**Answers to Sarah’s Questions**

Lynn Conway v 2-22-18

**1. Tell us a little more about your background and how you got to where you are today.**

As a child during WWII and now 80 years old, I’ve traversed a period of tumultuous technological and social change. My father was a chemical engineer, my mother a kindergarten teacher. Our basement bin was filled with scrap lumber, fabrics and craft materials on the way to kindergartners for creative play. Pulling odd stuff together to make weird constructs, then using them to stage creative-happenings, was a major theme during my childhood. Seems I never really ‘finished’ kindergarten, for I’m still drawn into such adventures.

Listening to the BBC during the war, I was amazed how the glowing, smelly electrical things inside our [big radio](http://ai.eecs.umich.edu/people/conway/Radio/Radio.html) helped people ‘talk to us’ across the ocean. I also thrilled to railroads, big bridges, tunnels and skyscrapers, and especially airplanes, running outside to watch if one flew low overhead. At age 5, I got my first big book, [*The Wonder Book of Knowledge*](http://www.gutenberg.org/files/41111/41111-h/41111-h.htm). Learning to read while prowling its pictures and text, I became fascinated by the stories behind wondrous ‘modern’ technology.

I gradually became aware that it was engineers, like my father, who created such things. By my early teens, I’d developed a quiet but burning passion for math, science, amateur astronomy and telescope making. I studied hard at school and haunted the White Plains, N.Y., public library to learn everything I could about all that. It’s no surprise that I went on to study physics at MIT and then electrical engineering at Columbia University.

**2. What has been the most transformative technology you’ve been involved with over the course of your career? What technology do you anticipate will be game-changing that’s still coming down the pipeline?**

In the early 60’s, Columbia’s EE Department tightly coordinated with IBM on the development of empowering early knowledge in digital computing. As a grad student I took every course I could in the emerging field. One of my professors, Herb Schorr, suggested an independent study of M. V. Wilkes’ recent work at Cambridge on ‘self-compiling compilers’. I delved into [Wilkes’ papers](http://ai.eecs.umich.edu/people/conway/CSE/M.V.Wilkes/M.V.Wilkes-Tech.Memo.63.1.pdf), implemented his WISP symbolic list-processing language on Columbia’s [IBM 1620 computer](https://en.wikipedia.org/wiki/IBM_1620) (using knowledge of its hardware details and machine code), and began toying with sequential self-compilations of enhanced versions.

Reflecting on my WISP experience while studying Everett Rogers’ [*Diffusion of Innovations*](https://en.wikipedia.org/wiki/Diffusion_of_innovations), I became aware of an electrifying possibility. Once such a digitally encoded bootstrap was built, that ‘thing’ could quickly evolve under the pressure of competitive/collaborative efforts by others to improve its functionality. Such encoded bootstraps had the potential for self-exponentiation in both technological power and usage prevalence, as a function of the technological and social environments into which they were ‘launched.’ Digital technology thus had the potential of triggering cyclically-expanding ‘chain reaction’ diffusions of both itself and its human usage. This was it. I was hooked! The exciting work also led to a job, [working for Herb at IBM Research](http://ai.eecs.umich.edu/people/conway/Memoirs/ACS/Lynn_Conway_ACS_Reminiscences.pdf).

Jumping ahead to today, we observe computational thinking spreading rapidly through and empowering many disciplines, not just within STEM but also across the social sciences, humanities, arts and design. Digitally encoded ‘bootstraps’ for innovative new infrastructural functionalities are also being created, entangling with, and amplifying the effects of each other. The [RepRap Project](https://en.wikipedia.org/wiki/RepRap_project), begun by [Adrian Bowyer](https://en.wikipedia.org/wiki/Adrian_Bowyer) in 2005, is a classic example. By evolving a 3-D printer that can [‘print copies of itself](https://www.youtube.com/watch?v=v4ovZ7dQFd4)’, the project launched a ‘material bootstrap’ analogous to self-compiling software compilers of years ago, enabling countless engineering, architectural and artistic explorations of its potentialities. Just as those who created the printing press opened a new world, a world in which others created novels.

Looking ahead to the future, we see ever expanding [entanglements](https://ia800408.us.archive.org/26/items/EntangledAnArchaeologyOfTheRelationshipsBetweenHumansAndThing/entangled_an_archaeology_of_the_relationships_between_humans_and_thing.EBOOKOID.pdf) of such evolving systems inside the global ‘technological + social ecosystem’ that mutually supports and is supported by us as we go along. Rather than trying to pick ‘one thing’ to build a career on, expect many opportunities to engage and impact that evolving world.

**3. What is your take on Silicon Valley’s “Brotopia” image, and what needs to be done to make it a more welcoming place for women and minorities?**

Down through the ages, women and men have been so socially-bifurcated that most identify as if they were members of different ‘tribes’ or even different ‘species.’ Sustainable social communities result only when these co-dependent tribes manage to stably cross-colonialize each other. Resulting patterns of ‘inter-tribal’ behavior shift over time as each tribe jostles for relative advantage, just as in the co-dependent cross-colonizations seen in class, caste, slavery, feudal and imperial systems.

As internal tribal boundaries drift, such societies may feel like they’re ‘improving.’ However, so long as the underlying bifurcation remains intact, gendered life-experiences remain ‘the same’. For example, during my lifetime I’ve often witnessed what seemed, at the time, to be enormous changes in the behavior patterns between men and women. Yet those ‘tribes’ ongoing bewilderment by each other feels just as profound today as when I was young. *Brotopia* comes as no surprise. It’s a modern social swirl entangled inside an age-old tribal whirlpool.

However, major techno-social change now occurs within a generation, instead of being spread across many. Rates of change have passed a tipping point, and an awesome reality is emerging: *As the rate of techno-social change increases, we’ll all live far further into the unfolding social future than we ever dared dream*.

An important side-effect of the rapid intragenerational change is that older people often find themselves stuck in the past, and thus violating new codes of behavior. Happenings and artistry such as [#MeToo](http://time.com/time-person-of-the-year-2017-silence-breakers/), [*Brotopia*](https://www.amazon.com/Brotopia-Breaking-Boys-Silicon-Valley-ebook/dp/B074LQKJJC/), [*Black Panther*](https://www.rollingstone.com/movies/news/black-superheroes-matter-why-black-panther-is-revolutionary-w509105) and [*A Fantastic Woman*](https://www.theguardian.com/film/2018/feb/18/daniela-vega-transgender-star-film-industry-a-fantastic-woman-interview) hint at creative methods for enabling social communities to more rapidly visualize and traverse such paradigm shifts.

**4. How do you envision the 'techno-social systems’ emerging in our industry from anthropological and sociological points of view?**

First some words of caution. Avoid distraction by momentarily flashy emergent technology and marketing hype. Reflect on the greed, controlling nature, siloed culture and social immaturity of the current tech industry, as witnessed in the [Facebook debacle](https://www.wired.com/story/inside-facebook-mark-zuckerberg-2-years-of-hell/). Try to understand the panicky feelings triggered by books like [*How to Fix the Future*](http://fortune.com/2018/02/06/how-to-fix-the-future/) and the [apocalyptic AI warnings](https://www.cnbc.com/2017/08/11/elon-musk-issues-a-stark-warning-about-a-i-calls-it-a-bigger-threat-than-north-korea.html) of Elon Musk. Read the insightful essay “[Forget Killer Robots—Bias Is the Real AI Danger](https://www.technologyreview.com/s/608986/forget-killer-robotsbias-is-the-real-ai-danger/)” by John Giannandrea.

You’ll then understand why KentaroToyama says in *Geek Heresy* that“technology alone won’t change the world” and that we must instead “[Rescue Social Change from the Cult of Technology](https://geekheresy.org/).”

How will this happen? First, thinkers in fields outside tech will increasingly and computationally embed, commingle and evolve their fields’ knowledge systems and impact. These social and humanistic forces will cross-colonize the underlying technologies in countless now unanticipated ways. As these vaster forces come into play, the tech industry will decreasingly ‘naively control’ the unfolding of social futures.

As fields such as anthropology and sociology, ecology and economics, history and philosophy, design and the arts reframe themselves atop coevolving underlying technologies, they’ll also help raise collective consciousness of the entangled nature of the resulting ‘techno-social systems’.

Ecological and [epidemic Processes](https://en.wikipedia.org/wiki/Epidemic_model) are providing mathematical frameworks for partly-modeling such techno-social dynamical-systems. As collective consciousnesses of our embeddings within such systems arise, a more widely-disciplined data-driven science will help us model and increasingly predict these systems behavior, much as we now model and predict the weather.

**5. How can we make these systems ethical, diverse, adaptable and sustainable for the ~~industry~~ world as a whole?**

We must [create much wider awareness of the entangled techno-social nature of ‘things’](https://ia800408.us.archive.org/26/items/EntangledAnArchaeologyOfTheRelationshipsBetweenHumansAndThing/entangled_an_archaeology_of_the_relationships_between_humans_and_thing.EBOOKOID.pdf). Instead of just engineering ‘things’, we must consciously prototype and engineer measurably diverse, adaptable, ethical and sustainable patterns for ‘using those things’. Think of it as extending local ‘building-codes’ to evolving regional ‘techno-social-system usage-codes’.

The coming wave of change will rapidly spread new forms of [cooperative capitalism](http://www.peersincorporated.com/), trigger major re-alignments in [political economy](https://en.wikipedia.org/wiki/Political_economy) and transmute the role of the [city in history](https://www.amazon.com/City-History-Origins-Transformations-Prospects/dp/0156180359). This global process will be analogous to that described by Eugen Weber in [*Peasants into Frenchmen: The Modernization of Rural France, 1870-1914*](https://www.amazon.com/Peasants-into-Frenchmen-Modernization-1870-1914/dp/0804710139/ref%3Dsr_1_1)*,* only running faster and on a vaster scale.

The earlier social maturation of today’s young people will sensitive them to these emergent techno-social dimensionalities, and position many for leadership in the emerging Techno-Social Age. They can further enhance their future opportunities by following foundational work in fields like anthropology, sociology, ecology, economics, complex systems, and history. As Winston Churchill says, “[The farther backward you can look, the farther forward you can see](https://www.brainyquote.com/quotes/winston_churchill_136790).”

[The incoming wave of techno-social innovation](http://ai.eecs.umich.edu/people/conway/Memoirs/Talks/Columbia/2016_Magill_Lecture.pptx) has the [stunning potential](http://engineering.columbia.edu/visionary-engineer-lynn-conway-bs%E2%80%9962-ms%E2%80%9963-heralds-dawn-techno-social-age) of reigning-in our unsustainable over-use of planet earth, sustainably providing *ever-increasing* infrastructural functionality and life experiential-amplification per person, while consuming *ever-decreasing* energy and material resources per person. In parallel it will open-up unprecedented explorations of ‘*what it’s possible* *to create and experience*.’ For this to sustainably unfold, we must motivate widespread cooperative generation, bootstrapping and sharing of encoded techno-social procedures for measurably doing *ever-more* with *ever-less* in diverse environments all around the world.

**6. What would you say is the most important professional lesson you’ve learned over the course of your career?**

Over the years, a cluster of recurring ideas have helped me live an adventurous, creative life. Think of them as ‘commands to myself’ that pop into mind when triggered by unfolding events. I encourage you to evolve your own set as you go along, to keep you on track while exploring your unfolding life.

Here are mine: Follow your curiosity. Don’t be afraid to be a beginner at new things. Be agile. Be bold. Step outside your comfort zone. Grow fast by learning from lots of mistakes. Never let expertise within some silo entrap you there. Never stop learning. As Eric Hoffer says, "[In a world of change, the learners shall inherit the earth, while the learned shall find themselves perfectly suited for a world that no longer exists](https://en.wikiquote.org/wiki/Eric_Hoffer)."

When you’re a beginner on a team, earn your keep by eagerly ‘gathering firewood’. When apprenticing, seek out and learn from the very best, from those who really know the moves. When moving up, be kind and encouraging to others. Spread some excitement and fun. Avoid arrogance and elitism. Share all growing knowledge of the moves, especially with newbies.

Be a patient and vigilant observer. Be open to spotting anything ‘unusual’, big or small, wonderful or awful, cool or weird. Go-meta to envision hinted-at wider contexts, asking yourself “What’s this weirdness an instance of?” The biggest opportunities appear out-of-the-blue. You’ll miss them unless you ‘expect the unexpected’. When its game on and you’re on a mission, pull out the stops, dig down deep and go for it. As Bob Noyce says, “[Go off and do something wonderful!](https://leslieberlinauthor.com/wp-content/uploads/2011/05/Core_2007.pdf)”

Envision your career ahead as a series of adventurous missions, interspersed with periods of R&R, networking, team-joining, apprenticing and training. In the end, [your memories of those missions](http://ai.eecs.umich.edu/people/conway/VLSI/MPCAdv/MPCAdv.pdf) and all the cool people you adventured with [will mean everything](https://press.princeton.edu/titles/10676.html), far more than any transient fame or fortune found along the way.