"Covering":

How We Missed the Inside-Story of the VLSI Revolution*

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I'm delighted to comment on Lynn Conway's outstanding piece "Reminiscences of the VLSI Revolution: How a series of failures triggered a paradigm shift in digital design." What we often forget in engineering and science is that innovation and technological progress happen because of actions of *people*, people who have personalities, lives, and life stories that influence them and are influenced by those around them. Lynn's story provides a case in point.

I'm writing this from a "younger" perspective having known Lynn personally for only about five years (but having been influenced by her work for more than 25 years). Lynn's story and work have touched me personally on many levels, as a student, as a Columbia faculty member, as a VLSI educator, as a former IBM employee (I worked for five years at IBM Research after completing my Ph. D., many years after Lynn left), and as a gay man. I'd like to provide commentary from each of these perspectives.

As an electrical engineering student at Princeton from 1984-1987, I was first influenced by Lynn through the famous Mead and Conway text book. I graduated from Princeton in three years (a deal with my parents – they would pay for me to go to Princeton if I worked hard and completely my degree in three years – a good deal, indeed) but this left me "skipping" a lot of courses that I knew I could teach myself and signing up for the more advanced courses.

This trick worked well for me except when I wanted to sign up for EECS 420 (VLSI Systems) in my senior year, a new course based on the new Mead and Conway textbook. I had skipped the required course in digital logic because I knew that I could just teach myself the material over the summer, and the professor who taught the course at the time would not let me in because I did not have the prerequisite. I was determined to learn the material myself, which I did by reading the Mead and Conway text cover-to-cover. I feel a certain vindication since I now teach VLSI Circuits at Columbia to over 45 students every fall. Wow, that was a good book.

As a Columbia faculty member, I am very proud to count Lynn among our great alumnae. Columbia's engineering school and electrical engineering program have a very influential history and Columbia's faculty continue to innovate and train outstanding students. The size of our program is small and I often feel that we are really under-appreciated when compared with larger schools such as MIT, Stanford, or Cornell. Columbia's engineering program also leverages the incredible strengths of the larger university with strong science departments and a culture of out-of-the-box thinking. Columbia provides an intellectual culture to prepare students to do great things. There is no greater testament to that than the life and career of Lynn Conway.

As a VLSI educator, I sense that few students today recognize the impact of the Mead-Conway text and how it led to the "VLSI revolution." In my own classes, I always make sure to mention the impact Mead and Conway had on creating the "culture of circuit design" now embodied in our electrical engineering program, including a emphasis on hands-on design projects. Lynn's contribution to making this happen, it seems, has not been fully appreciated. From that first course in the fall of 1978 that Lynn taught at MIT, things had already exploded to 113 universities worldwide by 1982 (just four short years!). Today, virtually every electrical program in the world has a course in modern VLSI design.

As a former IBM employee, Lynn's story touches me in two important ways. First, IBM Research was and still is (despite the many changes at IBM and the industry these last 15 years) an amazing place with many amazing people, my husband among them. The time I spent there was very influential on my future career and I still have many productive interactions with IBM – it's a great place and a great company and I think Lynn would agree.

That being said, the history of what IBM did to Lynn in the 1960s surrounding her gender transition is unconscionable. Fortunately, this is a different time now and IBM has done a 180-degree turn in recognizing and valuing LGBT persons. For those who aren't in the know, this stands for "lesbian, gay, bisexual, and transgender" and refers to people whose diversity is manifest through sexual orientation or gender identity.

IBM adopted a policy of nondiscrimination on the basis of sexual orientation in 1984 and added "gender identity and expression" in 2002. After 40 years, it is finally recognized that companies cannot afford to do without some of their best talent in the interests of archaic prejudices. Over 50 major companies now have policies of nondiscrimination on gender identity and expression, including tech giants like Apple, Hewlett-Packard, Cisco, Intel, and Oracle.

Last but certainly not least, from my perspective as a gay man, Lynn's story demonstrates the discrimination that LGBT people have faced (and continue to face) in this society and the negatives this brings. We know about the influence of the "Mead-Conway" book, but no one seemed able to explain what had actually happened. Untold went Lynn's story as the hidden hand that innovated, shaped and guided the VLSI paradigm-shift through the book, the courses and the MPC79/MOSIS-infrastructure.

It is now becoming clearer why this story was missed. Lynn's accomplishments as an engineer are remarkable, but when placed in the context of the discrimination and personal struggle she faced as a transgender woman, they are epic and inspirational.

In a time when gender transitioners were pathologized, stigmatized, socially ostracized and virtually unemployable, Lynn found herself the innovator at the center of the VLSI revolution. Constantly fearing an "outing", she worked passionately inside the laboratories of Xerox PARC to orchestrate events while minimizing external exposures – thereby remaining a mystery-person to those outside.

Kenji Yoshino, noted law professor at NYU, in his book *Covering: The Hidden Assault on our Civil Rights* talks about the hidden cost of hiding one's identity, or "covering," for LGBT persons. As we see from Lynn's story, this "covering" not only consumes tremendous time and energy, but the actual contributions of such persons can also go unrecognized, hidden away in the background.

This year would have been the 100th birthday of another computer science pioneer, Alan Turing, who committed suicide at age 41 after been persecuted for his homosexuality. Imagine how many more contributions he would have made to our field had he lived longer. While Corporate America and most universities have come a long way in recognizing the important role that LGBT people play in the diversity discussion, there is still a long way to go; meanwhile many continue to remain in the closet out of intense fear.

Lynn's amazing story of accomplishment and personal triumph in the face of personal adversity and overt discrimination should serve as an inspiration to all young engineers. We are thankful that she has shared these memorable reminiscences with us.

Columbia's new Northwest Corner Building,
location of Prof. Shepard's research laboratory.

About the Author

Kenneth L. Shepard received the B.S.E. degree from Princeton University, New Jersey, in 1987 and the M.S. and Ph.D. degrees in electrical engineering from Stanford University, California, in 1988 and 1992, respectively. From 1992 to 1997, he was a research staff member and manager with the VLSI Design Department, IBM T.J. Watson Research Center, Yorktown Heights, New York, where he was responsible for the design methodology for IBM's G4 S/390 microprocessors. Since 1997, he has been with Columbia University, New York, where he is a professor of electrical engineering and biomedical engineering. He also was chief technology officer of CadMOS Design Technology, San Jose, California, until its acquisition by Cadence Design Systems in 2001. His current research interests include carbon electronics, power electronics, and CMOS mixed-signal design for biological applications.He was technical program chair and general chair for the 2002 and 2003 International Conference on Computer Design, respectively. He has served on the Program Committees for ISSCC, VLSI Symposium, ICCAD, DAC, ISCAS, ISQED, GLS-VLSI, TAU,and ICCD. He received the Fannie and John Hertz Foundation Doctoral Thesis Prize in 1992, a National Science Foundation CAREER Award in 1998, and the 1999 Distinguished Faculty Teaching Award from Columbia. He has been an associate editor of *IEEE Transactions on Very Large-Scale Integration (VLSI) Systems* and is currently an associate editor for *IEEE Journal of Solid-State Circuits* and *IEEE Transactions on Biomedical Circuits and Systems*. He is a Fellow of the IEEE.