Oral History of Lynn Conway
2014 Computer History Museum Fellow

Interviewed by:
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Dag Spicer: What were your most important life lessons, over your career and life?

Lynn Conway: Reflecting back, I think some of the most important lessons have come from observations, just curiosity-driven observations that revealed meaning to me; you know, things I've learned along the way. Kind of always being a bit shy and on the outside, I think I've tended to be a keen observer and trying to figure out kind of what's happening and how to do things. And so in a way it's like life to me has been a long series of trying to figure things out; how to make something, how to do something, how to learn something. And so that became a habit I think at a very early age.

Spicer: What was your proudest moment?

Conway: Actually thinking about proudest moments is interesting. It's an interesting question because how do we define that and so forth? But I think the most- sort of the most exciting moments, the things that I was proud of because I knew there were so many latent possibilities in something, is when a cool idea occurred, just having a cool idea occur. Also kind of flipping that, sometimes taking a bunch of cool ideas and imagining how to cause some kind of happening or cool hack that you could do, if you're able to actually make that happen and pull it off-- it's savoring the moment; it's sort of reflecting on how cool it was to have done that. And I think an example there is really I had this amazing road trip back from MIT in late January or early February in 1979; traveled back to [Xerox] PARC and went across the Southwest in winter. And sort of the whole trip, I knew something amazing had happened and I was just savoring the moment, that whole trip, kind of on a- on kind of a high, listening to rock-'n-roll music along the way; which I've always tuned in to music. And so sometimes right after an adventure, just the feeling about reflecting on it and savoring it.

Spicer: And in this case it was your MIT course, in 1978 that gave you that feeling of…

Conway: Yes.

Spicer: …pride and--

Conway: Yes that's right. That was after the full success of that course, that actually everything had kind of amazingly come together and worked, with the help of our team at PARC, people there who worked and collaborated; and then of course the amazing group of students and other folks at MIT that helped make that happen.

Spicer: What were turning points for you in making your life decisions? What inflection points happened in your life that led you down the path you took?

Conway: Well you know, thinking about decisions, I think-- I made many kinds of decisions that really were inflection points; and made them differently in different cases. So there's no one clear pattern. An example was when I was leaving Memorex; and Memorex was fading out of the computer business and I had job offers from Xerox PARC and from Fairchild Semiconductor. And in that one I made a-- I actually made a kind of matrix of the two opportunities and a whole bunch of factors to cross-compare and weighted some of those and kind of came up with a decision method to decide. And I decided to go to PARC. And so that was a very calculated- apparently calculated and rational decision. But I think also embedded in it was kind of a set of intuitions and attitudes about- feelings about the work environments at both places, from what I'd observed and so forth. So that was that type. Now others, sometimes it's decisions that are made because they have to be made, under pressure; time and circumstance. A contingency occurs; and it may actually be a critical turning point. And that's made differently; you know, experience-based, trying to use as good a [illegible]

problem was that all the-- the only people who could design these kind of chips in the newly emerging MOS technologies, which had this dramatic scaling future, the only people who could do that were people who worked in the semiconductor companies!   And so a lot of this had to do with how do you shift that to where anybody that knew how to frame designs and create them in a language, if you will, that could be printed, could do that; and then another place could simply print those. And the possibility of doing that was very analogous to what was emerging with the laser printers at PARC. So it’s sort of like: Okay now we have all these people that are writing stuff and whatever; and then it’s being printed. Why can’t- why can’t we do that same thing with creating machines to be printed in silicon? Okay so there’s that. Then the other side to it was that the reason-- one of the reasons that the designers were working for the semiconductor companies was that - in order to design a chip at the time - you had to have a whole bunch of special, different pieces of design being done at different abstraction levels, including the basic architecture, the logic design, then circuit design, and then very importantly the layout design; all being done by different people. And the various people in the different layers passed the design down in kind of a paternalistic top-down system, they- the people at any one layer- may have no clue what the people at the other- levels in that system of people are doing or what they know. They only know if it’s been sort of, quote, ‘correctly transformed from a prior level to come down to them’, how to decode that level of design and then re-encode it and pass it to another level further down. So there’s this hierarchy of disciplines. So you had a lot of- you had a lot of people involved in the design of something like a microprocessor. But it turned out that you could look at the whole thing another way and you could realize that really from the designer’s point of view about all you needed to know for kind of a first-order cut at designing was, to use our new kind of the terminology and coloring of the day, that when a red wire crosses a green wire, it makes a field-effect transistor; which is to first order an almost perfect switch. And when it’s on, it has a certain resistance. And what’s really important-- both on and off but especially when it’s off-- it has quite a large capacitance just hanging there open. So that you can compose things out of switches, resistors and capacitors-- no inductors; everything is simple. And you have the ability to make all kinds of elaborated structures where you don’t even have to do, in a sense, logic design as had been previously conceived; because really the primitive isn’t the logic gate, the primitive is these FET switches. And so an architect -- knowing what a computer is, and knowing how it’s composed of registers that are connected in data paths, with state machines to control the flow of information and processing through those data paths -- could see that all of that stuff could be composed out of these FET switches and interconnecting wires. It was kind of like designing a microprocessor wasn’t a lot harder than like designing a pinball machine, back in the 1930s when you knew about relays and about symmetric functions and all that sort of thing. And what you see is what you get. You could look at it, and you could reverse-engineer in your mind exactly what’s going on, by just looking at it. But the way the industry system was in the 1970’s, a lot of the people working in logic design or working in circuit design or layout, including some of the architects, actually had no actual clue either what an FET switch was, or what a computer was; in a sense. They were very specialized in some arcane area of it, working with a bunch of other people to tune and evolve existing designs. By coming up with the simplest-- kind of like ‘stepping stones across a creek’-- composition rules and primitives at each level of abstraction-- it seemed possible, as with using the viewgraphs and conveying what this was, to have people learn how to do all this by just learning at each stage what those primitives were and how you could put ‘em together; and in a very short period of time they grasped how to playfully explore making digital systems in silicon. So that-- all of that kind of came along.

Along with all that, there was sort of a sudden realization that what appeared to be toy-like work— remember, this is going on at Xerox PARC, and it's not in one of the major semiconductor places – although we had a big laboratory there doing semiconductor processing research.--But this group of people at PARC, in playfully working with this, came up with essentially a really dramatic simplification of how you design chips and put them in a-- put the patterns in a form that could be really easily made. And that last step-- was kind of the key one-- was coming up with a digital specification that was scalable for how to create the geometric patterns, how to instantiate them, so that they could be printed in silicon. And I think-- I think that's had a lot of impact over time, even in a variety of areas as we've moved towards making more multi-physics kind of machinery in MEMS technology and beyond -- where the same process is going on of understanding what design rules to put in the EDA, the software --so that if whatever you specify at that level can be scaled down to a certain point- but no further- that thing can be made if you then convey it to a process that is consistent with those rules. So now what's really interesting about this is that-- we have to remember that in parallel with these conceptual notions of how you would make chips-- is this notion: 'Okay we need some tools to actually do the making; we need the equivalent of word processors to take our thoughts and put them into language that can be printed'. And so there was a kind of new form of electronic design automation that started to appear that was very simple, that just simply-- and it evolved in parallel-- that played with these methods and jointly evolved, so that you could- you could specify designs using these tools-- although they were very primitive tools at first, such as the work on Icarus that Doug Fairbairn and Jim Rowson did—these apparently very simple tools let you quickly capture your ideas, put them into a printable format and do things like make arrays of cells from a cell and so forth; and then we accessed fabrication so that we could make and see 'would these things work?' 'Would these rules work?' And they did! And so to kind of jump ahead on that, you can now see the possibility of creating a-- almost an ecology of methods and tools and software and printing-- where you have one set of machinery that you're using to put your tools into to create the next level of machinery. So you have tools that are helping you create what amounts to more powerful machinery, which you then print. And as you print that you now put your EDA software, further evolved with new dimensionality and more power, into those new machines that are mat was6-3.9(o)-1.4d t8—1pl are mat was6-3.

to look really quite odd because let's-- let me give you an example: If you looked at the design rules used, and you would find that they were not-- they weren't a large set of rules. And so, they weren't 'optimal'. You could easily in the current process take a particular area on the chip and have people hack at the layout using a finer set of design rules and shrink it by some amount. Now, the counter to that is it turned out people in most of the industry at the time, were actually creating the layout patterns by carving and cutting up Rubylith. So, the layouts for the masks weren't computer-generated. It was being done by hand. These huge things were then essentially photographed, reduced, replicated, and so forth. But our designs looked very unoptimal, and a person who knew about handcrafting Rubylithst would say 'this can't be right'. And 'It's not'— for it could be made much smaller in that way. And other people look at some of the patterns. And the patterns just look too simple, too much like weaving or quilting, rather than complicated looking tangles of gates all connected together, okay? But I think what people didn't realize is that even then, if you took the area and time and energy that you would invest in doing a particular computational function created our new way, even though at every level of abstraction, it appeared to be 'unoptimal', the net result would be it would be way more powerful in those measures than something similarly implemented that had been optimized at each level of existing abstraction! So, this is potentially very unsettling, because now you don't need people that know how to minimize gates. You don't need people to carve layout patterns in Rubylith. All these people that are working these different specialties and optimizing them are now going to be displaced by essentially some simple EDA tools and creative writers that know how to write things that you can print in silicon. So, you could see how the pushback started -- and then there's other dimensions: At some point, the existing TTL industry noticed, and began I'm sure, becoming concerned about 'what would happen if [this stuff took off]?'.Okay, it's fine if somebody makes microprocessors and memories. But you made everything else out of TTL. What if people could actually just 'print stuff in silicon'? And now all these boards full of TTL could be replaced by a few extra chips? Well, so now we have that kind of pushback happening. And quite frankly, since it all appeared to be coming from kind of 'unknown, uncredentialed sources, if you will', and being done in a university course at MIT rather than in a high tech, hugely funded industry that was making lots of monies off the commodity parts they were selling, it seemed 'unsound'. So, I would say that that was—that was when that sense of unsoundness was starting to propagate. At the same time, the excitement propagated in some of the other academic community out here in the Bay Area and elsewhere about what had happened at MIT, how they'd done that. And of course, that's always interesting because I guess it's like: 'okay, MIT did that'. Meanwhile-- no one seemed to think to ask me what had happened! It was really kind of cool. I mean I think that's the other thing. There's this theme running through all of this: I think very often the people in charge don't have any idea of the dangerously innovative things that people down in the ranks, who are unknown to them, might be doing. You see? And even here, that might even be part of what cast a layer of apparent-unsoundness over it. However, all of that pushback kind of created an atmosphere where I increasingly felt it. Part of it was generated by internal pushback at PARC. PARC had an internal politics among different laboratories, the System Sciences Laboratory and the Computer Science Laboratory. A lot of pushback came from the Computer Science Laboratory. They had to think that whatever was going on with Conway was clearly unsound, because they knew me, and I'm just a regular PARC person there just doing my thing. How can this person have anything to do with upsetting an industry? Well, it had to appear to be unsound, really quite seriously. So, there was that. And I think all of this caused a lot of mental turmoil in my mind. And it was in the spring of '79 that I got an idea. And I ran around trying it out on people.

people participating in that social event, how to use tools that collectively enable them to all in a coordinated way, get their stuff printed in the same magazine. Same thing, now with silicon chips, except all of these people were scattered somewhere else. They're all around the country because you want to have this roll out at different universities. So, there's a dimensionality of it that has to do with using the Arpanet, i.e. the Internet, to provide social connectivity and data connectivity to cohere and orchestrate all these things. So, as that spring went on, I got the idea of creating what amounts to a 'happening' that was a 'collection of, in a sense, hack-a-thons like the one at MIT', but now more than one would be going on

courses. And over a hundred projects were being done. I think it was a hundred and twenty-nine. And-- now see-- something on that order. I think maybe that's the number of designers participating. But the-- all these courses were kind of launched and kept on track and stoked by a series of messages we sent out in order to keep everything cohered as a social-- sort of a 'social happening'. And it was really very interesting, because if you can go back and talk to people who participated and ask them what did they think was going on. See, this is-- because it's not clear that they had any idea that this was anything but 'ordinary business'. You see, it all seemed so simple. And it all just kind of went along. And it turned out everything fell in place, just like it had at the MIT course. Virtually all of these courses ran that script, and could predict where they were because they were all using those handwritten notes. And it was easy to communicate with them about things, because they're all operating within a common culture. But the variances would now be that different schools started to make their own EDA tools. And so, all of a sudden, there's a startup of competition in that EDA dimension to make tools that would help with design rule checking, etc., that would do various things that they might be able to do better than the other universities could -- but everything was cohered by having all of the layout specifications transformed, in whatever tool they were using, into an open source intermediate format -- so that you were able to essentially shield yourself from the particular kind of code or methods being used by a particular EDA tool to create the layout patterns. And at that same time, that same interchange format was used to distribute to all the universities Dick Lyon's common set of input/output pads, a common set of programmable =logic arrays for making finite state machines, etc. And so, it all began to develop the sense of kind of an open source framework where you could share things that helped everybody do their designs. But whatever designs were produced could be shared with other people, if they worked, because they were all in this format. And so, all kinds of possibilities started to emerge. And the mind could reflect back on what was happening in just making group magazines where a lot of people participate in a happening to get a magazine out on a certain issue, where, let's say, the different authors are actually working in a coordinated task where there is some connection between all the articles. They're using pieces of one in the other, or cross-referencing and so forth. So, there's a whole set of sharing possibilities that can be done. And so, observing what was happening, the mind could race ahead and think about how to further stoke EDA development and how to stoke sharing so as to amplify the activity. And I think part of then what happened and was so interesting-- now, I think this is really very important-- is that at almost all wouldn't have accepted them anyway because they looked too weird. They went and the showed them at their own showing. When you see them together, it's like 'now you catch on what this is'. So, this what was happening in these university hallways all around the country-- was this sort of thing that was happening out there. But who would know it was connected with anything else? Well, Lambda magazine cohered that. And reports were made on this. And so, that magazine evolved along with the development of EDA tools, along with the now surge of courses that started expanding. And so, by the '82-'83 school year, it went from one course at MIT in 1978. In 1979, it was twelve courses. By '82, it was over a hundred. And it was an explosion of activity. But it also-- now began getting out of hand--So, now we have lots and lots of people learning how to do creative writing in silicon. So the issue was always 'how are you going to print all these designs?' Bert Sutherland had begun talking about maneuvering this before this actually triggered and started. So he was thinking about this. We had run another event, MPC580, in the spring of 1980, I mean, actually, a little group was even started in order to cohere that. That was tremendously successful, too, but we couldn't do this anymore just at PARC. So, what we did was that Bert, having connections at DARPA and USC/ISI—(USC/ISI, the Information Sciences Institute did a lot of contracting for DARPA for software development) --and the idea occurred to Bert to see if we could institutionalize the ongoing operation of MPC79, MPC580, somewhere like ISI, and doing it via DARPA support. The folks at DARPA-- Bob Kahn and the folks there; Duane Adams and Paul Losleben-- could see now, with the success of especially MPC79, that 'this was it'. It was really clear what the possibilities were. And so DARPA provided funding for the transition of that technology to ISI, where it became known as the MOSIS System. And, of course, what's sort of interesting about that, is MOSIS has been running all these decades, okay, and MOSIS has no idea where it came from! <laughs> See, that's the way-- it's a way-- <sighs> and, you see, Bert saw a way to transfer technology that was running, and dramatic that the sort of waves of almost generational waves of technology, instead of coming in 20-year cycles, or 10-year, or 7-year, are now coming in maybe 5-year or 4-year cycles. And we're also seeing now another kind of convergence come back. It almost reminds me of the 'microprocessor + memory' production in the early days of the semiconductor industry, to where now what we have is, we have as OEM systems like, right now, there're cell phones. That'd be kind of-- the smartphone is now the commodity thing that has incredible capability, and so many people find it central to their life that all over the world that's spreading like wildfire. But that is actually channeling thought that really-- everything is done with this "one-hand machine", as the Chinese call it. And what's so interesting is there could be so many more things that the microcontrollers, if interconnected, could be embedded into and animate, that aren't just a commodity part, but where there's incredible diversity of possibilities of new things that could be created and designed in all sorts of new ways. So, instead of having high rates of change of a common technology shared by everybody, so the whole world is going through these huge changes in what we're doing almost in lockstep, it's like it'd seem to be healthier to turn loose a much different 'kind of making' that's more participatory, more diverse, more locally situated, and so forth. So that's kind of a thing I've been thinking about a lot lately, and wish there were ways to encourage that to happen. And so it's almost like-- it's really strange and eerie--it's almost like I'm finding myself, and people I collaborate with are finding themselves thinking, "My goodness, we're right back in 1975, '76, where we're seeing the peaking of something and dramatic possibilities for it all being different". But how do we-- what stepping stones do we put in that creek to go from here to there? What bridge do we build to get from here to there? And I think the younger generation is all wondering that, too, because there's a lot of age structuring in our current situation that is becoming really difficult, because imagine: If you actually were an older professor now at a lot of universities, even our best universities, have you been able to stay up with all the technology waves that have come over the last 30, 40 years? <laughs> Are you in contact with the world the students you're teaching are now living in? And they're looking at you to give them the wisdom to know what to do? See, the changes are so fast that-- and they're all occurring in lockstep. That's why, in a sense, some spreading and diversification of that, back through the breaking out of the bubble of "you only make microprocessors and memory chips". Now "you only make cell phones". Well, no, wait a minute. <laughs> You can embed the silicon machinery and the MEMS machinery and all these wonderful new things that can be made in the microworld into all kinds of things, and it could be more participatory because we know how, now, to have learning be done in new ways, where it's experiential-based and team-based and more of a social process. So-- and then there's room for elders <laughs> who have the wisdom of having seen many prior changes so that they've seen each of these before, and they've seen the effects of a change. And so that's sort of like remembering back. I'm thinking about changes I had known about because I happened to be interested in them; things like the AC revolution-- the electrification of America-- things like the radio revolution, [Edwin Howard] Armstrong's work. One person had provided this series of steps-- did so much-- and a body of-- a community of people cohered around that knowledge and just went wild with it. And then there's this breakpoint in World War II at the Rad Lab [MIT Radiation Laboratory] — pulse and digital circuitry for exploiting radar, and so forth. And that opened the door along with the computing machinery that was also being exploratorily developed during World War II; the two converged, and, after the war, the explorations ramped-up towards computing machinery. And so, closing the loop on that, it's as though maybe we need for people to see the grand adventure that we're all on eD-7(u)-.6(es oyrica)hysnn ofinnovatiose and then that is another abstraction level that we can use to launch off in a new direction. And instead of everything being a pyramid leading to a few commodity parts that are sold to the world, a few people get rich, and everybody else is a consumer of a common commodity and their lives are run by it, you flip that, and maybe almost everybody gets a chance to participate as a “designer and maker” for at least some of the things in their local habitat. And so things can be innovated and made at finer scales, more locally situated, and more people can participate in the adventures of designing and making. So, anyway, I’ve gone on and on. <laughs>

Spicer: No, that’s a great answer.

<crew talk>

Spicer: Ready for the next question?

Conway: Sure.

Spicer: This one is kind of interesting. What might you have done besides what you did, if you had another career or another life?

Conway: Oh, I--

Spicer: It’s kind of a weird question.

Conway: Yeah. I’m thinking about other directions. When I was little, I was always really very interested in music. I was always fascinated by music, and so I learned to play instruments; played the piano, played the saxophone, and then later played the trombone, which was deemed more appropriate at the time. <laughs> And... but music really fascinated me, and during World War II-- I grew up during World War II, and so there’s a whole set of things around the aura of that era. But I listened to classical music especially, and I had a little vacuum-tube radio-- a little, small thing-- that was on a bed table by my bed, and so I would turn it on at night, and I’d go to sleep early, but I would listen to radio for a couple hours, and quietly so to not disturb anybody, listening to music. And there were really good stations out of New York City. I grew up in Westchester County, mostly, except for a period during the war when we lived in Bethesda, Maryland. So there was that resonance with the feelings and emotions stimulated by music that was kind of always there, and-- but, while it affected me a lot, I think I was too constrained and inhibited to be a good music performer at the time, and so, although I really enjoyed playing-- I actually ended up playing in the Westchester Symphony, playing my trombone, <laughs> and that was wonderful, but I never got, really, into any of the garage bands or stuff that was really creative, that I also resonated with highly. And so I could imagine, if things had been different, I could’ve been a musician of some kind. I don’t know what. And that would have been wonderful. I mean, the adventure of music that’s still unfolding is just incredibly dramatic, and I think people totally underestimate the power it has in our lives and the way it triggers memories. And if you're responsive to music-- I use the music of the different periods to actually evoke and cohere visual memories of what was happening at that time. And so, at peak times, a lot of my memory is based on the connection between music I'm listening to and what was happening. It was really kind of interesting. So that's one possibility, but there are probably others, and... maybe I could've been a teacher. But, see, I'm not sure I like the idea of teaching. I have a lot of questions about-- I think more about learning and how to put stuff out that you can play *with* and build *from* than showing *how to do*. It's just a different notion about it.

Spicer: Who were your role models?

Conway: Whoa. <sighs> Role models. Who are my role models? There's many dimensions. I always had a picture of Steinmetz that I always had on my office walls all along, because he was symbolic of someone who somehow was able to surmount, really obvious in his case, physical challenges, but also political challenges. His-- he'd had to come here, with problems being-- this sort of thing about socialism at the time, and all of this. So, kind of an outsider kind of person who, nevertheless, was accepted, embraced, and appreciated because of the fun things he was doing, and how exciting it was to be doing that and spreading that and having that all take off. An amazing guy, and even-- and older in life, the love of the outdoors, the Adirondacks that-- never married or had children because of concern about passing on whatever that [his ailment] was, but beloved by people, surrounded by a lot of people. An amazing life. There's a-- he-- so you take someone like that, and you see there's a touchstone there, and it isn't on the work, it's the having the adventurous, fun-filled, engaged life, in spite of this or that or the other thing. But there are others. I know when I was growing up, I think I took my parents as role models, and in different ways. And my father was a chemical engineer-- research engineer; worked at the Texas Company, as it was called. He was in the Chrysler Building in New York City. That's where I was born-- in Mount Vernon. We lived in Hartsdale, and then Scarsdale. He's working down there. And he was tapped early in the war to be chief engineer of the U.S. Synthetic Rubber Program, and ended up running the program that did the shootout of-- I always get mixed up if it's seven and six or six and seven different kinds of rubber and numbers of plants, but there was this big, huge, monster shootout to select the best of the processes that people could pilot for production scale-out of the types of rubber that were needed that could be made from oil. And so he was involved in that. We went into Bethesda, Maryland. And so there's a lot of stories I could-- I actually recall a number of incidents and fragments from the war, and things that happened around that, including him coming home all hyper and excited, bringing these smelly blocks of different kinds of rubber that had just come off of some facility somewhere that were particularly interesting to him, and I don't know why they were, except they each smelled different. <laughs> And I got to see-- later in the war, I got to see some of those same things when he took us to a flight line where B-17s were heading off to the UK. I didn't know where they were going at the time, but I think the whole idea was they were going to go bomb Germany, and-- but taking the tour and seeing all the different kind of rubber that was in the airplane. The airplane wouldn't go without this rubber that was in it. So, you see, there's an classroom. And so her classrooms were a never-ending saga of giant adventures going on-- of kids building things with blocks, and playing music and dancing, and doing art, and all that. So, somehow, out of all of that, I got infected with all sorts of strange memes, you see, just because there's this stuff going on. And so my father got me and my brother a really giant chemistry set when we were fairly young, and that led later to all kinds of adventures, doing all-- making all sorts of things that you probably weren't supposed to make, <laughs> and just exploring. So there were my parents and a lot of other people. I-- clearly, I was meant to be an engineer, be a maker, builder, but I got really infatuated with physics because of how physics helped cohere everything, and helped cohere making. And so, actually, when I went to MIT-- I was 17 when I went to MIT-- I really didn't know what the heck was going on, so I decided I'm going to be a physicist, because at the time this was the coolest thing to be. And I think a lot of other people have followed that path because of the war. The physicists 'had saved the universe and made bombs that blew everything up', and 'they were the ones that knew it all', right? And, of course, it wasn't till I was a bit into my studies at MIT that I realized that I'd actually missed my calling there, because I really ended up there getting infected with the emerging surge of paradigm-shifting knowledge that had come out of the Rad Lab at MIT, and it was being injected in the electrical engineering courses there, to where you didn't just learn traditional circuit theory, but you also got infected with the basics of pulse and digital circuitry right as it was sort of being rushed out of the lab and being codified in engineering courses. And that was a profound experience for me because you could look back and you could see, okay, Steinmetz, and then Armstrong, and then now this stuff! It was happening again! So it's sort of like... I've always been interested in these sort of shifts, and it even goes back into astronomy, because when I was little I got very, very excited about astronomy. We went to the Museum of Natural History in New York City, went to the planetarium, and actually saw a little telescope that you could actually we couldn't afford tit, but some could buy it. You could-- if you had this thing, you could actually see craters on the moon, and all this sort of thing. And I got really interested in astronomy at a pretty early age, and began reading stuff to the extent I could understand it, and looking and trying to understand how planets and things moved, and how to visualize all that. But what was interesting is I had this book-- I think it was called *Men, Mirror, and Stars*, and I think I must've been about... I don't know... nine or something. But what it was is it talked about telescopes, and it went through the history of telescope technology. And there, again-- there, that was maybe the first time I actually fully-grasped this idea of these revolutions that were occurred at points where you went from, for example, the long, small-lens, compound telescope of the very early days of optical telescopes, to circumventing chromatic aberration that way and its limitations, to how you could scale that by making speculum mirrors, and then silvered mirrors, and then the innovation of the achromatic objective, and suddenly you have a burst of movement and pushing of an envelope in refractor technology. And then the big mirrors and the big silvered mirrors came, and then, of course, later, photographic technology. But that book showed the dramatic shifts in technology. That y. We e(ogy. e)5 there may be role models back then that did something that actually has a parallel, you see? So it’s really interesting. I kind of feel like a lot of what I’ve done is just playful adventuring, but having been stimulated with sort of an unusual collection of sort of basis points-- of points of view about what people can do, and so forth. And, in a way, it’s never about the things; it’s about the ideas that get in motion in groups of people-- ideas on how to make things and how to compose things, whether that be music or silicon chips or radios or just simply electrical technology. A lot of the same-- a lot of the-- and so here we are now, and it’s like we’re almost back in 1975 again, or ’76, like when I first jumped in on this.

sense a way of breaking out of the current box we're in with commodity OEM things. Instead of just having a few automobile manufacturers, and they all make automobiles that look almost the same, and you have your cell phone, and you go to your office and you live in your house, and they all look the same and they're getting more same everywhere. Why isn't there more wildness? Why isn't there more diversity? Why do we always stamp out wildness? I mean, I think... I sort of feel like I was always like a weed growing in a very, very tailored garden, and people would come and get rid of that because that doesn't look right; this doesn't belong here. And so why don't we accommodate wildness, and why don't we even have an area of the garden where you just let it go wild and see what happens? Not going to hurt anything.

Spicer: Well, English gardens are like that, I think.

Conway: Yeah, to some extent.

Spicer: <laughs>

Conway: Yeah, to some extent. And, in fact, there's a whole story there. My webpage links to that. There's a really incredible video about *What is Wild* that talks about English gardens and the alternatives, and I think there are many lessons in that about culture and about conforming things to a rigid pattern versus allowing some wildness and diversity, because in the end, more people, I think, would rather be in control of designing their own lives in a variety of ways and creating their own habitats in a variety of ways. But if everybody's going to make and create and design, then we need to provide means for doing it sustainably, and I think this whole microworld is a way of exploring that, that actually we'll shed many of these big, massive constructs, because it'll be possible to build structures, lives, mobility methods, and so forth, out of less and less material, and yet have it all be dramatically more adventurous and interesting and exgro,ts all this to discover. It's ju-- so, in a sense, it's all just starting. It's all just starting. The printing of matching that is now going to just really run wild. But it

ll being run by just a few manufacturers. It will all w

more and more participants. And--

an in that sense?

a big impact.

interesting to make, and getting pennies in their social account, based on whoever might adopt or propagate that, there's some different way of that all running-- so that people collectively and individually can better notice an exciting innovation that's been made way around the world somewhere—an innovation they might be able to use that's kind of really cool for what they're just trying to do. So that is-- so a lot of this has to do with how do we even know what's going on, how do we notice, how do we share? So viewing the world as this giant bee colony where people have just been soldiering along and going out and doing things, coming back, doing the waggle-dance and all that, this whole colony is somehow now being connected in a way that we 'are coming alive' in a new 'group conscious' way, sharing and seeing and noticing and adventuring, so that we don't just end up being soldiers here and this there and that there, but a whole new set of possibilities emerges, even though we're still in this same sphere. So...

Spicer: Very good. Shall we take a break?

Conway: Yeah, let's take a break. <laughs> Yeah.

<crew talk>

Spicer: Can you tell us a bit about your childhood and your parents growing up, and early influences? Did you like school, for example? Those kind of things.

Conway: Yeah. I... I-- as I'd mentioned, I grew up in Westchester County, living in Hartsdale, and then Scarsdale before the war, and when we moved to-- let's see. I was probably just entering school when we moved down to Bethesda, Maryland. I really started school there. And it was during the war years, and so that that's a backdrop for a lot of experiences, and framed a lot of experiences that I had. But just within school, which is the main preoccupation there-- and I remember a lot about the school-- had a kind of uneventful but really exciting period in kindergarten, and then went into first grade, and actually did very well in school, and as a part of that, ended up skipping

anthropology she's studying, and she brings the books home, of course, and so I was reading these ways for more people to share in such adventures, and especially in the adventures of making things as an engineer. I mean, I think just the making of things-- the fun of designing, combining, making, where you have a need and you just figure out how to fill it, the process of innovating— even where you may be re-innovating something that's been innovated before, but if you innovate it and you didn't know anything about it, then you innovated it! And that process is accessible to everybody, rather than this myth that, "Well, we all know that almost everything has been done so far, and we're operating now only at a frontier people don't really have a clue, really, who I am or what I'm doing, or if they know who I am, it's, "Oh, okay, we have this computer scientist or this professor here," but you're there because you've insinuated yourself into a situation where you don't want people to know what you're doing because, if they do, you can't ask them just random questions and figure out what's going on. So it's kind of like I think of myself like I'm a detective trying to decode things so I can figure out their parts that I might be able to put together and do in a different way, and it's all just play. <laughs>

Spicer: That's great.

Conway: Does that make any sense?

Spicer: Yeah. Perfectly.

Conway: <laughs> Yeah, okay.

Spicer: Thank you.

