
Gibson

Generation STEAM Interviews

Stan Hanel

Interviewed by Anne Marie Hamilton-Brehm

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Paseo Verde Library

Anne Marie Hamilton-Brehm: *Today is April 4, 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 Stan Hanel who is teaching the electronics workshop in our STEAM Series. So Stan tell me a little bit about your background and career and what interests you in this subject that you're teaching.*

Stan Hanel: Yeah, I really fell into it. It was amazing. I started out, went in the army for a while and got out and then was looking at what kind of career I wanted. I started in accounting. It was actually at UC Berkeley. I was going to be a CPA and then I wound up getting sick and I had to drop out of school and needed a job. And so I found this that there was some training going on for some soldering and I got my first job on an assembly line back in 1979. We were building particle counters for the emerging semi-conductor industry back in the Silicon Valley. So we were building instruments that would actually measure what the number of particles, dust particles, in the air because when we were making chips back then if any dust particles fell in the chips while they were being fabricated that could ruin the chip. So the air, the clean rooms that the chips were built in, had to be perfectly clean and we had instruments that would actually take samples of dust, count the number of particles and actually size them: half micron, one micron, etc. and count them. So it was a neat company and I was…it was a good job and I enjoyed the people I was working with. Silicon Valley was just taking off at that point and then it just got really exciting just to be there, to be around the culture at that time. And in 1979 just a perspective, the first Apple Computers were just coming out and in 19, early 1980's the first IBM PC's. So basically I had been in the army and knew a little bit about electronics but not a lot. So as I was building things I started taking classes at my local junior college and I had some great teachers there as well and it was one teacher that owned a little company on the side that was making computers. And he taught me about micro-processers and that was what really got my light turned on. It was a little chip at the time; it was made by a company called Intel. It was an 80/80, 8 zero/8zero micro-processer but all the things I could do he taught me how to program it and the next class he taught me was how to connect it up to different things like printers and different things like that. So I, I saw at that point, this was around 1984 or 5 that basically, or actually before that, probably early 1980s. Those chips could go inside a lot of

different things and make them smart and so that was kind of where I went and I got interested in digital logic, micro-processers and how you can make ordinary things like a typewriter or things like that smarter just by using micro-processers. So that was called embedded systems and that evolution at the time when it started that the chips that we were making would have tens of thousands of transistors. So along the way there was an Intel, one of the founders of Intel was Gordon Moore, and he talked about something that later became called Morris Law and every three years we could double the amount of transistors, these little switches, that would turn on and off at millions of times a second inside the chips. So today our little cell phone now has millions of transistors, millions of switches that operate at what we call gigahertz speeds. They turn on and off at a billion times a second. So that to me was truly amazing to be part of that growth, to watch where we were going from just basically at tens of thousands of chips running at maybe 4 million times a second to now a million chips or transistors in a chip running at billions of times a second. So just tremendous to be and to live during that period. It's been really fun to be in that. In the Silicon Valley as an electronic technician I had a lot of job security because there was so much growth. Every two years new industries would arise so we had digital cameras, we had cell phones. So I worked for my particle company, accounting company, for about five years but then we got bought by another company and after all the work we put into it I realized that with all these changes in the Silicon Valley job security wasn't like the old days. My Dad had worked for Lawrence Livermore Labs for 30 years as a mechanical engineer and retired out of there with a pension. In the Silicon Valley companies would come and go within 5 years so it was a…I started looking at just learning more and, but the neat thing was that you could always find another company that was starting up and get in on the ground floor as a technician and then be able to learn from there and grow. So that was the fun part. And so after 5 years I wound up volunteering. The company I was with got bought and I was laid off. I chose not to leave the Bay Area and go back East to join the company and they gave me a severance pay and I went and I figured well, if you're going to work that hard, why not do something that might be beneficial to the local community; work for people. You know it's fun to find out the technology but how does it benefit people? How does it help people. And so I went up to the Palo Alto Veterans

Administration and volunteered and they happened to be working with Stanford University on a program to help people with spinal cord injuries, people that were totally disabled, quadriplegic, or paraplegic, and try and help them use computer technology. At the time it was just emerging in the 1980's to try and make their life better. So we had a mechanical engineering professor, Dr. Larry Lifer, who was reading that program and many of his graduate students that were working on their masters and PHD's in engineering at Stanford were coming over. We were writing grants and trying to take their ideas and see what we could make with them. It was pure research; it was a lot of fun; we did a lot of things with robotics. We had a robotics work station where we could control it just by voice so someone who was totally paralyzed, it would have... in the 1980's voice recognition was very new. It's getting better these days 30 years later but at that point we had a robot arm, an industrial robot arm that we could control when we tried to use it for activities of daily living for somebody that was totally paralyzed. So basically could it brush your teeth? Could it comb your hair? Could it be a computer workstation that would pick up the phone and hold it to your ear? So those kind of things we looked at and did our best to do the research and go from there. Another fun project was what happens when somebody has a stroke and how can they be rehabilitated and one person who was a bicyclist came up with a stationary bicycle that had a lot of sensors on it. And so what we found in that industry is that at the time a lot of tracking the progress of somebody trying to recover was always kind of subjective, that the physical therapist or the occupational therapist would observe them and then they'd have to write down progress, kind of their best guess. If we could add instrumentation to those, to those things that they were using we could actually get data and actually track their progress in real time so that was a lot of fun. So we did have an instrumented bicycle that basically was the pedals were controlled. They could actually work as a motor to help somebody that was just coming out of a stroke actually move their feet for them and then the bicycle would start out in the reclining position. You can think of an exercise bicycle laid on its back and then as basically the person got stronger we could let them push the pedals and the motor could provide resistance instead of moving it for them. So as they got stronger with more resistance we could start to shift them vertical and start to stand them on the pedals and then basically as they pushed the pedals they

would basically get stronger and stronger. The bicycle could be split so that basically you just pedal one side if one leg was weaker, work that weaker leg longer, or connect the two together so you're working both legs together. So the nice thing about stroke research was that the bicycling movement that is very similar to the walking movement, if you can get somebody bicycling and moving like that then they can walk. You know, walking comes much quicker. We looked at all sorts of ideas. That was a wonderful thing and we got funding and I was a contractor. And then I heard about this company in Sunnyvale that was working on people with quadriplegics. Our grant money was running out and I needed a job again (chuckling) so I had a…and I heard about this company and went down and interviewed for them and got hired. They needed somebody to be their production manager so I'd done a lot of building and soldering and so they accepted me. And at the time what I found out was that they had been working with Professor Stephen Hawking in Cambridge, England, and at that point he was…the story behind him is he was a brilliant physicist at the time who was suffering from Amyotrophic Lateral Sclerosis or Lou Gehrig's disease. It's a basic loss of neuron control from the brain to the different motors in our body so that usually starts at the extreme parts, the feet and the hands, and then gradually you lose control all the way through. A lot of people that get that disease, that gradual degeneration of the motor control, die within three or four years. Basically they get to a point where their, even their automatic, semi-automatic systems that keep us alive start shutting down. So usually the last thing to go is to be able to control, is things around the face, the movements around the face and then the eyes. The eyes you can usually move or blink even because they're so close to the cortex of the head. So we found that basically if we could come up with some kind of binary switch that could be turned on and off we could control the computer with that just by that motion and so we could adapt different switches to the laptop or just to the hand or even to an eye blink. If we could move just the cheek muscle or the eyelid we could make that into a binary signal that would control a computer. So the way Professor Hawking's machine worked and we could have…the person that I worked for, Walt Moltose, the way he got started, his wife's mother also had ALS and so they wanted to find something for her. And then when they heard about Professor Hawking , he knew of him and donated the equipment for his wheelchair so that was done in about 1986, 1987 and we

worked with an installer, David Mason in England to install that computer and maintain it. So I built some of the things that went into that computer while I was working for them. It was a lot of fun. At that point Stephen Hawking wrote a book called, The Brief History of Time and had just come out and it caught on. It was amazing. He had used our system to organize the book and so by using that binary motion he could basically monitor a screen that was blinking back and forth that had an array of letters on it. And so basically the way that…it would take him three clicks to find that letter. It would go through the array and highlight the top half of the screen and then the bottom just like that. The click would freeze the screen in the top half of the screen then would go line by line in that top half and start cycling through. And the second click would freeze it on the row and then it would start going in that row to the five items or so in that row just like that. The third click would get you that letter and then we could do something like predictive word for you, word abbreviations. So if he pops up the letter A he'd get another screen that would have lots of words beginning with the letter A. Then it could do the same cycle. Three clicks would get him to that word. We also had specific phrases that he used and we could store those. So once he could select words we could also put it to a printer, from a computer to the printer. Laptop computers were just coming out at that time and so we could connect those up. But there were also things called voice synthesizers that were just being developed. We could take text, words that were written in text, and convert it into sort of natural sounding voice. And the best state of the art at that point, it was something called the Deck Talk and that was…there was another company that we worked with called Speech +. Our company was called Words + and we used the Speech + synthesizer because we could make it portable. We could make it where we could…it could be on a wheelchair. Up to then they would usually have to plug them into the wall. So they came up with a way to make a portable device and so that was what became Stephen Hawking's voice. It was called Perfect Paul and it was a Deck Talk voice. It was a Perfect Paul, Beautiful Betty and then a child's voice also. But he chose Perfect Paul and decided to stay with that throughout his career. So there's been…one story I like to tell was that over the years he's had lots of opportunities as voice synthesizer technology has gotten better to actually take a much more suave sounding voice, much more smoother voice, possibly even a voice that was closer to his original voice before he

lost the ability to talk, but he chose not to. He felt that people recognized the robotics sounding 1980's voice. It was his identity so he's kept that and had as a, with a sense of humor that, that's what people recognize. So that was a wonderful thing. The company moved from Sunnyvale down to…Walt, the owner had worked for the Space Industry; he was actually a rocket scientist at one time and so he had done work for the space shuttle out of Edwards and so his family was down there. He moved the company down there into Lancaster. They were around for about 30 years. They just got sold out to a company called Prentke Romich Company and then spun off as a pretty much a repair shop now. They pretty much maintain the existing equipment but not a lot of new innovations since then. But with Professor Hawking he got adopted by Microsoft and Intel and they continued to expand his capabilities on his wheelchair. So now as he continued to lose…when we worked with him he was still able to use some motion in his hands to activate his switch and then later as he lost that ability he could still move a cheek muscle. So what they did is they adapted a little sensor, infrared sensor, on the cheek muscle so that as long as he could move that he could do a binary motion, still control his computer, generate speech and then with the voice synthesizer he could also collect and prewrite a speech. And then he could actually give a presentation to scientists by clicking on the sentences one by one. It would do the speech or just play the collection of text through the voice synthesizer. So there's a lot of neat things that came out of that. It was just a pleasure to work…I worked for them about three years and we helped a lot of other people that were paralyzed. What I loved about the company is it…we used a key as a symbol for the company that we could basically reconnect people that were trapped in their body back to the world, back to their family and friends by being able to communicate. So it unlocked the person, we called it unlocking the person by being able to allow them to communicate. So it, that technology is around now in, in the industry and there are different versions of it but one thing where technology really changed somebody's life.

Anne Marie Hamilton-Brehm: *Yeah, no kidding. How were, you were in California for a long time. How did you end up coming to the Las Vegas area?*

Stan Hanel: Great idea, yeah. Great dream. My wife worked at Stanford. She was a records manager and she got a chance to retire early. They were actually…it was the dot-com bubble

was kind of imploding. It was kind of a recession. I had been with a start-up company after I left Words + I went to work for a company that actually started out of the same lab, out of the Stanford lab. It was initially for deaf blind people and it was a glove that had sensors around the hand and so basically the idea is to finger spell. You can run that through a voice synthesizer and do signed voice. You know, feel and then start a communications system. Also would work with deaf blind. You had a little robot hand that could basically, the deaf blind person could feel the motions of the finger spelling in the hand and then actually be able to, you know, sign and whatever and communicate back. So we tried to…so that was one of the students that Professor Lifer, Jim Kramer, Professor Lifer's. He was working on his Ph.D studying to what was called then gesture recognition. He was trying to find ways to do that better, so we started with a glove and then we wound up getting involved with something called virtual reality which was also very popular in the 1990's. That glove could be used to navigate just like a mouse would in 2D space. You could use the glove with sensors on it to navigate 3D space and actually interact with your hands with the virtual world inside it. So at that time that target was a big gaining institute. It had an advanced research facility. The idea was can you become if you want to immerse yourself inside the game. The movie Tron was that idea that you plugged in the computer and you're in that virtual world.

Anne Marie Hamilton-Brehm: *Yeah.*

Stan Hanel: And so that went for a while. So the company I was with then, with them about seven years and they basically, we got sold to another company and at that point the dot-com was bubbling up. It was the dot-com bubble and a lot of small companies like us that had a team of engineers could be bought by a bigger company so we got bought out. And so I got cash and stock and my wife was at the point where she could retire from Stanford too and our grandkids were living in St. George. So we thought this would be a good chance to spend a couple of years here in Las Vegas and that's now turned into 15 years. (Laughing) Amazing how this place is, it's a wonderful place. I really…it's become home now and I really enjoy it.

Anne Marie Hamilton-Brehm: *Yeah. You must enjoy living here. Well, how did you become involved in the STEAM Series?*

Stan Hanel: Right. Yeah. That was, that was fun. I got, what I missed about being out here is we really didn't have that bubbling energetic culture that we had in the Silicon Valley so I missed that. But there were certain groups, Pololu is a company that had a robot farm every week and then, and then I heard about this SYN Shop was being formed. That was by Tony Hsieh Downtown Project and, and, but the group had already been around, you know. It'd been in existence, kind of a loose collection of people meeting in a garage from different, you know, un, uncommon…there wasn't a lot of similarity between the group except they liked to build things. And so we had people from Blue Man Group, you had people from Cirque de Soleil, just people were technical people. Burning Man, people that were from the Nevada Test Site. And so I heard about the group and I had to find out more and I came down. They were just getting some, this little shop that was donated by the Downtown Project rent free for a while to try and set up this kind of maker space. A maker space, it kind of started again in the Silicon Valley in the Bay Area where you would have a bunch of different tools in one, one shop and tools that were too expensive for one person to own but you could share it and have access. So things like C and C machine, laser cutters, 3-D printers, things that are new technology that I couldn't fit in my garage or anything like that but by going down to the shop and paying $40 a month or so you'd have access to all that to work on your own project. So, and just the networking, the ability to meet all these different people from these fascinating backgrounds. And that was the fun part that I had missed in the Silicon Valley and wanted to recreate here. So that's, it really has been a joy to be part of that again here and kind of build up a beginning tech culture out here that is kind of something that's really needed I think. To offer alternative industries and jobs. And the people are great too. It's just, they're really smart, interesting people to talk to and learn from and so it's a great experience.

Anne Marie Hamilton-Brehm: *That's great. So I guess Stephen Platt, our manager at Green Valley, he got this grant to make the STEM Series and then recruited you to teach the electronics component of that and so how did you develop your workshop?*

Stan Hanel: Yeah, that actually started. Bill Tomiyasu is a very important part of this. He's a, was on the Board of Directors and started an education committee in the SYN Shop in maker space. And so basically we needed teachers so he put out a request for teachers and, you

know, whatever you want to teach, you know, bring the idea to us. If we like it, we'll approve it. And so I sent them one on this little chip that's called a 5-5-5 timer and it's used in a lot of projects and my boss said okay and we got to do it and people liked it. So Bill said, "Well, can you do six of those classes?" And do a series of electronics, you know, one a month and so we talked about it and it seemed like fun. You know, we put it together, we brainstormed and came up with an idea and so for two years now from October to March we kind of been working out these classes. And the focus was we had people that were very smart software programmers there and a lot of people that were into crafts. We have sewing machines. We have wood-working machines. So how do you teach electronics to crafts people? What's the approach? Rather than have books and lots of theory and everything, how do you get hands on experience so they kind of learn something. So that was a challenge and we talked about it and worked it out so for two years we've now done 12 classes, two sets of six classes and in that process we were able to kind of trial and error learn what worked and what didn't. And so when the Henderson grant came along it was a good fit because we'd already been kind of experimenting with how to do that and so Bill was an important part working with Stephen and they've really been partners and bringing the two together. I'd say they'd both get equal credit for all the good work they've done to work as a team and then motivate other people to jump in too. And once that process started over a year ago from the grant, writing the grant to figuring out how to do it and everything, we've had a pretty active education committee that, that's come up with things. So there are basically seven teachers, each with their own expertise from the SYN Shop. I'm just one of seven and so in order to help…and I couldn't do it by myself. I need volunteers, people that can walk amongst the tables while I'm talking and show people. You know, if somebody didn't quite understand spend a little more time with them than I can while I'm up at front. And so, likewise, for the other teachers I'll go and volunteer for them too, especially the ones that are electronics related that I can help. And I learn just as much so that's the fun part is that I learn from them and even teaching I get a lot out of it. And the kids have been great so far. The parents have been really helpful. The kids usually want to be there and parents usually want to be there and they want to be involved too and it's just been a wonderful experience. As Stephen can probably tell you, it's been very

popular and there's a real need for this area. I think there's a real hunger for it. We see the people want to get their kids in and get excited about it. So there's a way to combine art and science I think and so that the STEAM idea was from Steampunk but also this idea of science, technology, engineering, math with an A for art in the midst of it to kind of make it engaging, make it interactive, make it fun, and so that's the real challenge. There's so many good teachers out there in this area that are trying real hard and have art. I've got some wonderful teachers in this area that are really motivated and have great effects on their students but what we're trying to do is just some little one-shot classes that will hopefully spark an interest or bring something that gets people to have their light turned on like mine did when I was taking in that micro-processing class. Is there something we can show somebody that's fun or interesting that wants them to learn more about something. How can we spark that interest and so that's been the fun part.

Anne Marie Hamilton-Brehm: *It seems like that would be really great if there was like an electronics club or something like that in Henderson. Do you know of like other clubs besides the SYN Shop that is doing stuff like this?*

Stan Hanel: There are. The Pololu Electronics and Robotics is a company in Henderson. They do mail order kits that are…their ads are shown in some of the hobby electronics magazines as well. But it was started by three MIT students that came out here and basically set up shop by themselves and now they have 50 employees. And what they did along the way was start up a robot meet-up group about ten years ago. So as the company formed in order to tell people more about their products they started a local robot club so a lot of the same people I met through the robot club are also at SYN, at the maker space too. And they were actually around a lot longer and still going. It's called LV Bots, the Las Vegas Bots are LV Bots. They meet every second Thursday at the Pololu Electronics, their office building and it's usually in the evening, usually Thursday nights. And they have engineers there, people for everybody that knows robotics. The other thing that's happened is the first robotics program in the schools has been very helpful. There's been a lot of high schools in the communities that have adopted that and gotten it…put together student teams so that introduction. And what I like about robotics is it combines all different things, not just electronics but mechanical things, motors. You really get

a whole wide swath at how electronics can interact with all these different things to make something. So when you're building a robot the first thing you try to do is make it move a little bit and maybe make some sounds so you can make it sing and dance a little bit. That's a great way to get started. But that's, for me, one of the things that happened on the site is after I got interested in microprocessors there was a company called Heathkit at the time that actually sold a robot that you could build yourself and it kinda looked a little bit like R2D2. And it would actually work and do a lot of things. So I built one of those and really got interested and, you know, reinforced my interest. And there's so many areas in electronics that you could get into and that's what's good. If you're not good at one part there's probably three or four other choices where you can be good at it. And so that's what…I'm still learning. I can't learn it all in one lifetime there's so much in electronics technology right now that one lifetime is not enough to learn it all. But I'm very happy to focus on one area and learn as much as I can. And some of the companies I've been with have actually tried to push the envelope and, you know, inundate a little bit more and add more to the knowledge that's out there. And that's really exciting when you come up with something that nobody's done before and are able to do it and then pass it on to, you know, the world to make the world a better place. So that's the fun part.

Anne Marie Hamilton-Brehm: *Well in your work too, it must have been challenging to keep up with technology. It must have been changing very quickly. How did you keep up with technology along the way?*

Stan Hanel: Yeah. That's the key is you try and find a niche that you're really interested, that you're passionate about and then as that evolves you want to learn more and you learn on the job. A lot of times you couldn't go to a school to learn it because it was so new they'd have to train you how to do it on the job. So, I would usually get training from the company I was working for, basically being paid to learn which was wonderful.

Anne Marie Hamilton-Brehm: *Yeah!*

Stan Hanel: And then, and then working with a great bunch of guys that were equally motivated and so we did start-up companies trying to, you know, come up with something and hopefully sell it. Not all were successful. We had some, some that didn't make it also

[Chuckling]. So just about a half a dozen over that during the 90's, then some of the dot coms. And then I went out as a consultant and I figured rather than work for one company I'll create my own little consulting company and then anybody that needs something built I'll try and help them out. There was, I had three different companies come in at the same time…

Anne Marie Hamilton-Brehm: *Wow.*

Stan Hanel: …and it got busy. All in Palo Alto and so it that was an exciting time but very tiring. I didn't quite make as much money as I thought. [Laughing] I broke even. So when my wife got a chance to retire and the one company I was with got sold to a NASDAQ company, I had a little cash and some stock to come up here and I thought retire for a while. But the dot com bubble bursting, that kinda…my stock kinda didn't quite do as much as I was hoping so, so in a way it was good because I kept working and in a year when I got here and found some little niche industries that I could contribute to and it's been fun. Then now to meet all these other people that I didn't even know were around through the Maker Space, through people that are, you know, in all different areas and it's been a really big gathering point that maybe we'll get a little technical community going to get there and make some great things. So, that's the fun part.

Anne Marie Hamilton-Brehm: *That's great. What do you hope that participants in your class will learn? You were…I listened to your class today and you covered a huge amount of material there so what do you think is the takeaway?*

Stan Hanel: Yeah, well that was a challenge Bill gave me. Can you compress those six separate classes that came up in one three-hour thing.

Anne Marie Hamilton-Brehm: *That was really good.*

Stan Hanel: It was exciting.

Anne Marie Hamilton-Brehm*: Wow.*

Stan Hanel: You know, you're really trying to do that. We're still not there yet. I got through maybe two or three of the classes into one thing and also make it fun. So, we knew we were trying to scale it down but be interactive so it wasn't too complicated but just enough that

hopefully people just get a taste of something. And so like I said there's multiple areas. We covered basic electricity; then we got into electro-magnetism. We talked about wearable technologies as well. So, I tried to give a survey of different things and with different people in class maybe one or the other would spark something and hopefully go from there. And that's, that's the whole, whole of our Generation's team is we're not going to be able to teach them everything in one presentation but if we can provide a little spark of interest that says, "Okay, I want to learn a little more about that, or, I'm excited. Let me go after that project and learn it." Because even if you have an advanced degree, I work with people that were studying for their Ph.D's and that sort of thing. It still comes down to tinkering, to trial and error, to making things, building things, seeing if they'll work. If they don't, you know, learn from it and go on. So that process is universal at all, you know, whether you're a crafts person or a, a Ph.D working on a doctorate.

Anne Marie Hamilton-Brehm: *Umhmm. And there's more available online these days too.*

Stan Hanel: Yes. And lots of great resource now and I'm looking at more ways that we can pull that in to maybe even live have, you know, people go out, do searches, you know, while they're listening to something. It's amazing being a student now. All the information resources you have at your fingertips, almost too much. How do you digest it all? And so that's a big challenge but, you know.

Anne Marie Hamilton-Brehm: *Why, can you talk a little bit about why this STEAM, being part of this STEAM program is important to you?*

Stan Hanel: Yeah, just that everything the we've talked about, networking with other people that have a lot of similar and even different interests to learn from each other to build a community of people that are just similar to that culture in the Silicon Valley that I kinda missed. Back there we had, I was a member of the Home Brew Robotics Club and I also was a member of the Electric Auto Association so we have an active Las Vegas Electric Vehicle Association that's…

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

Stan Hanel: …that's linked to the one in Silicon Valley so when I came up here I started working with that group and the networking was fun. And then through STEAM just hoping to pass that on, getting up to my 60's now and if there's something that I can share with somebody that's just starting out that might spark something or lead them to be more interested in something, then that's, that's fun for me, you know, just to pass that on. And I'm not going to be around on this sort of thing too much longer so [Laughing] it's a good time.

Anne Marie Hamilton-Brehm: *What advice do you have for students who are interested in pursuing a career in science or technology?*

Stan Hanel: Yeah, if you're…I'd say just go for it. If you're not great at math STEM is science, technology, engineering and math and it's…if you can master all those, great. More power to you. But not everybody is good at math but they might be good at engineering which is applying science so they might be able to think of an idea and how do I get there? What do I have to learn to get there? And they might be focused like Ben Franklin. I brought it up to my class. He was very good at…he didn't really like memorizing math tables but he really liked math for measuring so, you know, things. So, he learned just enough math to measure things but he was more interested in how to print things, how to use the technology at the time to, for what was the social media of its time, the books, brochures and newspapers and that sort of thing. So that idea, Franklin, I bring him up not only because he started the first library which is really appropriate for the STEAM application at the library here, but also because he was a maker. He was the kind of guy that was get interested, fascinated about something and then he was almost obsessive about it. So not only did he master the printing business by age forty. He also became interested in electricity just from seeing a sideshow on a street fair like our First Friday show. And from there he basically just got absorbed in it and just changed how the world saw electricity in the brief period of ten years before the Revolutionary War started. He became world renowned for his studies of electricity and his fascination, his curiosity, his interest, his deep interest of knowing, you know, trying to learn, understand. So that kind of drive, you have that even though you may not be a great mathematician or a great…understand science that well, you'll want to learn. And that's the key I think more than anything.

Anne Marie Hamilton-Brehm: *Motivation.*

Stan Hanel: Motivation and the interest and the curiosity, you have that you're a scientist. [Chuckling]

Anne Marie Hamilton-Brehm: *How do you think the Maker Movement is going to affect the future of civilization?*

Stan Hanel: Yeah, that's a big, big thing but what's fun is it's bringing back manufacturing practices so when I started out I started on an assembly line and we built stuff. Back then the electronics were so new that we had to go out and recruit people and nobody had ever been trained to do it. There weren't really formal schools so they would go out, search out for, to populate assembly lines, somebody that was good with their hands. And so the best candidates were actually women that had small hands that could work with these little devices but the hairdressers, the manicurists, people that were accomplished at knitting or sewing, they could do things with wire harnesses and the skills adapted really well. So, that's how we started and we built all our own stuff in house. We built, we had a wave solder machine for making print circuit boards. So I went from assembly into actually testing the boards after they were built and then, and then learning more about…I had to learn electronics. In order to test it I had to understand how the different components worked and so as I went along through my career I was not only building stuff but then learning how to invent stuff. And so that was the really fun part after I'd had ten years' experience or so is working with people that were creating something new that had never been done before. And so I could, I wasn't really an engineer but I had enough skills that I could complement them so if they had an idea I could bounce my ideas off them and we could work together and come up with something we could fabricate that would actually work. And so that was the thing. So I would say if you're not, if you don't be, don't let it turn you off if you're not great math or you're not great at physics or that sort of thing. There's so many niches in this area that you can find something that combines art and science and can be very rewarding, very fun and be something you'll want to do for twenty or thirty years and you never get tired of it. So that's the fun part of it.

Anne Marie Hamilton-Brehm: *That's neat. Do you have, is there anything that we didn't cover? Or do you want to tell another story about how science and technology really helped somebody?*

Stan Hanel: Yeah, that's the amazing thing. What's fun, especially when I'm at chip industry and electronics is what we talked about, something called Moore's Law. And Gordon Moore was a co-founder of Intel back in the 1960's and he was, somebody was working on integrated circuits, was the idea of taking transistors and different electronic components and putting them inside these chips, and so when I was starting out we had tens of thousands of transistors in a chip. And then his way of observation, which was later called Moore's Law after Gordon Moore, was that every two years they could double the amount of transistors in the same space. So say something the size of my thumbnail, every two years I could put more and more transistors on that thumb nail. And so we, I lived that. I started out when I was just beginning and then just watched the evolution. Every time we could do that we could launch brand new industries every two years. So we had a really surge during the '80's and 90's where every two years you were, all these new technologies were coming out. You still see that today although it's getting harder and harder to do. But now the distance between the transistors on an integrated circuit now is in, in just, it's almost to the point where it's just nanometers or just atoms separating they're so close. So it's getting harder and harder to scale up. But one chip now instead of tens of thousands of transistors can have millions and even a billion transistors on one something the size of my thumbnail. So, it's amazing.

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

Stan Hanel: And a lot of people don't know about all that's gone in that history, that story. And so it's good to kinda bring that in to try and give a perspective that, that cell phones have enough pockets. How powerful this thing is. It's amazing.

Anne Marie Hamilton-Brehm: *Yeah. It is amazing. Well, Stan, it was great to talk to you today and I really appreciate you coming by and I'm excited about the STEAM Series. I think everybody's getting a lot out of it.*

Stan Hanel: Yeah, and the other teachers are really good too. Tom Flores worked on some of the space equipment that's out that again changed the world. We've got some people that are involved with some other test site, some other things that I think…it's just a great opportunity for us to contribute too and meet each other and work together and also have something launched.

Anne Marie Hamilton-Brehm: *Yeah, thank you so much.*