Generation STEAM Interviews

Tom Foster

Interviewed by Anne Marie Hamilton-Brehm

May 2, 2015

Paseo Verde Library

Anne Marie Hamilton-Brehm: *Today is May 2, 2015. We're at the Paseo Verde Branch of Henderson District Public Libraries in Henderson, Nevada. My name is Anne Marie Hamilton-Brehm and I'm interviewing Tom Foster who is teaching The Renewable Energy, Liter of Light Workshop in our STEAM Series. Thanks for coming Tom.*

Tom Foster: Glad to be here.

Anne Marie Hamilton-Brehm: *Tom, I'd like to start out by asking you about your background and career and what is it that interests you in the subject of renewable energy?*

Tom Foster: Well, my education and training and experience, I'm an electrical engineer, practicing, consulting electrical engineer. For the last 20 years, I'd say, I've been working with lighting power and communications systems for buildings, lighting for parks, and all of that pretty much has been local in the Las Vegas area for 20 years at least. A lot of work at the schools and a lot of work at parks throughout the Valley here. But my beginnings were at the jet propulsion lab in Pasadena. Right out of school, actually as a senior I worked at what's called Space Sciences Lab up at Berkeley and when I graduated we were working on an instrument that was going to fly to Mars, the infrared spectrometer. And when I graduated they said, "You know it's time that we have to have somebody at Jet Propulsion Lab to integrate the instrument onto the spacecraft and would you be interested in doing that?" I said, oh, yeah, sure, that sounds good. So I ended up at JPL and I was actually a University of California employee at the time working side by side with the JPL people and I was the eyes and ears of the instrument as it integrated onto the spacecraft working with the JPL engineers to help them understand how it worked and what our interface was. They went through all sorts of testing that they do prior to launch and then went with the instrument down to Cape Canaveral for launch. There were actually two instruments to launch, Man of Mars 6 and 7 they were called. They flew by Mars. They did not orbit and they didn't land. But as they went by this infrared spectrometer that I worked on looked at the composition of the atmosphere and determined, it was estimated that up until then that it was pretty much all carbon dioxide. But we found some traces of water, the instrument found some traces of water in the atmosphere as well, especially around the area where the polar cap was melting and it had been thought that that

was strictly a dry ice polar cap so it was CO_2. Turns out there was some water mixed in there. Of course nowadays based on the Landers and Rovers and so on we're pretty sure there's probably some water still under the surface throughout the planet, not just at the poles. So that was the first instrument I worked on and then when that project concluded I was asked to stay on at JPL as a JPL person to work on other science instruments which I ended up doing. One was, the next one actually was a magnetometer, measured magnetic fields, and this was bound for Jupiter and Saturn. Again there were two of them, Pioneers 10 and 11 they were called. They lasted many years past their intended life and they got to the edge of the solar system before they lost radio contact. But they ran for a very long time and I worked on developing, building the magnetometer portion of that spacecraft instrument package. And when that was done the next project I moved on to was an infrared radiometer. Measured temperatures of the surface and of the atmosphere at Venus. And again, that was a fly-by, I'm sorry, it was an orbiter. It actually orbited Venus but it didn't land and took data for quite a while and we got more of an understanding of the atmosphere in Venus, what it's temperature characteristics were and so on. I stayed there basically at JPL including the Berkeley time for 10 years and I had an opportunity then to buy an electrical contracting business and so I decided to do that. I always had an urge to be in business for myself, be an entrepreneur, so I took that opportunity even though the work at JPL was very exciting and very satisfying. I thought I'd venture out and try something different so I did and did that until from '77 until '91 and then I went to work at a company called Ralph M. Parsons, it's an international engineering firm, and I worked on FAA, Federal Aviation Administration, they were traffic control centers they were called. There are 22 of them in the country including Puerto Rico, and they did the air traffic control guidance to the aircraft in the air between airports across country. That's why there are only 20 or so of them. But they are large facilities and I worked on, did a power upgrade on those. Had to be very reliable power, generated backup and so on. You don't want to lose air traffic control while you're flying in a plane. So that was, that was about a five year project and then when that wound down Parsons had a contract with the Clark County School District here in Las Vegas to build and renovate schools with a new bond issue they got. And there was a competition to pick an engineering firm to head up that effort and Parsons won it and they

were looking for people from Pasadena to come up to Las Vegas and participate in that program. That's what I did so that's how I ended up in Las Vegas in 1995.

Anne Marie Hamilton-Brehm: *Okay.*

Tom Foster: So it's been 20 years now, June 1, actually. That project lasted here for about three years and during that period I worked closely with a lot of people from the school district. And the project concluded so I had a choice of going back to Pasadena to Parsons headquarters or staying here and along with my previous electrical contracting business I did electrical engineering as well, for buildings and so on. So, and, of course, I had experience at Parsons doing that. So I decided, talked it over with my wife, and we decided to stay here. Business was booming. Construction was booming at the time, it was '98 or so. So we jumped in and our first clients were the school district and we branched out and got several hundred clients now. But it's been quite a while building that base and that's still what we're doing. That's kind of my background.

Anne Marie Hamilton-Brehm: *Okay. And you were inspired I think by your father's work too. Can you tell me a little bit about your Dad?*

Tom Foster: Yeah, my Dad, I'm amazed still. I don't know how he did it. But he joined the Navy and World War II after Pearl Harbor without a high school diploma. And I think there were quite a few young men in the country at that time that were in the same boat. Everybody wanted to get involved. You know, it was a very serious situation. So he got involved. He was actually never went overseas in the Navy. He was stationed in the middle of the country repairing airplanes, Navy airplanes. So when he got out of the Navy at the conclusion of the war he decided he would go back and finish his high school education which I believe took him about a year, and then went to four years of college at Tufts University to become a mechanical engineer. Doing this with two kids and a wife working a full-time job and still got an engineering degree in four years. I don't know how he did it. He must not have slept at all. But he became a mechanical engineer and his work moved us out to California from Massachusetts and I was about ten at the time. And he worked in aerospace here in Southern California, at North American Aviation at the time it was called. Worked on quite a few projects and

eventually they relocated him up to Palmville, California, which they had a facility that built the F-15 rocket plane, worked on the B-70 bomber. And I actually worked on that one summer out of college, I think my first summer in college I went to work on the B-70 as a draftsman drawing blueprints. And then he moved later up to Seattle. He worked on, for a while Boeing was working on a supersonic transport similar to the Concord. They never went into production on it but he worked on the research and development on that. So he was an example in a household of being an engineer. My brother and I both grew up watching him do that and I subconsciously I think it led us both into engineering. My brother's a mechanical engineer. I'm electrical and, you know, when you do things in your life sometimes you don't realize the far-reaching impact of it but his effort and his example ended up with his two sons being engineers. Then I've got a step-brother who also is a computer engineer. So his three sons are all engineers. My son is an electrical engineer. My daughter is a mining engineer.

Anne Marie Hamilton-Brehm: *Oh, yeah.*

Tom Foster: And my daughter's daughter is now a sophomore in high school and she is intending to become a computer software engineer. So, you know, his effort is reflected down through our family for 3 generations and is still going. So a lot of people don't realize that the example they're setting for their kids and so on can impact generations yet born.

Anne Marie Hamilton-Brehm: *That's right. Not only for your family but for all the people that they helped through their work too.*

Tom Foster: Exactly.

Anne Marie Hamilton-Brehm: *How did you become involved in the STEAM Series?*

Tom Foster: Oh, how did that start? I went to a Maker's Fair, it was called in Las Vegas, I think two years ago, about. Took my grandson with me and they had all these neat projects people had done and so on, so forth. And I've always kinda been a tinkerer in the garage and this and that, so one of the organizations that was there was the SYN Shop it's called. It's a makers space in Las Vegas, SYN Shop. So a little while went by and I kept looking for them on the internet and found out where they were and I walked by the downtown in Las Vegas on Fourth

Street across from Neonopolis. And I'd walked by their storefront several times but it was closed and lights weren't on and said well…but I got lucky one time and swung by and somebody was in there. The lights were on. I said oh, great. So I went in and they greeted me and said, "Oh, would you like a tour of what we're doing here and this and that". I said, sure. So to me it's a big, it's a community garage and it's where guys that like to tinker and gals that like to tinker in their garages or at home can go and use a bunch of equipment that they can't afford individually. So they've got wonderful…they've got 3-D printers, they've got sewing machines, they've got wood-working tools and it's just besides the equipment, the people that show up are…you meet all sorts of people that are really interested in what they do. The software guys there, the hardware guys there, woodworkers and if you're stuck on something, you work on your project and are kinda stuck on something, you just reach over to the guy that's there who might know how to do it. "Oh yeah, here's how you do that, and this and that." So it's just a great collaborative space so I've been involved in that just as a member. I'm not a board member or anything. Just a paying member. And somewhere along the line one of the board members mentioned that they're collaborating with Henderson Libraries on a grant to teach some STEAM classes. And they kinda had an outline list of what the things are they wanted to teach and one of them was renewable energy. Well, I'm in the power business, designing and so on and so forth, so it seemed to me right up my alley. I said I'll take that and that's how I got involved in the STEAM program.

Anne Marie Hamilton-Brehm: *That's neat. What have you been doing in your class and what do you hope participants will learn. I, I announced it as the Liter of Light at the beginning of the interview and so what, what is that all about?*

Tom Foster: Sure. I was noodling around as they say on the internet one day and I came across this Liter of Light. I might have even found the story in the Wall Street Journal or something about it so started looking into it. And it's a program that started in the Philippines and now it's throughout the world in over 20 countries. And in the developing world about 27, let's say 25, 27 percent of the people on the planet do not have access to reliable electricity. They might have it sometimes but a lot of places have none at all. They've never seen anything like a light bulb or artificial light. They don't know what it is. As an aside, though, I found out these

developing countries have not spent the money for wired telephone infrastructure, like we had in this country before we had cell phones and so on. They've leaped right into the cell phone era. So a lot of these areas that don't have access to electricity will have cell phones. Well that sort of puzzled me. I said how do they do that? Well, they…of course, they need cell towers and they do have cell towers and those cell towers have generators. That's how they get the power to power up their cell tower. And also there are locations where you can go and charge your cell phone. But it's a two hour walk each way. So that's a big problem, too, is keeping these phones charged. And they're not used just for communicating with your loved ones or whatever. A lot of these areas, of course, are agriculturally based. That's their economy. They're farmers. And what they use their cell phones for is to find out what the market price is for their produce. So they harvest at the peak of the period and get the most money they can for their crops. So it's a business tool for them. So I found out, you know…so I'm looking around and what I'm finding out is they don't have any light in their houses. Their houses are typically a 12 or 15 foot square made out of whatever they can find local materials. It could be pallets or cardboard. You never can tell. Some places build them out of, if they have access to it, bamboo. Different types of structures out of bamboo. The roofs are usually corrugated metal, steel, so they build these side by side by side and back to back so there are no opportunities for windows. And the only light that can come in, comes in is through the doors. Well, 5, 6 feet away from the front door is another set of these. And I'm talking, of course, in very poor areas. A dollar a day is a typical income. So even during the daylight it's dark inside these places and there's very limited what they can do. A lot of them cook outdoors because that's the only daylight they have, for example. So the Liter of Light people, what they found out is if they took a 1 liter or 2 liter soda bottle, clear, and filled it with water with a couple caps of bleach to keep it from turning moldy with algae, if the they stuck it in a roof with about a third of it above the roof 2/3's into the space, the sunlight coming in would be…the water would bend the light rays and diffuse the light on the inside and it'd end up being like a 60-watt light bulb. Really light up the interior compared to the darkness they had. So this movement got started about 2 years ago called Liter of Light based on a 1 liter bottle of discarded soda bottles. So they built them out of these local materials with the roof flashing they built the roof

and so on and adhesives to seal it against the rain and it cost about a buck and a half. So these are great things for these people because they don't have light during the day. So that, that's how I got involved with Liter of Light. And one of the problems is, of course, is when the sun goes down the light goes off. Because it doesn't generate light, it just diffuses light; sunlight. So the next step for the Liter of Light people was to come up with a way to use LED's to provide light at night using the bottles. So they came up with a method of inserting an LED into the bottle, into the water, but it's isolated from the water by a water-tight seal. And so photovoltaic cell on the roof, battery supplies charged during the day. Then at night the battery lights the LED. And this is a great boon because it gets rid of kerosene lamps which were the main source of light in the Third World at night. But it costs a lot of money for those people. It's 4 dollars a month typically for kerosene and the fumes they give off is like, in such a small space is like sitting in a room with someone smoking two packs a day.

Anne Marie Hamilton-Brehm: *Ugh.*

Tom Foster: So they have terrible health problems because of it as well. So…

Anne Marie Hamilton-Brehm: *It's probably a great fire hazard too.*

Tom Foster: Exactly. There are a tremendous amount of fires. People dying from fires, burns, because they can knock over and it starts a big fire, people burn. And actually I believe the numbers are like 2 million people a year worldwide die from these kerosene fires.

Anne Marie Hamilton-Brehm: *My goodness.*

Tom Foster: It's huge. So there's even an organization started up separately called NoKero.org, and their goal is to wipe out the use of kerosene for lighting in these Third World areas. So Liter of Light is right in line with what their goals are, what the No Kero people's goals are. So they're retrofitting their soda bottles that are already in the roof with the LED insertion and now the people have light at night. So that's what our class is about actually. I talk about utility style or utility size renewable energy sources by scaling it down to a residential and then down to what I call point of use which is just a bottle with a light in it. And the class builds one of these and this is an example of a repurposed garden light from the 99 Cent Store for a buck and

a couple of pennies for a couple of the parts and we just relocate the LED from the electronics here down into the bottle. This is a sealed soda straw so you can fill this with water and it keeps the water out of the LED and when it gets dark it turns on.

Anne Marie Hamilton-Brehm: *Yeah, that's neat.*

Tom Foster: We build this with the kids in the classes and to demonstrate to them the concept of how this all works and the need for it in the world. So that's what we're doing.

Anne Marie Hamilton-Brehm: *That's neat. How did you develop the workshop?*

Tom Foster: Well, since I was interested in the Liter of Light Project, I got interested in it and before the STEAM classes were brought up I had already been working for a while on an LED light to work with the Liter of Light people just on my own. And it started out with a competition, local Illuminating Engineering Society of Las Vegas held a competition a year ago last October to design a hospitality light fixture luminaire. And I had just recently read about the Liter of Light and I started thinking about how I could incorporate an LED light into that program and I thought well maybe this, maybe I could bring some publicity to this program by entering into the contest, competition. But, you know, it's not really a hospitality fixture, we're thinking hotel rooms, nice LED looking thing, so I called the guy in charge of the competition. I said, well look, I'm looking at maybe an idea for a residential light fixture, not hospitality. He said, "Well, you know, a hotel room is a residence for a night so yeah, go ahead and enter it." I said all right. So I entered it and this was what I entered basically but this is an example of what the Liter of Light looks like installed on the roof.

Anne Marie Hamilton-Brehm: *Uhhuh.*

Tom Foster: But my fixture clamps on to the bottom of this…

Anne Marie Hamilton-Brehm: *Okay.*

Tom Foster: …and it has photovoltaic cells around the inside facing the bottle so during the day some of that sunlight coming into the space is actually used to charge the batteries. And then there's a ring of lights underneath that come on at night and it gives you a pretty good light

level and it's got a motion sensor on it so when somebody walks in it comes on. And there's a delay after you leave it turns off because you don't want to use up the battery energy when nobody's in the space.

Anne Marie Hamilton-Brehm: *Right.*

Tom Foster: So I entered it and as crudely as it looks, it's not elegant at all, in fact I made the original light prototype out of some nesting food containers at the 99 Cent Store. Translucent, cut them up and made it work. Nonetheless, we won first place on the thing. Everybody thought it was terrific. And it did bring the publicity that I was hoping to get other engineers in town to start thinking about the rest of the world. And we take all of this that we have almost for granted but there are so many places in the world that don't have access to these light fixtures and lighting and all the advantages we have.

Anne Marie Hamilton-Brehm: *Right.*

Tom Foster: And it limits the kids how much they can study. They can't study when they get home from school because it's dark and it ruins their eyes trying to read by candlelight, basically is what a kerosene lamp is. And women have to stop working when the light goes down or the sun goes down because a lot of the family income is not just the farming but the women will do crafts of sorts and sell that for extra income. But they can't work at night in the dark. So if you give them light, artificial light, extend their workday a couple of hours, it can make a big difference in their family financial situation.

Anne Marie Hamilton-Brehm: *Yeah, yeah, that's neat. When you were telling the kids something about a program where these lights could be donated, could you tell me a little bit more about that?*

Tom Foster: Yeah, the Liter of Light people, one of the basic premises they have is to help people in the rest of the world. The goal is not to deliver them products that they can use. The goal is to have, to teach them to use available components that they have at their fingertips, repurpose them into something useful. Now they don't have a bunch of LED's laying around or batteries and that sort of thing, so some of the stuff, yes, they have to buy. But they teach the

people locally how to put these into an assembly of a light emitting diode solar powered light fixture. So the ones they're doing have a much larger photovoltaic cell than the one we use in the class, much bigger battery capacity and 4 LED's instead of one. So in other words they put out a lot more light. So if these were powerful enough, the idea would be the kids build them here and donate them to the program and they end up somewhere in the world lighting somebody's house. Now even these are better than what they have, nothing.

Anne Marie Hamilton-Brehm: *Right.*

Tom Foster: You know. But hard to read by, it's not simple for that, but would keep you from tripping over kids on the floor and stuff like that at night, like a night light. But we never got arranged to actually ship them over there. There's another product that the local Liter of Light people have come up with and it's kind of nifty. It's a little one pint canning jar and they put the components inside that and LED and they put a ping pong ball on top of the LED and it's got a tilt switch in its call so when you flip it over it turns on. They call it foot bottle or foot bot and it can sit on a table and act like a little tea light type of thing. Puts out enough light for that. So I did that here as well. I made my own little bit taller bottle and jar and used the same components that this has that we use in the class and put the tilt switch on it and it looked pretty neat I thought. It was…I didn't put the ping pong ball on. Instead I used a portion of the guard light that we had that we don't use in the class but there's a little clear section with some optics kind of on it so I cut that down to fit the bottle and I thought it came out pretty nice. Now those I don't know if they could make those. They cost, depends on where you get the components, but at most $2.25 each.

Anne Marie Hamilton-Brehm: *Wow.*

Tom Foster: For everything. So if they can make those maybe and sell them for 5 or 10 bucks on the internet just as a novelty to help finance The Liter of Light Program that might be a way they might be thinking about doing.

Anne Marie Hamilton-Brehm: *Yeah, that's, that'd be smart. That's cool. I've seen you at other workshops in the STEAM Series. Can you tell me a little bit about how you've contributed to some of the other work that's been done in the workshops?*

Tom Foster: Well, you know we have a presenter for example in my class I'm the presenter. But there are people there to help as well setting up, tearing down, and during the class helping with whatever the project is. So they need extra hands and, you know, I think it's a great way to spend a Saturday morning to go and help out in these classes. I learn something because there are things we had last week in chemistry and some things that I'd never seen before in chemistry. And I was able to help some of the kids with their little project they were doing. They had several of them actually. And I just enjoy inspiring the kids if I can, encourage them if nothing else to pursue a science technology career path. And there's one young girl there that so impressed me last week that I really only got to know her but I've seen her in all the classes. And she's a little Korean girl eight years old maybe, really into every class. She just dives in. She has great questions, she's so enthused. So I was asking her last week in the sci…in the chemistry one, I said, well, are your parents involved with engineering and science and so on? She said, "Well, I don't have a dad". So I kinda felt like pulling my foot out of my mouth but her and her mother came here from Korea three years ago. This little girl has absolutely no accent. She speaks perfect English. You would think that she was born here. And she said her mother can't get a job yet because she doesn't know any English and she's taking classes to learn English so she can do some work. So neither parent involved as far as we could tell in science and technology but she has a thirst for it. It, it's, and she's so encouraging and so I asked her…I knew she'd built one of my bottles in a previous class. So I said does your bottle light still work? She says, "Oh yes, last weekend we went camping and I took it with me.

Anne Marie Hamilton-Brehm: *Wow.*

Tom Foster: So she is really, she is such a neat kid.

Anne Marie Hamilton-Brehm: *Yeah.*

Tom Foster: I just see a great future for her. And these are the kind of kids…this is what keeps me coming back. Get some of these kids inspired like that and who knows where it will lead, you know?

Anne Marie Hamilton-Brehm: *Mmhmm, Right. Yeah. So that, that, that sort of answers my next question which was, what do you and your collaborators in STEAM hope to accomplish? Was there anything you wanted to add to that?*

Tom Foster: No, that's, that's really it. I mean these kids, a lot of them, may not be exposed at home or even at school to the possibilities of science and what it can mean besides something in a book or something on the board, but real life. What does it do? What does engineering do? What does science do? What's it all about? So to get these kids exposed to it, why this may be their only opportunity. I was fortunate because as I said, my Dad is an example growing up always encouraging us to putz around in the garage and do this or that. Take our bikes apart and put them back together, whatever. You know, we did a whole lot, just growing up we did all kinds of stuff with our hands. And these kids may not have that opportunity. Their parents may not have had that opportunity to show them as an example. So this might be the only chance they get. Who knows what switch will get turned on.

Anne Marie: *Yeah, right. But, I'm really impressed too with the number of parents that accompany their kids to this workshop and they're really getting into it.*

Tom Foster: They do. The parents get…they dive into the project just as much as the kids do and a lot of it is the first time they've been exposed to it.

Anne Marie Hamilton-Brehm: *Yeah, I get that feeling.*

Tom Foster: Yeah, so it's, it's good for the whole family and, boy, get the parents involved with the kids and then hopefully it gives a little mind set to the parents – I've got to keep guiding them in this direction and get them going this way.

Anne Marie Hamilton-Brehm: *Yeah.*

Tom Foster: Not just after the class but keep going.

Anne Marie Hamilton-Brehm: *Umhmm. Why is the STEAM Program important to you?*

Tom Foster: Well, I think I've covered a lot of that already but it's, it's…you know, I've been around awhile, had a lot of knowledge and I love sharing it. And whatever I can teach to

somebody, answer questions, I love doing that because, you know, people guided me along the way too and I'm just passing it on, playing it forward as they say.

Anne Marie Hamilton-Brehm: *That's right. Yeah. What advice do you have for students who are interested in pursuing a career in a scientific or technological field?*

Tom Foster: I've been asked that a lot. I participate in a couple of other STEM-type things throughout the Valley here and meet with students a lot and I always encourage them they've got to focus on their math and science. In honestly I tell them the math, for example, you've got to learn a lot of math that you're not going to use day to day when you get out in a professional career but it's important for you to have it because you have to understand the principles behind what you do use. A lot of the number crunching in our world, my world, is done by computer now. But you've got to be able to look at the output from that program and look and say, "there's something wrong here. It doesn't make sense." Because of your knowledge of how it's supposed to calculate and that all comes from your math background. So I encourage them they've got to study, take all the math classes they can in school. And the science, basic sciences, chemistry and physics, biology, you never know where it's going to lead, where you're going to need it, you know. An example I would use is my brother, the mechanical engineer, he just retired about two, three years ago from Woods Hole Oceanographic Institute. It's like, it's the oceanography capital of the world on the East Coast. They're on Cape Cod and how did he end up there as a mechanical engineer? Well, he was in the Navy. He was a Navy fighter pilot back in the Vietnam era. Never went overseas but about when he got his wings it started winding down the war so although he had a five year commitment to go in the Navy they basically laid him off. Said we don't need fighter pilots. So he bummed around a little bit and then he was back East in the Boston area visiting with my Dad, actually living there, I guess. And he was looking for a job and he was looking in the want ads and saw this ad for hydraulics technician at Woods Hole Oceanographic Institute. So he asked my Dad well, what's Hole? He said, "Well, it's a big oceanography operation, world famous. He said, oh, never heard of them. So he went down and applied for the job and he got this job as a hydraulic technician on a ship that carried the Alvin Submersible Research Submarine.

Anne Marie Hamilton-Brehm: *How about that.*

Tom Foster: Three-man submarine. So he's working on that and the captain of the whole operation came up to him shortly after he got hired. He said, "I've been looking at your resume, fighter pilot, mechanical engineering, this and that. Would you like to learn to drive the Alvin?" He said, "Yeah, I'd love to do that." Well, turns out that he's got the record of number of dives in the Alvin.

Anne Marie Hamilton-Brehm: *Wow.*

Tom Foster: Over 500 and he was the guy driving it when they found the Titanic.

Anne Marie Hamilton-Brehm: *Wow.*

Tom Foster: So, and you've got very interested in oceanography as a mechanical engineer but he had a little bit of biology background and he got more and more into that and he actually…they have named a marine animal, small little thing, after him. All the research he's done. So I caution the students to pay attention to all of your sciences, your basic sciences, because you don't know where your career's going to lead you. And keep your options open. But the other thing I tell them to do is also pay attention to your English classes because as an engineer and a scientist you have to know how to communicate your ideas.

Anne Marie Hamilton-Brehm: *That's right.*

Tom Foster: And your solutions. You've got to write reports, you've gotta maybe give some oral presentations, and it's important for you to know how to do that and if it's, for example, speech club in school, join it. Learn how to speak in public. So that's what I tell them.

Anne Marie Hamilton-Brehm: *That's good advice. Tell me a story from your career about how science and technology really helped someone, helped, maybe you were able to help someone by using science and technology. Someone personally maybe.*

Tom Foster: I've drawn a blank. Not sure. I mean, so many things, you don't know, how it affects some people because you're not dealing with an individual perhaps. Of course, it helped my grandkids with their science fair projects and my kids. Oh, I could give you one

story, I guess, about my son growing up with him. Now he's an electrical engineer. But when I was in school they had science fairs and I used to always get involved with those as a student putting in an entry. So in his school when he was seventh grade or so I think, there was a science fair at his school. So we thought about it, what could you do for a science fair project? So he was interested in computers at the time and at the time you couldn't go down to the store and buy a computer. If you wanted a computer like we have today you had to build it from a kit. But they had a lot of little computers on boards similar to the Arduino you might hear about today in the Raspberry Pi, that level, but not nearly as sophisticated and to program them you had to program with what's called Machine Language, there was a thing called Basic. There's very little, limited languages you can program these little computers with. So we got looking at that and this and that and so we thought up with the idea, imagine a record player turntable and four circles on it around the circumference, equally spaced. And some broomsticks cut to different heights in different colors, one goes on each circle. Then there's a device we call a flipper that when it was activated it would move and flip off the broomstick piece that was going by into a chute. So the idea was that it had a screen. Today we'd call it a computer screen. In those days it was a converted television because you couldn't buy computer screens and what the deal was is, there would be an image of the chute and you would…blue, green, red and yellow were the colors…so you would pick which colors you would want to stack in what sequence. Then you randomly put them on the turntable and hit go and the machine would start and it would stack them in the order you told it to.

Anne Marie Hamilton-Brehm: *How about that. That's a great robot.*

Tom Foster: So that was a neat little project and were weren't sophisticated enough to tell what color the sticks were but they were different heights. So we had, we called it a gate of infra-red diodes and receivers in the broomstick would come through it depending on how many LED's it blocked because how high it was and the computer would know that was what color it was and would do it that way. So it wasn't quite the way the kids thought it was. So I tried to work with him on it in terms of build some of the hard parts for him but what I encouraged him to do…okay, this is like eating an elephant, eat a bite at a time. So you've got to develop software. You've got to develop the hardware and the program. He wrote the

program and the only way you could store a program in those days was like a cassette tape player.

Anne Marie Hamilton-Brehm: *Oh, yeah.*

Tom Foster: So he saved on a cassette tape player and he wrote the program step by step. I said I want you to write down every step on a notebook, step by step what the program sequence is. So if you lose the tape, you can re-create it. "All right." So he did that, got the program working, got the turntable working, got the flipper going. So then it was time to integrate the pieces. This is how the real world builds stuff. So you integrate it together and tries it out and the first time the flipper goes it kills the whole thing.

Anne Marie Hamilton-Brehm: *Ahhh.*

Tom Foster: So the flipper was energized by a solenoid kind of washing machine, pretty powerful. So what was happening is that when that energized it set a big voltage spike down the power line and killed everybody. So I said all right, well, look, let's power, let's plug the solenoid into a circuit somewhere else in the house, a big extension cord, different from where the circuit is where the computer is and see if that fixes it. So it did. All right, so now you know how to fix that so when you get to the science fair you're going to have to plug one piece in across the room and an extension cord and the other piece right there and it should work. So the day came, took him to school in the morning, took all of his stuff with him and 3:00 seemed like in the afternoon they got out of school and an hour before that they set them all up in the gymnasium. And so I came home and I was anxious to see how it went. He says, "Aw, it's terrible. I mean I plugged that thing in all over the place and it kept killing it. There's no way it would work." And I said, well, I see things down in the model. He said, "All that work and it doesn't work and it's not gonna…the judges aren't gonna like it." And I said, yes they will. He took that notebook, I made him write down all the steps of everything he did in the notebook and it was there on the display and they looked through that and he ends up winning first place in the science fair.

Anne Marie Hamilton-Brehm: *That's great. Wow.*

Tom Foster: On top of that we, all the parents, it's open to the public at six so we go back at six and I said, John, try plugging it in over there. So he plugged it over in that and it didn't work so we tried over there, try there. Finally we found a place to plug it in and it worked. Kids were lined up like gangbusters trying to make this machine fail. They would get in there and they'd put all kinds of combinations, they'd put the thing in all different places and they'd tell it to go and it would stack it perfectly. And he was the hit of the show. Everybody loved it.

Anne Marie Hamilton-Brehm: *That's crazy. That's amazing.*

Tom Foster: That's an…that's an individual I guess and he ends up being an electrical engineer. In fact we've worked together. So…

Anne Marie Hamilton-Brehm: *Well that's a neat story. That's really great. Is there anything else that you'd like to tell me about your, your career or your work that we haven't covered?*

Tom Foster: Not…I'm just, I'm continually working with the Liter of Light people trying to perfect this light I'm working on, I submitted to the competition. Production version. I think I can get it built for about $15. That's a lot of money to those people. They make four bucks a month. But It could be…Sorry, they make a dollar a day. But it could be micro-financed so they pay a little bit each month. Right now they're spending $4 a month in kerosene so if they spend that…even if the interest rate is 100% which I hear it can be, in six or eight months the light would be paid for and there's no more kerosene bill and their health improves.

Anne Marie Hamilton-Brehm: *Right.*

Tom Foster: And the version I'm working on uses super-capacitors instead of batteries that last for about a million charge cycles so when I get done the fixture ought to last somewhere between 35 and 70 years of daily use.

Anne Marie Hamilton-Brehm: *Wow.*

Tom Foster: So it'll run for a couple of generations. The problem with the battery versions is the batteries wear out in two years and then you're out in the middle of nowhere trying to find batteries. Very hard to do.

Anne Marie Hamilton-Brehm: *Right.*

Tom Foster: So I'm trying to get around that by using the super-capacitors that don't have limited life time. There's no chemical reaction so they don't wear out basically. So…

Anne Marie Hamilton-Brehm: *That's a great solution.*

Tom Foster: That's what I'm doing. I'm still working in the engineering field but in my spare time I'm working on the light for Liter of Light people.

Anne Marie Hamilton-Brehm: *Well it sounds like you're accomplishing a tremendous amount for the good of humanity.*

Tom Foster: Well, I hope it does. I mean that's…you know I'm doing it because I love engineering. I love working and frankly the electronics involved with the light, I'm not an electronics guy. I haven't really worked with electronics at all since JPL. I've only been powering lighting which is a different aspect of electrical engineering but, you know, reading the books back up and understanding and look at circuits and understand how they're working again so I'm relearning all that stuff to apply to this project. So I'm having a good time.

Anne Marie Hamilton-Brehm: *Yeah, it sounds like it would be fun to revisit that.*

Tom Foster: Yeah.

Anne Marie Hamilton-Brehm: *Well thanks for talking with me today, Tom. It was a pleasure.*

Tom Foster: Oh sure. Oh, fine. Thank you.