, so what you're saying is that the instrumentation that has development to go exploring has lead the way to stuff like that? I pointed at the iPad. So they can archive that.

AN: And, with like how the funding for NASA right now is iffy and everything, does that effect how we should educate students? Or…

EB: It does discourage them.

AN: Right, so it is kind of doing the opposite.

EB: They read the news too.

LJ: Right.

EB: It discourages them and to the extent that the funding is curtailing the development and deployment of exciting and interactive space and aeronautics orientated curricula and materials, it's very damaging.

LJ: Do you think it is something that will… we're not see the effects of for a while?

EB: Oh this is all...

LJ: Kinda one of those?

EB: These are slow-motion catastrophes.

LJ: Yeah. Yeah, that's…

EB: Yeah. We're, actually seeing, I mean, the engineering shortage that's been developing for a while now, is beginning to bite. Because you know, the aerospace companies in particular, have to employ citizens.

LJ: Oh.

EB: And you know, a lot of them are really scrambling to find work force.

LJ: They have to actually employ U.S. citizens? So they can't import engineers?

EB: No, it's very hard.

LJ: Certain percentage probably.

EB: It's very hard to import engineers into the aerospace industry because, um, of various regulations designed to preserve national security.

LJ: Right, right, that's what I was just thinking.

EB: So when we, when they do import somebody, or when they do hire somebody who is actually not born here, they have had to already managed to become a citizen.

LJ: Oh okay, wow, I didn't know that.

EB: Um, which is... Now, we even face that here. There's a thing called the International Traffic and Arms Regulations.

AN: How would you readapt K though 12 education so as to place more emphasis on science and engineering, besides, you know, better educating teachers and helping teachers?

EB: Oh, that's all it takes.

AN: That's, that's what it would take?

EB: I mean, the kids, turn the kids… I mean, okay, you actually have a culture shift problem.

LJ: Uh-huh.

EB: Now, that, that, you have to change the culture of the United States.

LJ: That's really easy.

EB: Been there, done that.

LJ: Yeah.

EB: And I meant that literally. I have. The… and I'll explain that in a second... But you have to make it cool to be a nerd in middle school.

LJ: Yeah.

AN: Right.

EB: You have to make it…

LJ: I think it's becoming cooler.

EB: I think it is. I think it is. But here's a story. Last May one of the young ladies who grew up down the street from us, her parents still live there, mom plays golf with my wife. She graduated magna cum laude in the petroleum engineering from Texas A&M. In middle school she never admitted to anybody, she was a popular girl, with the capital letters. Popular girl. She never admitted to anybody she had the slightest interest in anything to do with STEM.

LJ: Really?

EB: She hid.

LJ: All that part of her.

EB: She hid all the part of her. And I think that's so sad.

LJ: That's very sad.

EB: I mean she sort of "came out" when she got to A&M.

LJ: Right, like, "Wow, I can really be myself now."

EB: My daughter really didn't get along with her because my daughter thought she was a, um, brainless flake. And my daughter was stunned when she realized, "Wait, Beth?!"

LJ: Like, "She's really smart? What?"

EB: You need to have a culture where the popular girls feel free to admit they like science.

LJ: Exactly. Exactly. Well just, I just saw on, you know, Facebook a couple of weeks ago, where there was a…, and it went viral, a little girl who wrote, did you see? Where a little girl wrote a letter to LEGO about…

AN: I saw it.

LJ: What kinds of options were there for girls for LEGO? I'll, I'll find it and send it to you. Basically she was saying. "All the LEGO stuff is like bakeries and beauty shops. We want fun adventure stuff for girls, in LEGOs. Why do the boys get to do all the cool stuff with the LEGOs and you have us making…you know, and everything is pink. And everything's da da da." And she said it very nicely and everything. And it went… It was on Yahoo! It was one of the strips. And, so I think there like is the impetus for like, "Hey! Quit pigeting [pigeonholing] girls into this, this, and this."

EB: The Goldiblocks ads.

AN: Yeah.

LJ: Yes, yes, exactly.

AN: What about for those students who don't get math or something like that. Is there something you can do to help them?

EB: It depends on their age. The, if they're under fifth grade, that's the teacher.

AN: Okay.

EB: That is totally the teacher. Because virtually no child under fifth grade, at least a fully capable child, really is incapable of doing math. But what happens when they hit puberty if they haven't been engaged in doing math, the circuits decay. It's, the neurophysiologists call it pruning, and the unused stuff goes away. So, a high school senior who's never done math may well never be able to do it, and there's not much you can do. Um, now that's not true there's not nothing you can do, because, um we're talking about an adult human being and those brain circuits can in fact grow back.

AN: Right.

LJ: Right. Like if they put their mind to it. But it would take like the equivalent of training for a marathon with your brain to get that back.

EB: Yeah it's much harder. It's like, okay. I learned four languages by the time I was sixteen. I couldn't learn another one now for love or money. Because, you know, if you… and I started some of them after puberty but I was still learning languages. I started, I continued learning languages starting at like nine or ten. And so the circuits for learning new languages were being used. And of course those are more powerful still when you're two…

LJ: Right. Then they are, yeah.

EB: That's your job when you are two.

LJ: Yeah, learn words.

EB: You have one job, learn words!

AN: So for younger students you said it is more teacher issue and part of that would be making teachers more comfortable with math. But would it also be just trying to get students to do more math work or is it creating…?

EB: Make it more fun. I'm actually not allowed to use that word in discussing education. Make it more engaging is the technical term.

LJ: Yes, yes there we go. But that's so true, that's so true! I mean I remember getting turned off on math in fourth grade. Like, just there was something we had to do. It was graphing or something and I was just… I don't know what my deal was. It made me like... I cried doing my homework. I remember that. And then I decided I wasn't good at math. Even though I probably could have been great, much better at math.

EB: My, my daughter, that unit [pointed at picture on desk], had a terrible sixth grade math teacher. She was an unconscious sexist.

LJ: Ugh, yeah.

EB: It took me five years to undo the damage.

LJ: Yeah, yeah.

EB: And I remember senior year, about the first three weeks of school every night I came home, "Dad I can't do this." "Yes you can." "No I can't" "Yes, you can. Well, let's go sit here in the living room." I think at some point in here it was, "Okay, I get to cuddle with dad."

LJ: Uh-huh. Right.

EB: But we've started in on the problem and I would sort of say, "Well, okay, explain the problem to me, what's the question?" And she would explain, she'd get about half way through and then, "Oh, I see." And she'd write down the answer. I never actually had to help her.

LJ: Right.

EB: What I did was I sat next her and I cuddled with her.

LJ: It was efficacy.

EB: And…

LJ: She didn't believe she could do it but she realized she could. She could do it.

EB: After about three weeks she said, "Okay I don't need to do this anymore, I can just do my math, can't I?" By mid-October she, they, they had a test, and this particular teacher, Mr. Wheeler, did the same test every year. He maintained security somehow. Janet got a hundred on the mid-October mid-term. Nobody did that.

LJ: Wow, awesome.

EB: No one had done that on that test for five years.

LJ: Sweet!

EB: Including, well, her big brother took a higher-level class so he didn't….

LJ: He couldn't compare.

EB: He couldn't compare. She gets to school. This, this may have been counter-productive. She gets to school and there is a giant banner, you know, height of that door, all the way across the front of the school. "Janet Bering, Queen of Math!"

LJ: Who did this?

EB: The math teacher.

LJ: Get outta town! What grade was this?

EB: This was in twelfth grade.

LJ: Wow.

EB: Twelfth, AB Calculus.

LJ: Oh, well she got a hundred on AB Calculus. And she deserves a banner.

AN: Yeah.

LJ: Was she like mortified about the sign?

EB: She was totally mortified! And you know, she went in the classroom and there were balloons and he said, "You know, you got a hundred on a test that no one ever gets a hundred on. No one has ever got a hundred on this test in five years."

LJ: Wow.

EB: And she went, "Oh." So she went on to get the calculus prize for her senior year.

LJ: Nice.

EB: Uh, but it, that took me five years of dogged….

LJ: Yeah, reinforcing and that's with, I think when you are talking about like training parents better. That's what you mean. And, you know, and any parent can do that. But they think they can't. Because they don't know calculus.

EB: I didn't help her. I sat there and made her do it and cuddled.

LJ: Right, and just supported. Yeah.

EB: I thought that was fun. My daughter's cute you know. But she went on. She went off to college planning to major in German. She graduated in biology, because she realized she was not just quantitative, but she was good at science and she hadn't ever understood that.

LJ: Ahh. Interesting. Very cool.

EB: So yeah you, you, making, being, making science cool in middle school is the key. I don't know how we do that.

LJ: Right. We're working on it.

EB: Convince them and okay, internationally famous geologists: rock stars.

LJ: Right. Right. Yeah..Like yeah. I'll work on that.

AN: Well I've gone through my list of questions but is there anything that I didn't ask that you'd like to touch on?

EB: No, no. But it is not impossible to change the culture of the United States.

End of interview