An Unexpected Woman:
The Inside Story Behind the VLSI Revolution*

Lynn Conway, Professor of EECS, Emerita
University of Michigan, Ann Arbor

In 2015, US CTO Megan Smith raised profound questions about women's contributions in science, engineering and math being erased from history. In this talk we explore a case study of such erasure, and surface a counter-intuitive conjecture about the underlying causes and effects.

*Keynote Lecture, LGBT Pride Month, Rackspace Inc., Windcrest, TX, June 28, 2016;
Based on a Lecture at the National Science Foundation, Arlington, VA, June 10, 2015.
http://ai.eecs.umich.edu/people/conway/Memoirs/Talks/Rackspace/2016_Rackspace_Pride_Talk.pdf
http://www.slideshare.net/LynnConway1/an-unexpected-woman-the-inside-story-behind-the-vlsi-revolution
www.lynnconway.com; conway@umich.edu

Setting the Stage:
Reflections on LGBT Pride Month and Human Life Trajectories

Historical Erasure of Women's Contributions in STEM

A Case Study: The Inside Story Behind the VLSI Revolution

A Counter-Intuitive Explanatory Conjecture: The *Conway Effect*

Thought-Experiments to Ponder:
Insights into Evolution of Culture in Animals
Glimpses into the Emerging Techno-Social Age

Lynn Conway Become a fan
Professor of Electrical Engineering and Computer Science,
Emerita, University of Michigan

The Many Shades of 'Out'

Posted: 07/14/2013 7:48 pm EDT | Updated: 09/13/2013 5:12 am EDT

Reflections on LGBT Pride Month and Human Life Trajectories

Readings from an essay on the White House Reception to celebrate LGBT Pride Month June 13, 2013

For full text, see:
http://www.huffingtonpost.com/lynn-conway/the-many-shades-of-out_b_3591764.html

The Many Shades of ‘Out’, by Lynn Conway

On a sultry June afternoon, as my husband and I strolled towards the White House East Entrance, I reflected back to the time of my gender transition, in 1968.

Shamed as a social outcast, I'd lost my family, my friends and all social support. I'd been fired by IBM, and lost a promising research career. In many jurisdictions, I could have been arrested and charged as a sex offender -- or, worse yet, institutionalized in a mental hospital.

Evading those fates, I completed my transition and began building a career in a secret new identity, starting at the bottom of the ladder as a contract programmer. Any 'outing' and I'd have become unemployable, out on the streets for good. Fear channeled me into 'stealth-mode', and for over 30 years I covered my past, always looking over my shoulder as if a foreign spy in my own country.

But this was June 13, 2013. What a contrast. My husband Charlie and I, along with many other activists, advocates and allies, were joining the President's White House Reception for LGBT Pride Month. The atmosphere was joyful and as we awaited the President, I reflected further.

I had been 'out' for 15 years now, or so I'd thought: out on the Internet to inform colleagues of my past, out as an advocate for transgender people, out as an activist against psychiatry’s pathologization of gender variance.

It was one thing to hide in the back-rooms of Xerox Palo Alto Research Center decades ago, launching innovations as the hidden-hand behind the VLSI microelectronics revolution in Silicon Valley. I didn't mind being invisible in my field back then, or that no one had a clue what I was really doing . . . much less who was doing it. I was thrilled to even have a job.

But 'out' has many shades of grey -- and even in recent years I kept on partly covering, shyly holding back, lingering in the darker shadows. Although times had changed, I'd clung to old habits.

Down through the decades no one could explain how the VLSI revolution actually happened. The results were simply taken for granted. Although I'd gained vital knowledge about generating such engineering paradigm shifts, I feared my personal history would loom large in folk's minds, and obscure attempts at explanation.

It wasn't till 2012 that I got up the nerve to publish a career memoir, and begin telling the story of how the VLSI revolution came about.

As the president entered the room, I glanced around and took in the joyful vibes. As he began to speak, I grasped the reality of how far we'd come. Times had more than changed: a fresh wind was sweeping through our society . . . especially amongst the younger generations.

Then I thought of the millions of other LGBT people out there. I tried to envision the enormity of lifelong struggles against stigmatization and ostracism, of losses of families and employment, of their oppression by having to 'cover', often not fully engaging life nor being known for who they were, what they'd done, who they loved or who loved them.

In a flash, I visualized the vastness of “The Many Shades of ‘Out’” down through time. And then it hit me: we've come so far, so fast, that ever so many others could begin shedding old habits too.

After all, freedom isn't just an external concept, framed by our laws. It's a gift of the spirit that we must give ourselves, in this case by going towards brighter shades of 'out'.

http://www.huffingtonpost.com/lynn-conway/the-many-shades-of-out_b_3591764.html

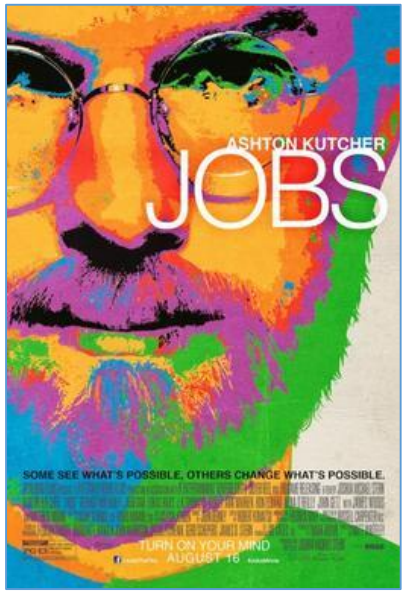
With that as a backdrop, let's now examine history's treatment of women's contributions in STEM

Link

First, listen as OSTP Chief Technology Officer Megan Smith reveals women in STEM being erased from history . . .

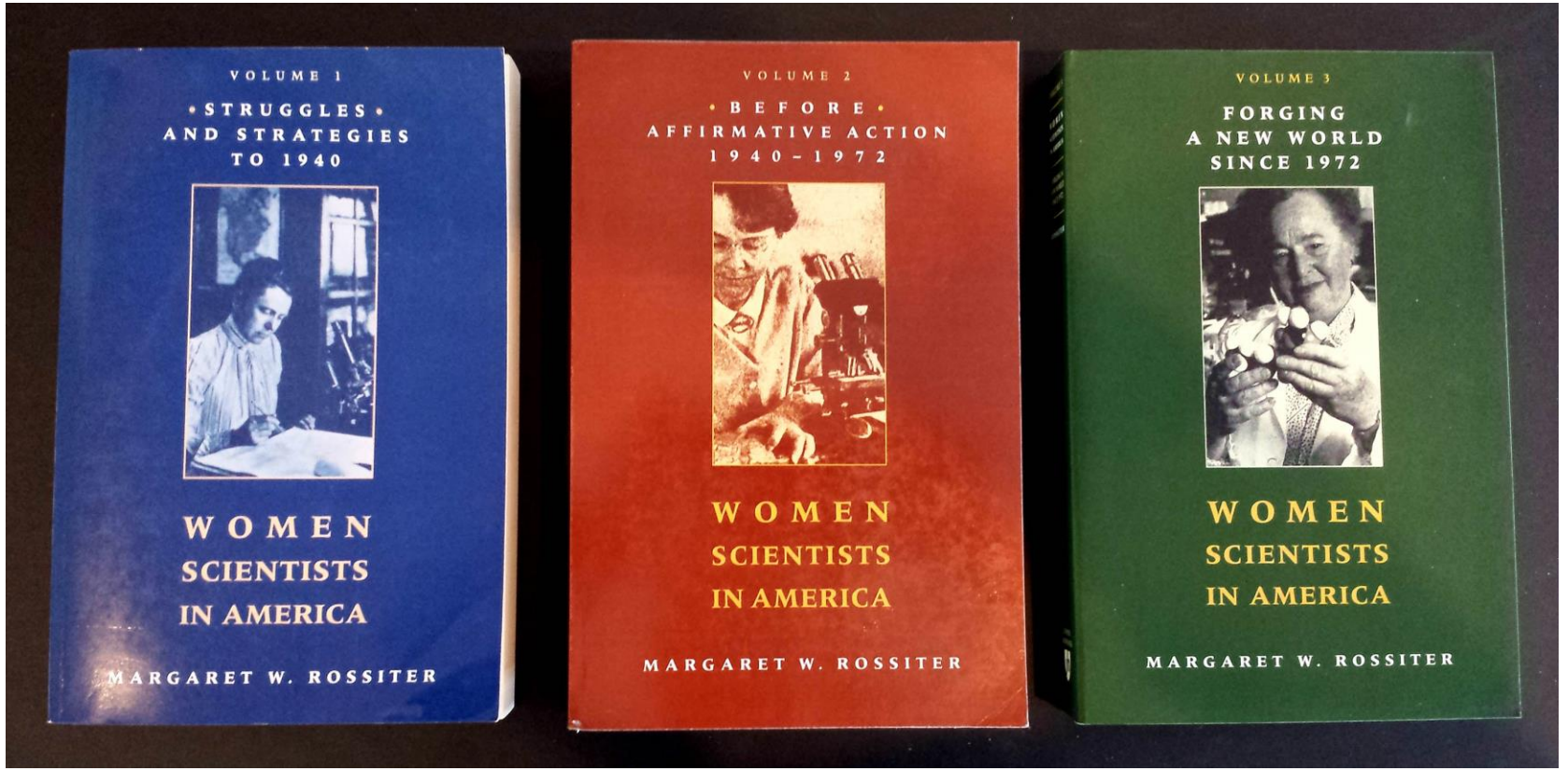
http://www.youtube.com/watch?v=fHyRdAyqV5c&t=0m1s
http://boingboing.net/2015/05/08/cto-megan-smith-explains-how-w.html
http://www.charlierose.com/watch/60554078 (4-28-15)

Although four women worked on the Macintosh team in the 1980s, not a single one was cast in the 2013 biopic *Jobs* with Ashton Kutcher. Even worse, all seven men who worked on the project had speaking roles in the film.



It’s not just that women have a harder time breaking into STEM fields, **it’s that the many contributions they *do* make aren’t celebrated.** “It's debilitating to our young women to have their history almost erased,” Smith explains.

This effect is seen throughout the history of women in science,
as reported by Margaret Rossiter in *Women Scientists in America*.



Her volumes document numerous detailed case-studies of such historical erasures.

In 1993 Rossiter coined the term “Matilda effect” for the systematic repression and denial of the contributions of women scientists, whose work is often attributed to their male colleagues.

This is analogous to the term "Matthew effect“, coined by Robert K. Merton in 1968, describing how eminent scientists often get more credit than a lesser-known researcher, even if their work is similar.

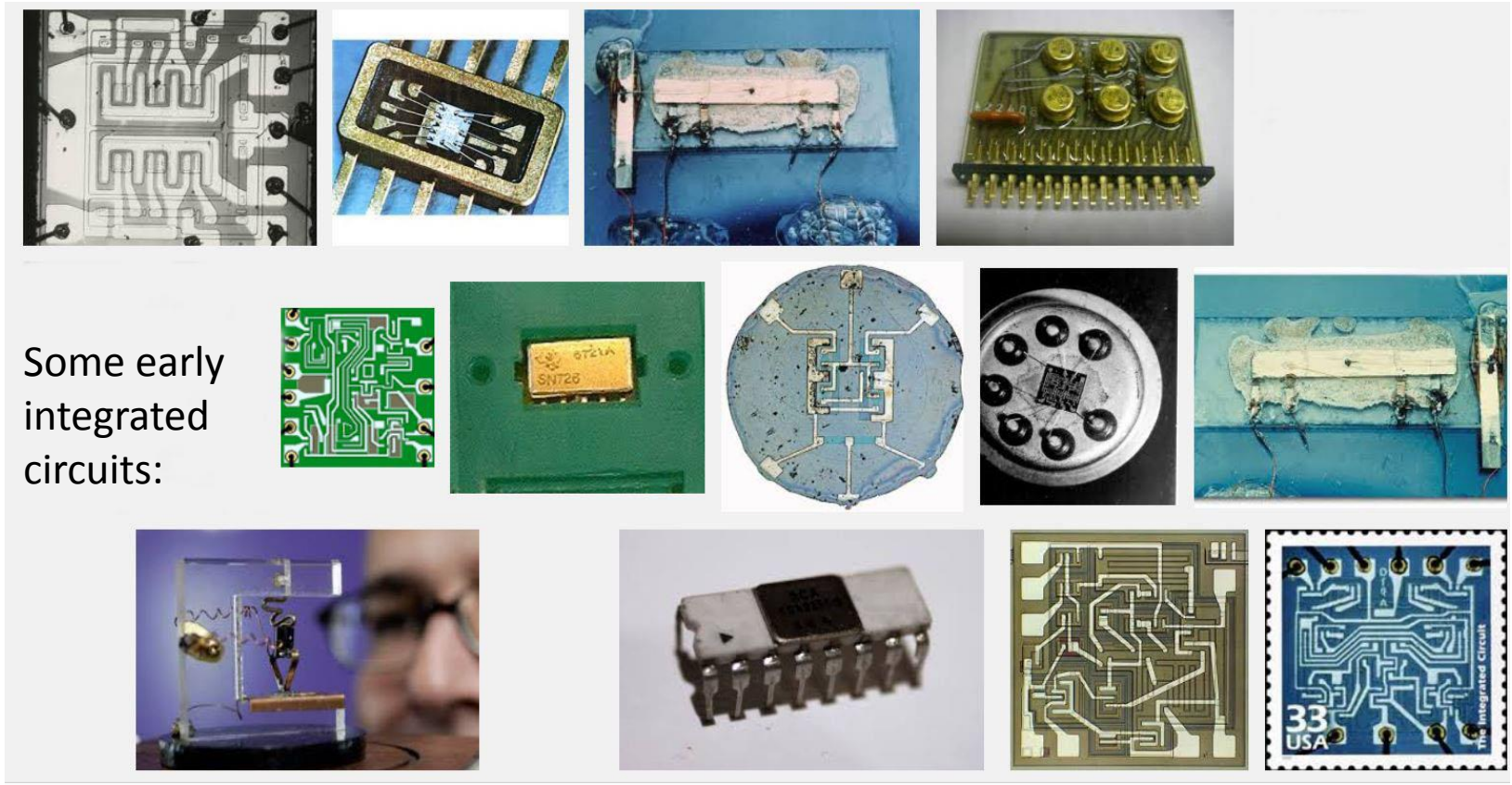
For example, a prize will almost always be awarded to the most senior researcher involved in a project, even if the work was all done by a grad student.

CASE STUDY: The revolution in Very Large Scale Integrated (VLSI) silicon microchip design and manufacturing, beginning in 1976.

Link

The stage was set by emergence of integrated circuit technology in the 1960's, enabling numbers of transistors and their wiring to be 'printed' onto chips of silicon . . .

Some early integrated circuits:



Snip from Goggle images

And 'potentiated' by the early 70s revolution in personal computing and networking:

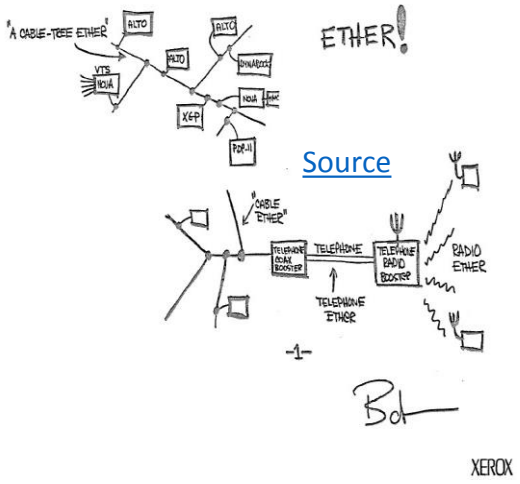
Innovation of the interactive-display, mouse-controlled "personal computer", the "Ethernet" local-area network, and the "laser printer" (at Xerox PARC) . . .

And the Dept. of Defense's "Arpanet" (the early internet, at DARPA) . . .

Xerox Alto, 1973

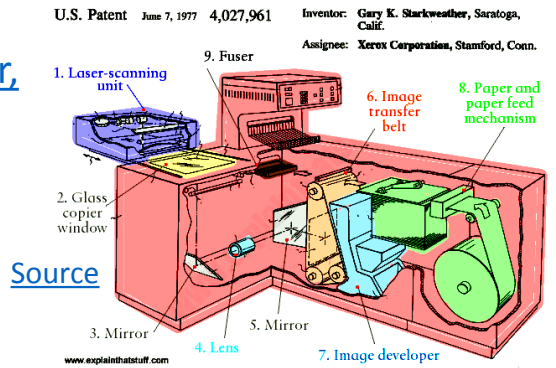
Wiki commons

Metcalfe's original Ethernet sketch, 1973



Source

Laser printer, 1971



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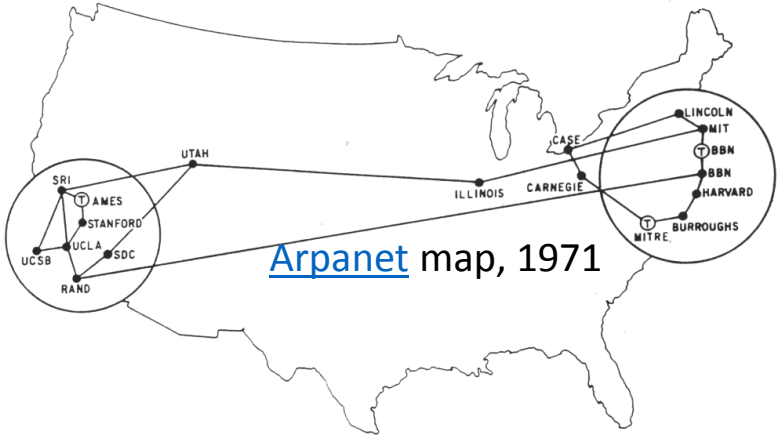
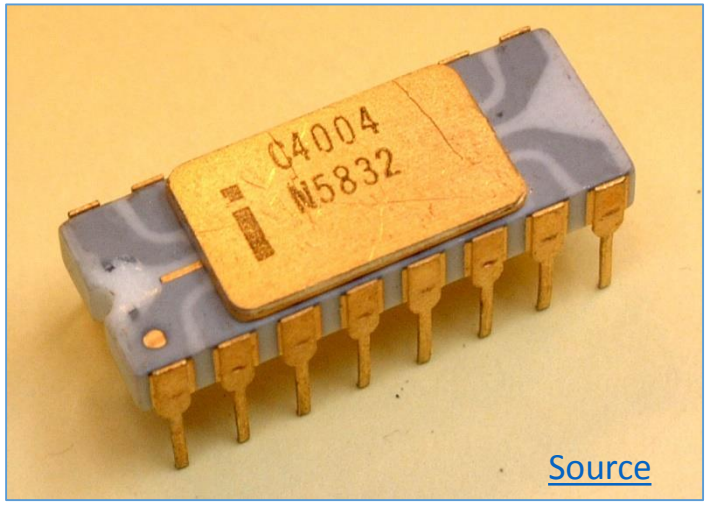


Arpanet map, 1971

Ongoing advances in lithography kept enabling ever-finer features to be printed, rapidly increasing the number of transistors printable on single chips.

And by 1971, a watershed was crossed with the introduction of the Intel 4004, the first single-chip "microprocessor": a "computer processor on a chip" . . .

It contained 2300 transistors . . .



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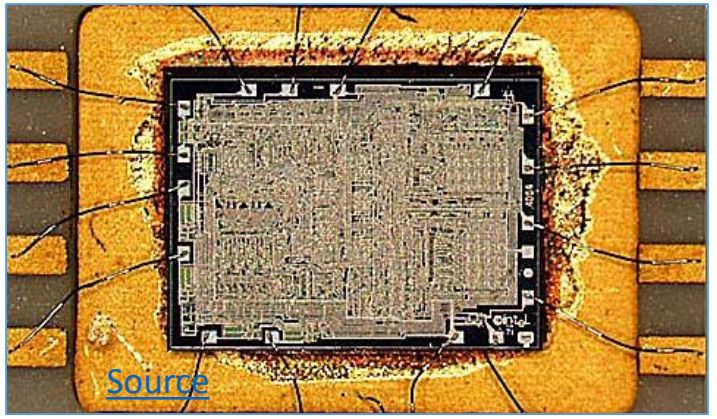
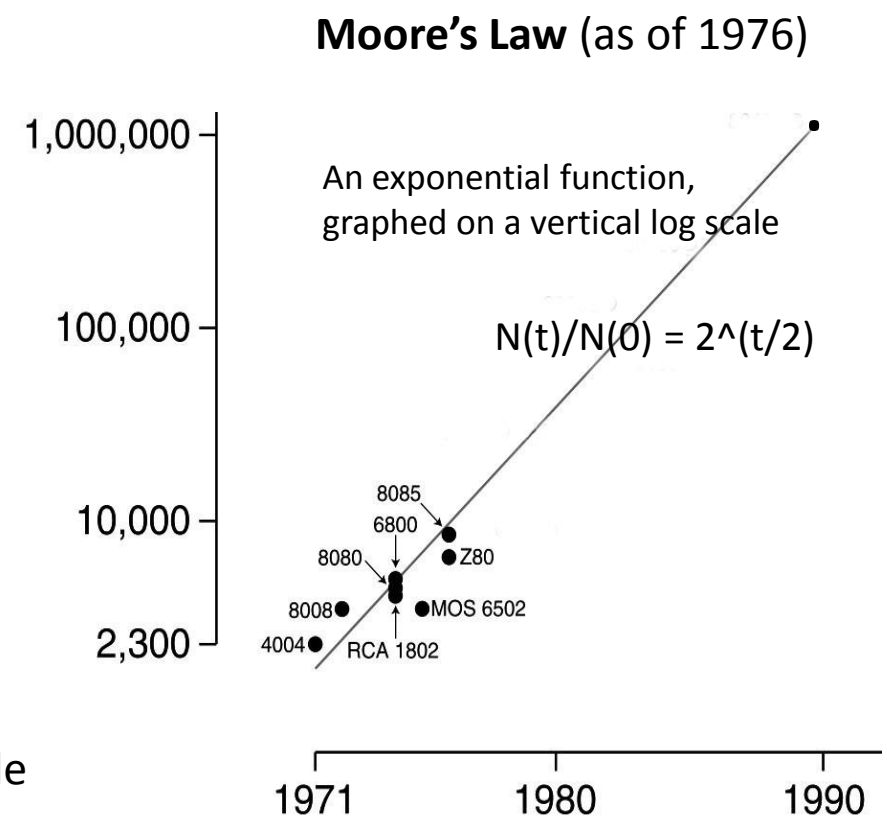

Source

Gordon Moore at Intel observed that the number of transistors reliably printable on commercial chips was roughly doubling every two years . . .

Carver Mead named this "Moore's Law" and predicted that there were no physical limits to increasing chip density up to at least 1 million transistors.

In 1976 this set-off a push at Xerox PARC and Caltech to figure out how to enable such complex chips to be designed.

After all, looking ahead it appeared conceivable by ~1990 an entire "supercomputer" could be printed on a single chip . . .



A sudden disruptive breakout was triggered by a cluster of abstract innovations, primarily at PARC . . .

Included was a set of scalable VLSI chip-layout digital design rules, as ratioed (dimensionless) inequality equations (Conway, Xerox PARC) . . .

These enabled abstract chip designs to be digitally shrunk down (and reused) as Moore's law rapidly advanced . . .

They also enabled accruing chip subsystem designs to be widely shared . . .

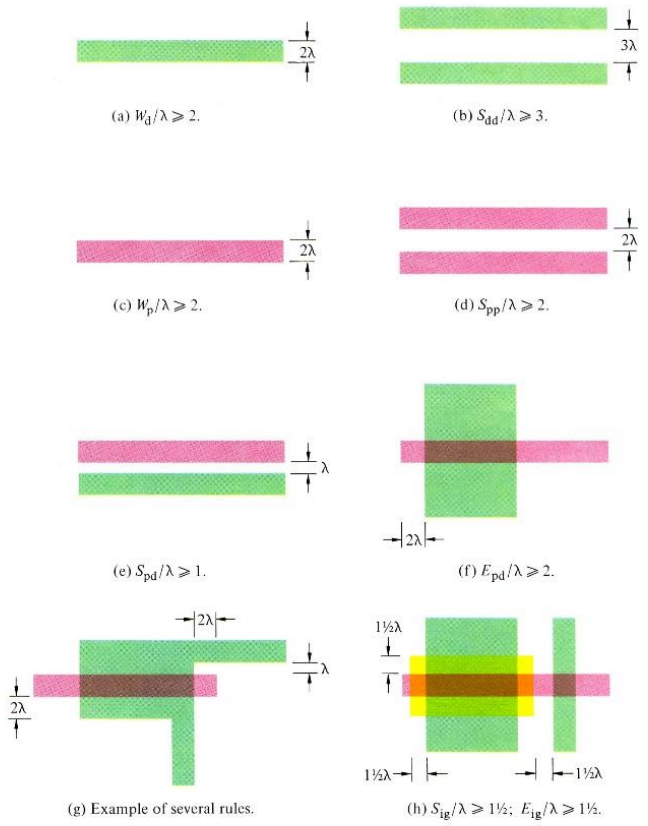


PLATE 2 *n*MOS design rules

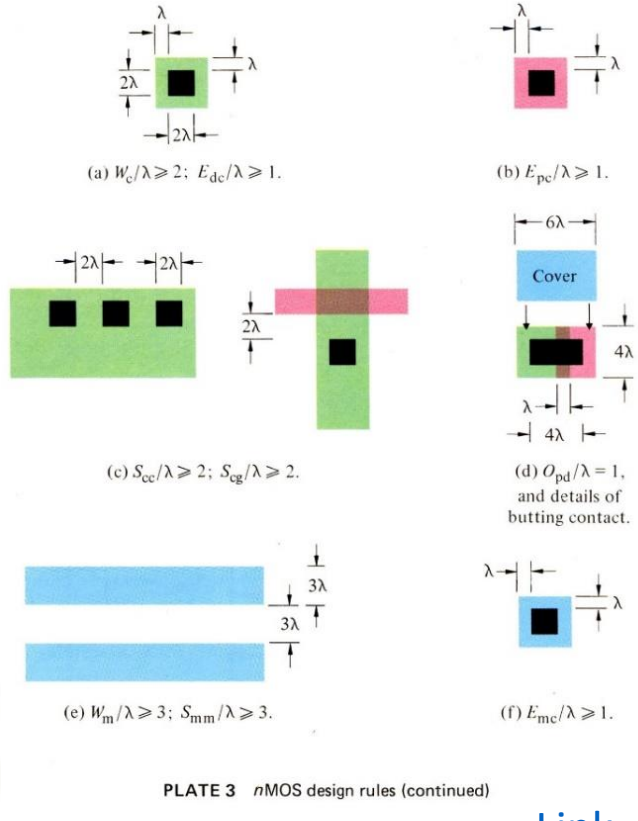


PLATE 3 *n*MOS design rules (continued)

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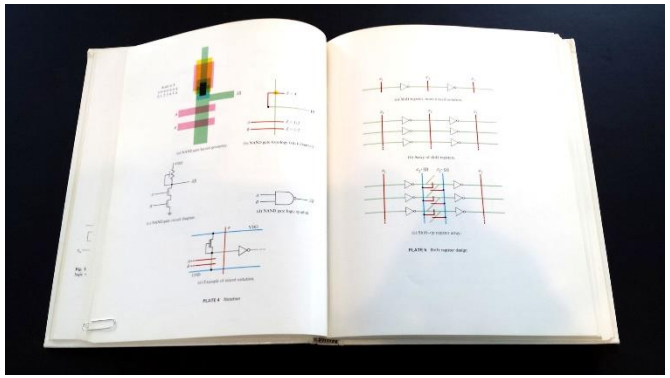
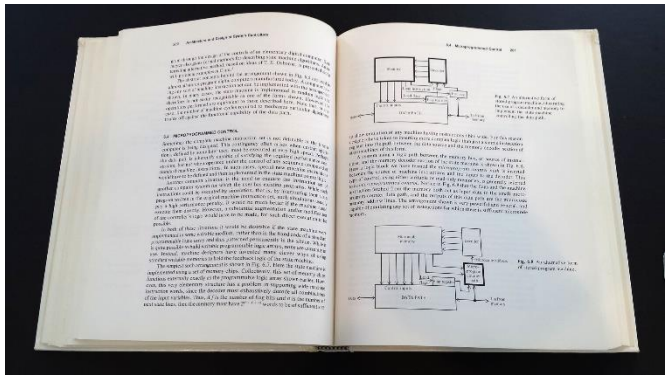
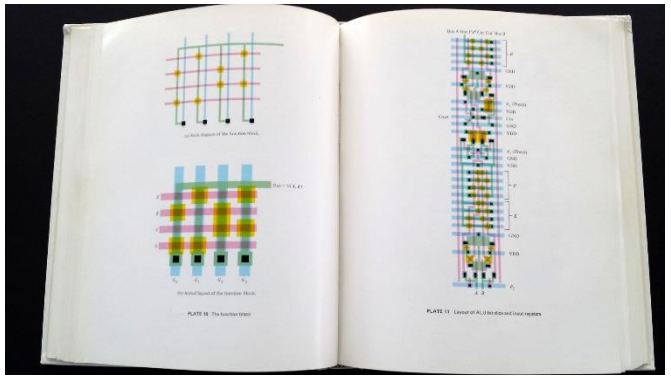
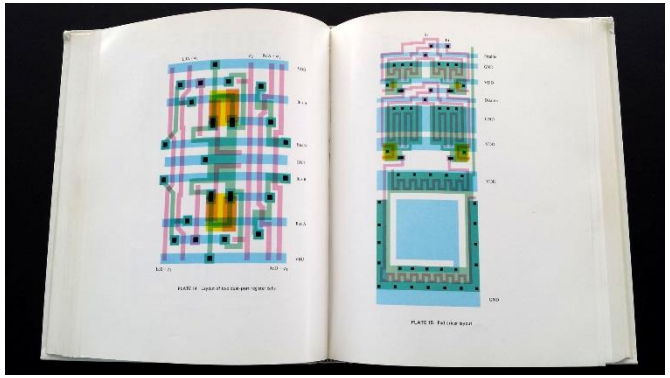
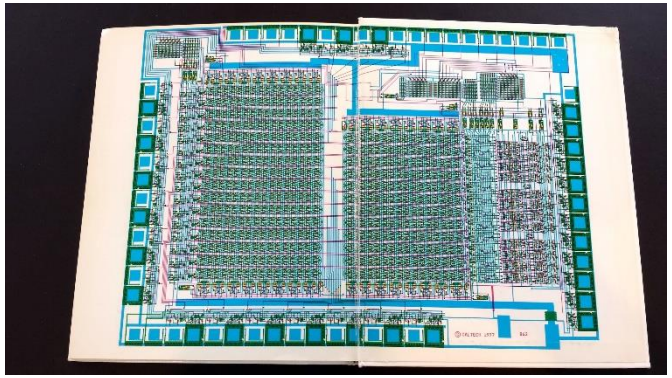
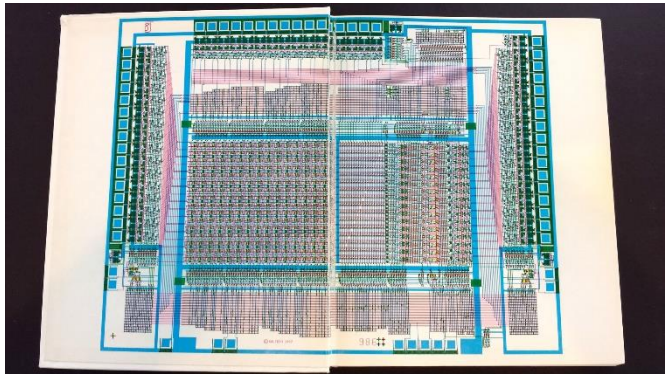
I began documenting the emerging new ‘Mead-Conway’ system of simplified, restructured, design-level abstractions and chip design methods in an evolving computer-edited book . . .

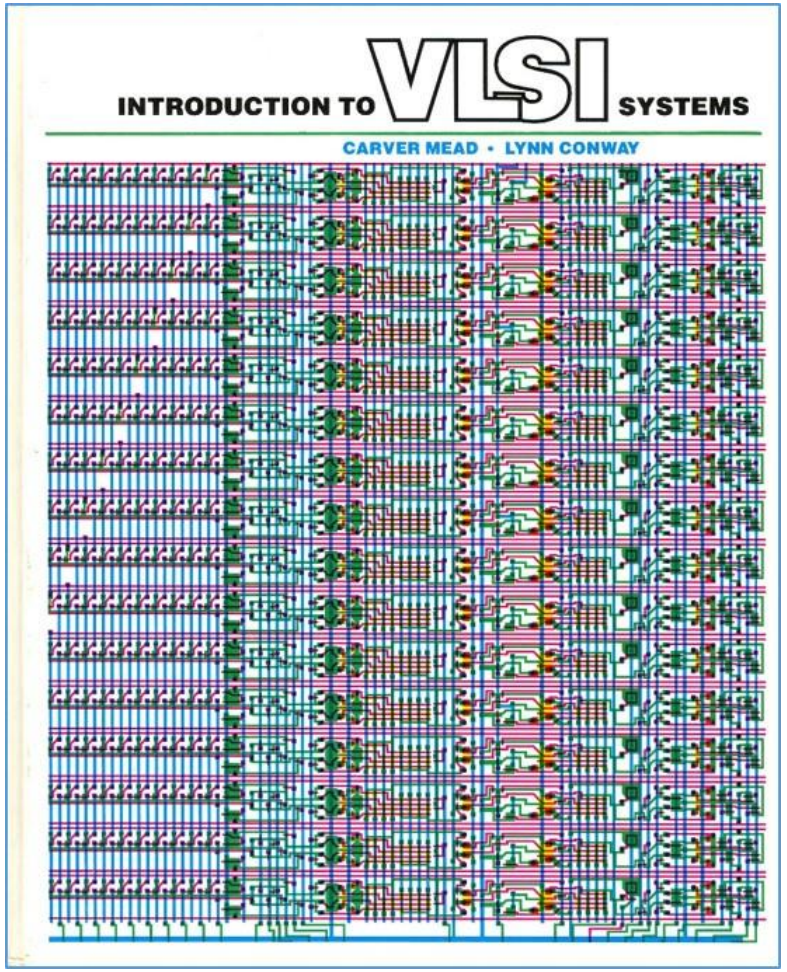
Link

Thus using our Alto computers at PARC not only as tools for generating chip-designs, but also to mechanize the evolution of the chip-design knowledge itself . . .

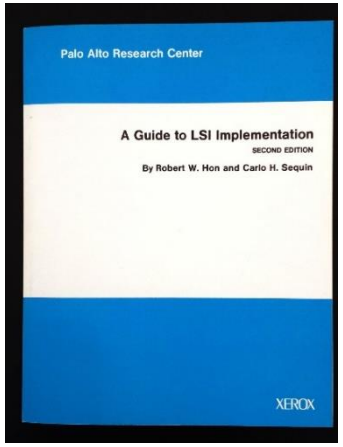
That computer-edited evolving book, printed using the laser printers at PARC, became the draft of the seminal textbook:

Introduction to VLSI Systems by Mead and Conway, published in 1980.

(later called "the book that changed everything" . . .)



We also used our Altos (at Xerox PARC) to generate [many open-source cell-layout-designs for key digital-subsystems](), easily disseminated to students and colleagues via the Arpanet …



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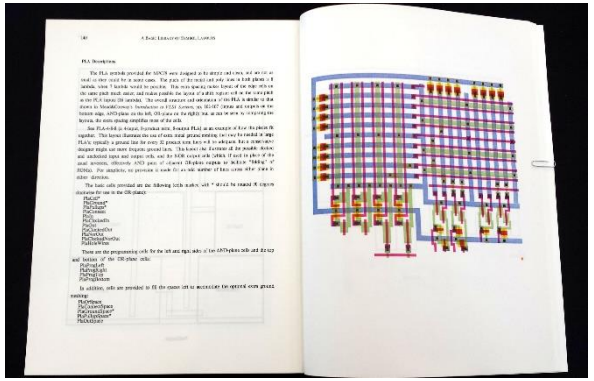
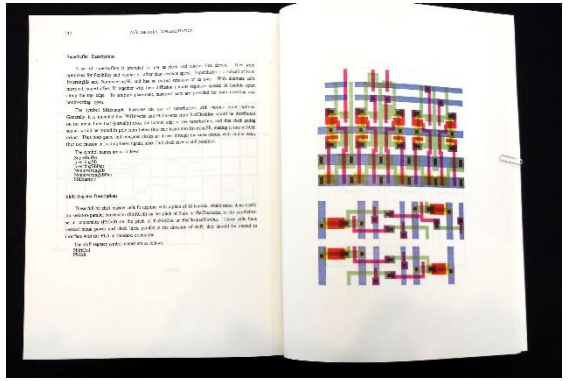
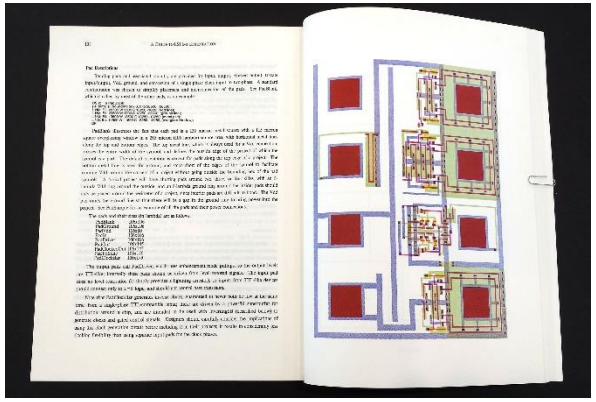


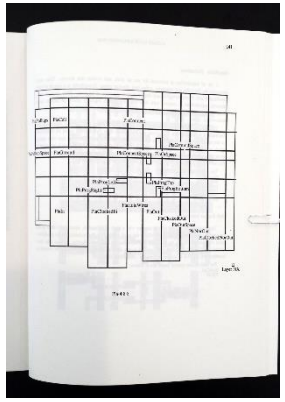
PLA cells



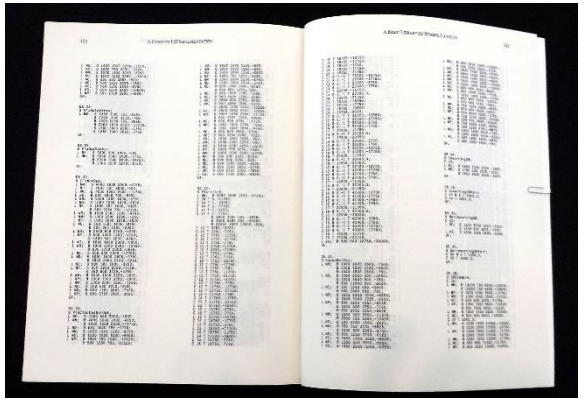
Clock drivers



I/O Pads



Cell locations



CIF 2.0 Cell-Library code

Following the “script” Charles Steinmetz used to propagate his revolutionary AC electricity methods at Union College in 1912, I introduced the new methods in a special VLSI design course at MIT in 1978.

THE M.I.T. 1978
VLSI SYSTEM DESIGN COURSE

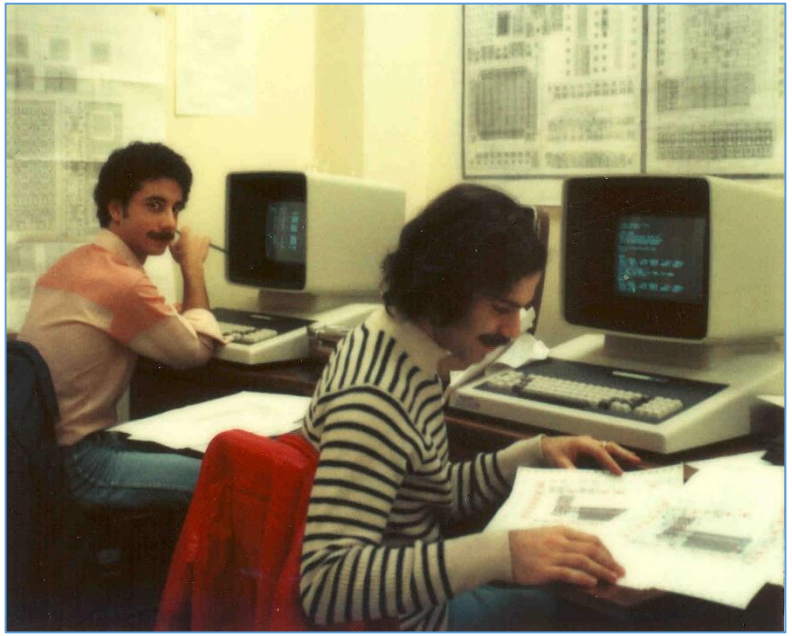
Link
Link
Link

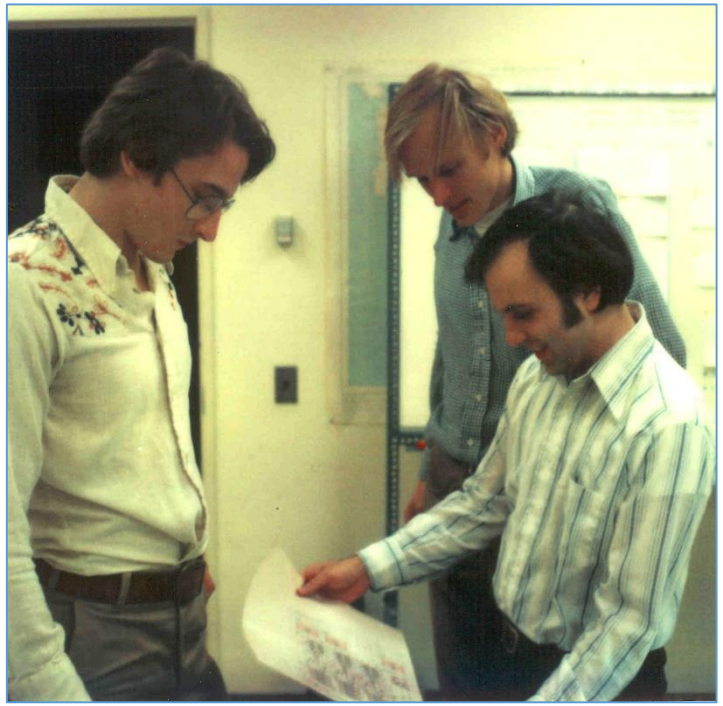
by Lynn Conway

[Update: 11-14-07]

This course was an important milestone in the development, demonstration and evaluation of the Mead-Conway structured VLSI design methods. Lynn Conway conceptualized and planned the course during the late spring and summer of '78, and taught the course while serving as Visiting Associate Professor of EECS at MIT in the fall of '78 and early '79.

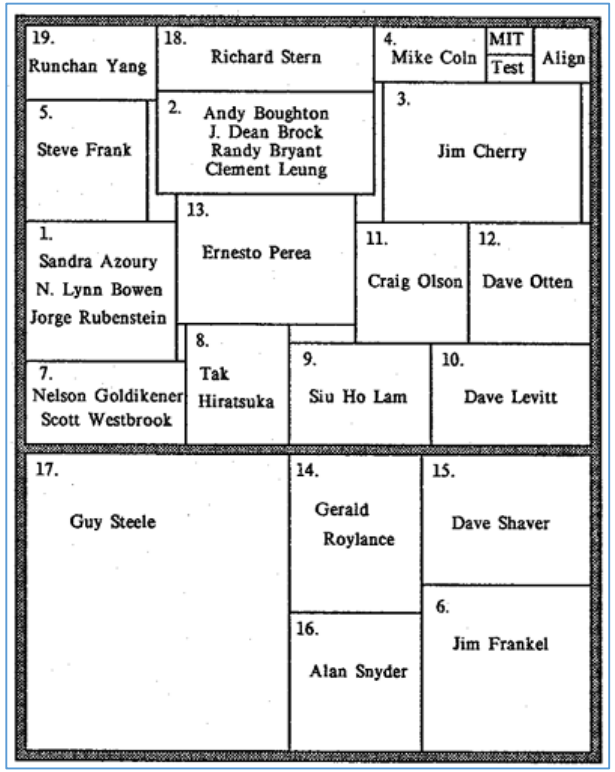
The students learned to design chips in the 1st half of the course, then did project-chip designs in the 2nd half. These were fabricated in Pat Castro's lab at HP shortly after the course.

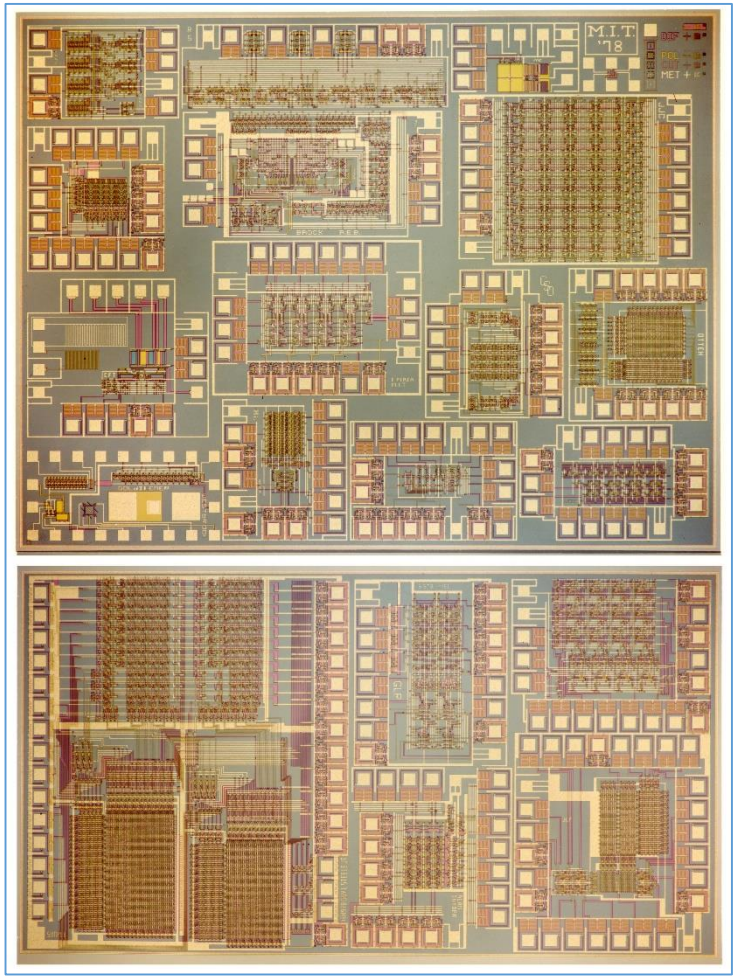




There were many amazing results including a complete Lisp microprocessor design by Guy Steele . . .

[Map and photomicrograph]
of the 19 student projects on
the MIT'78 'MultiProject' Chip





For more about the [MIT'78 course], see [Lynn's "MIT Reminiscences"]

The MIT'78 course stunned top folks in Silicon Valley . . .

And many other top research universities wanted to offer such a course. But how?

Suddenly, the answer came to me: Simultaneously rerun the MIT'78 course at several research universities, using my MIT lecture notes to keep things in sync.

Hmm. But how to "print" the resulting student project chips?

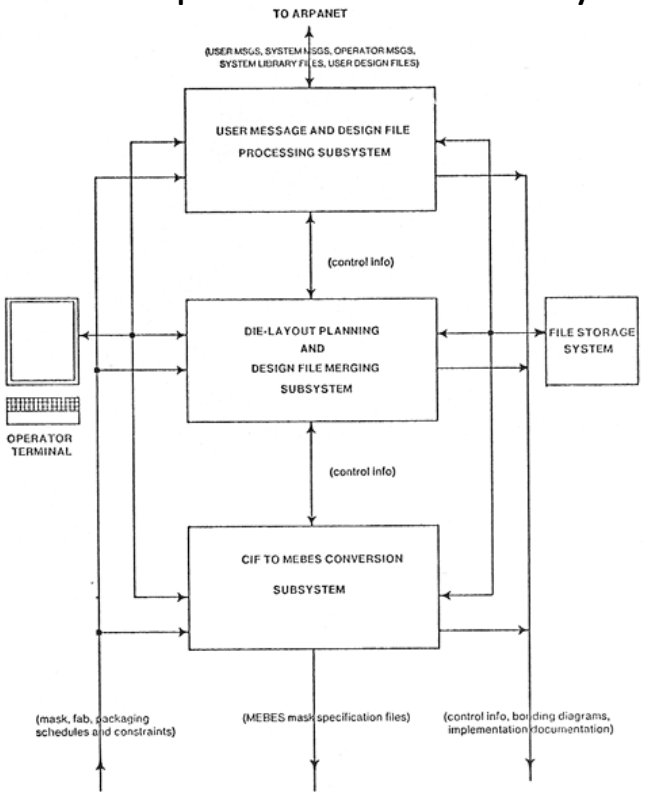
I suddenly visualized a new form of "E-commerce" QTA manufacturing system, enabling students' design-files to be remotely submitted via the Arpanet to a "server" at PARC . . .

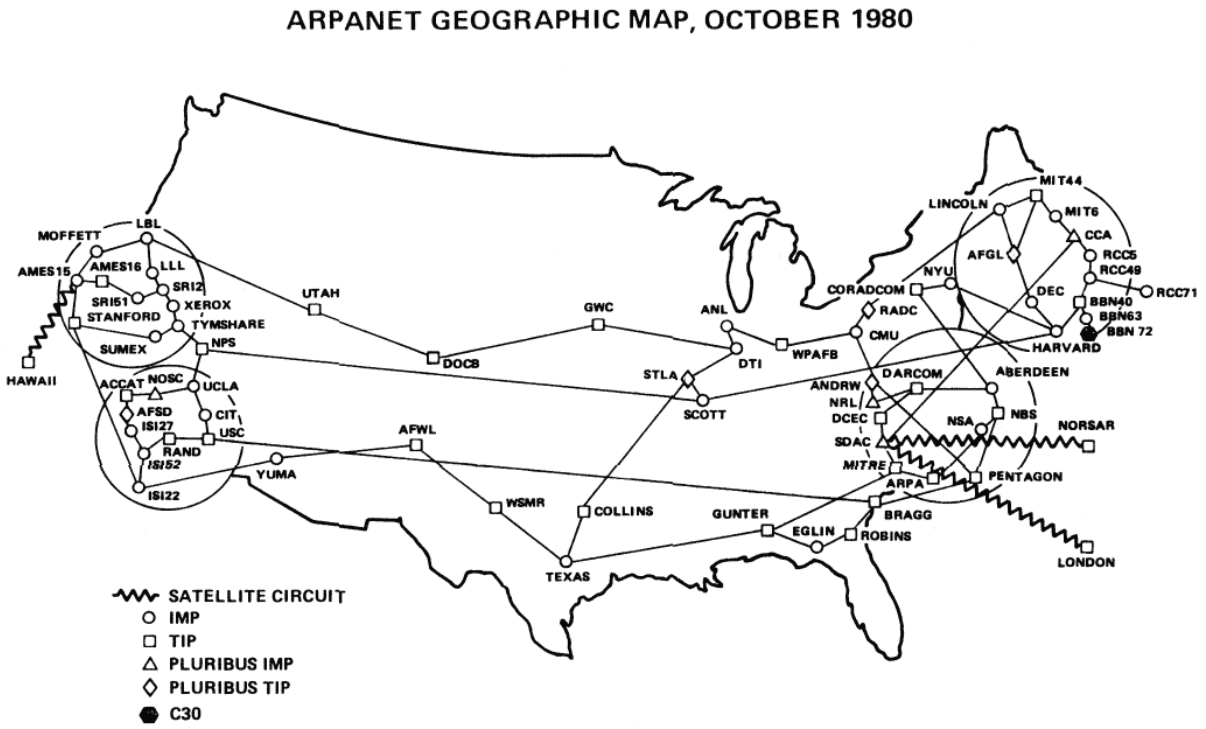
The server would run logistics-software to pack designs into "multi-project chip" files (like composing the print-files for a magazine, using remotely-submitted articles) . . .

We'd then make masks, "print" MPC's at HP Labs (where my collaborator Pat Castro had prototyped the first "silicon foundry"), and quickly return the chips to students.

In the fall of 1979, I orchestrated a huge "happening" (MPC79)* . . . It involved 129 budding VLSI designers taking Mead-Conway courses at 12 research universities…

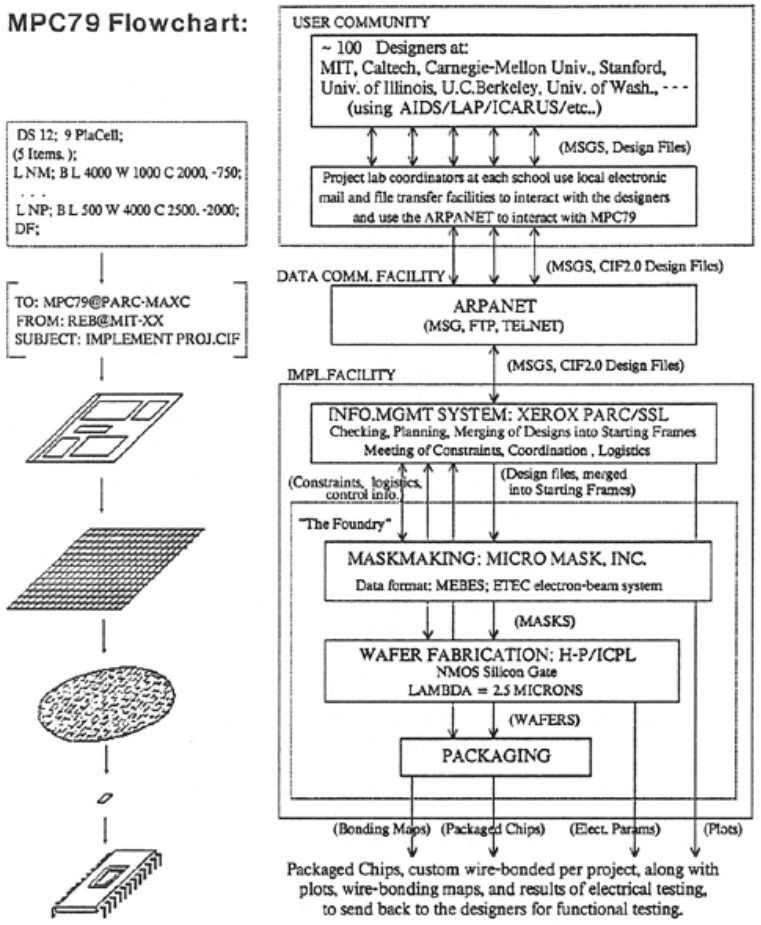
MPC79 Arpanet E-commerce system:





*The MPC Adventures: Experiences with the Generation of VLSI Design and Implementation Methodologies, L. Conway, Xerox PARC, 1981 (PDF)

MPC79 not only provided a large-scale “demonstration-operation-validation” of the design methods, design courses, design tools and e-commerce digital-prototyping technology …
it also triggered ‘cyclic gain’ in, and exponentiation of, the budding VLSI-design-ecosystem…



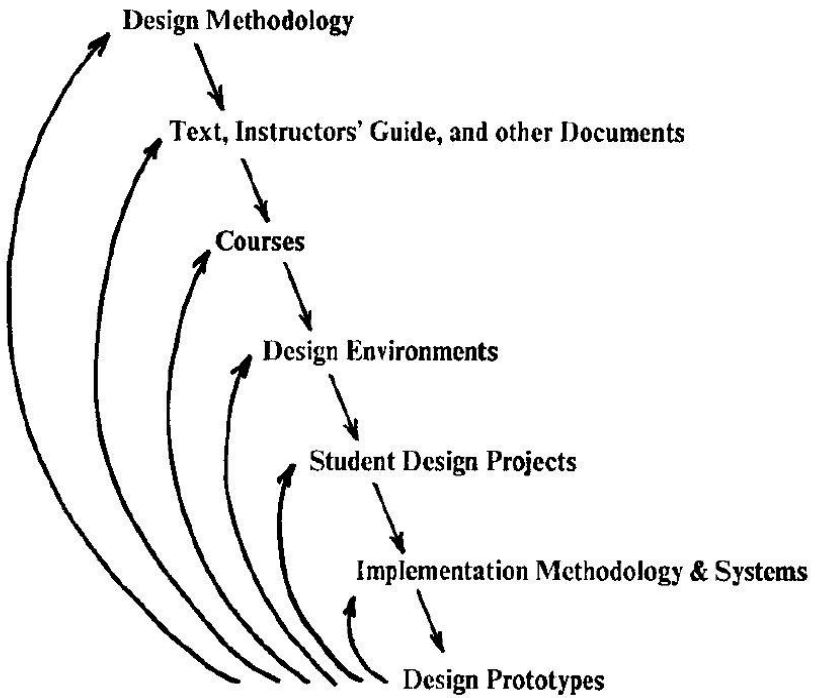


Figure 8. The Joint Evolution of the Multi-Level Cluster of Systems

The MPC Adventures, L.ynn Conway, Xerox PARC, 1981.

Visualizing how techno-social dynamics triggered an exponentiation in the spread of the innovative VLSI design and making ideas via the emerging internet communication technology . . .

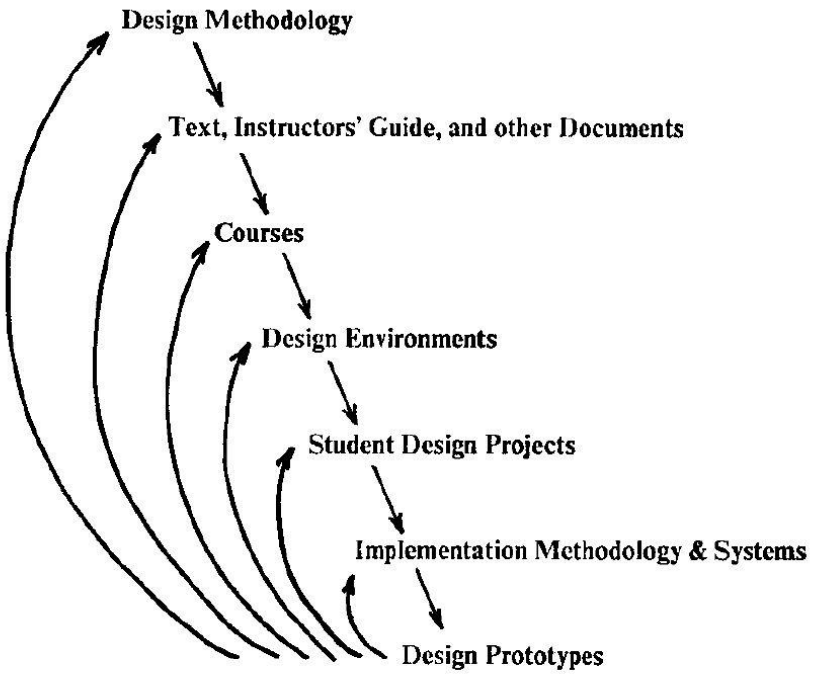
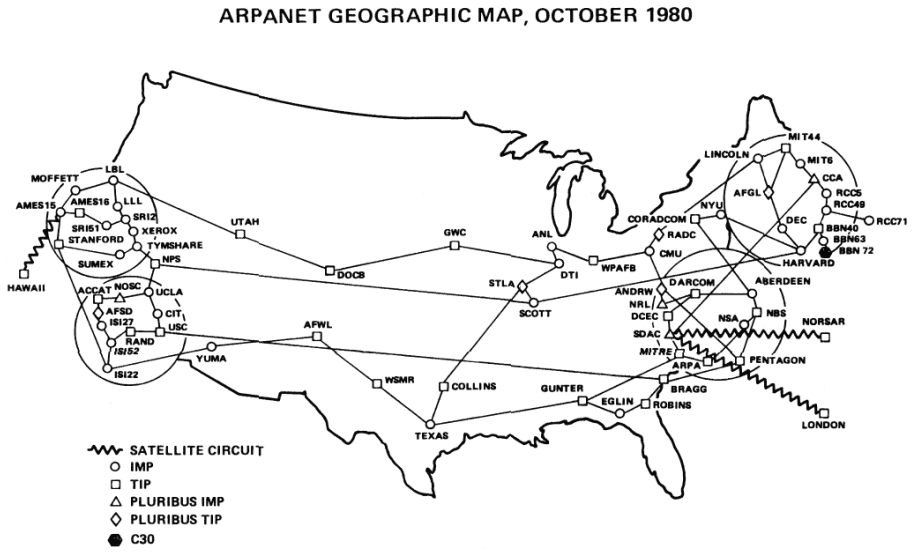


Figure 8. The Joint Evolution of the Multi-Level Cluster of Systems

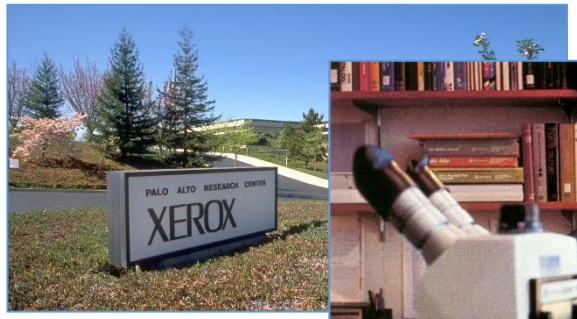
The MPC Adventures (p. 16)



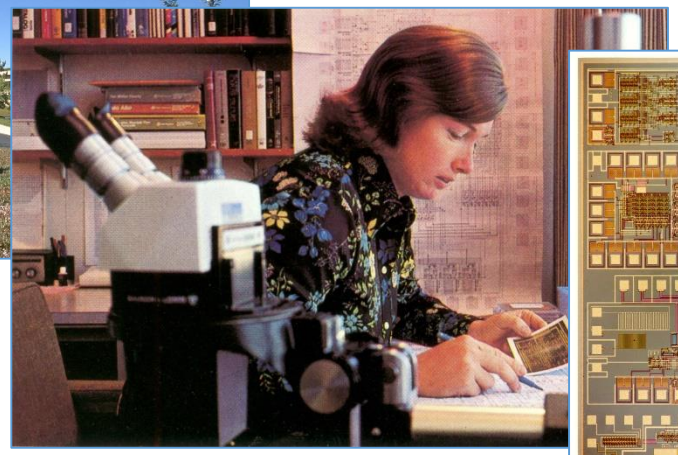
By 1982-83, Mead-Conway VLSI design courses were being offered at 113 universities all around the world

It had been a successful early experimental-exploration into what is now termed "social physics"

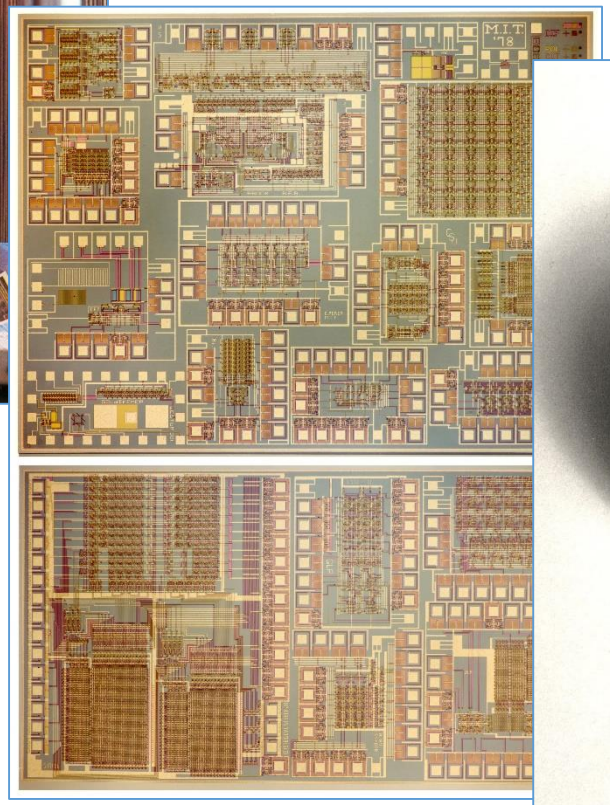
1976



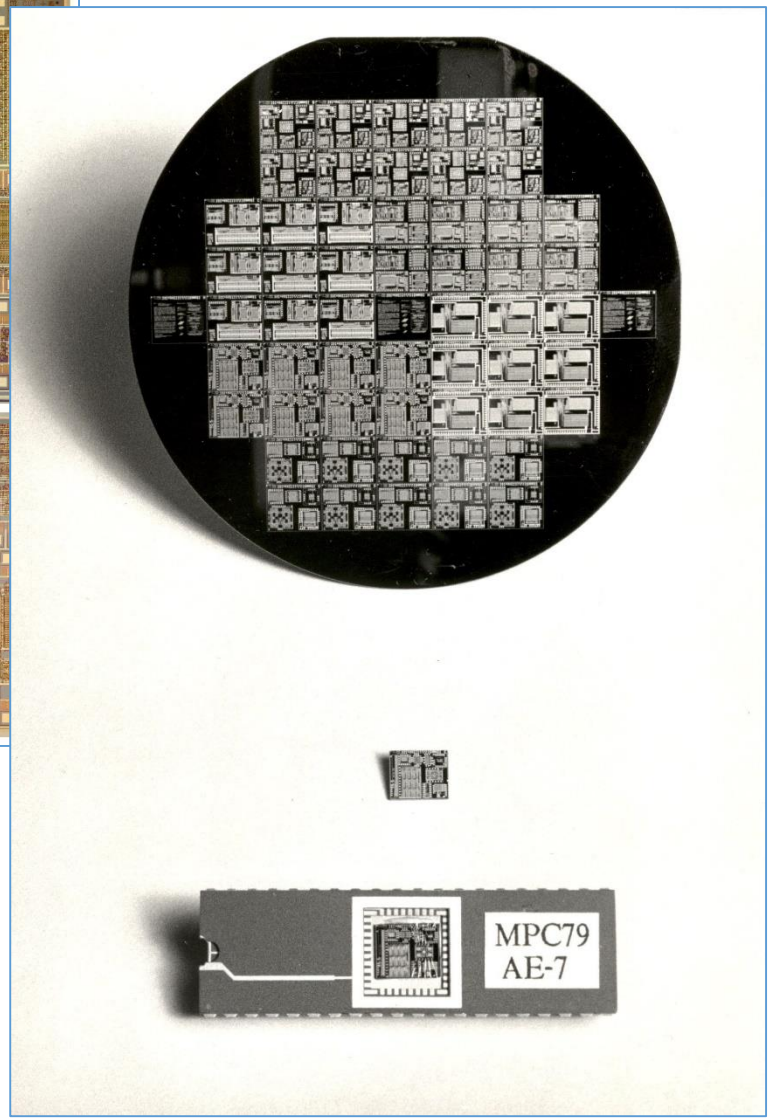
1977



1978



1979



Visualizing the exponentiating wave of VLSI innovation . . .

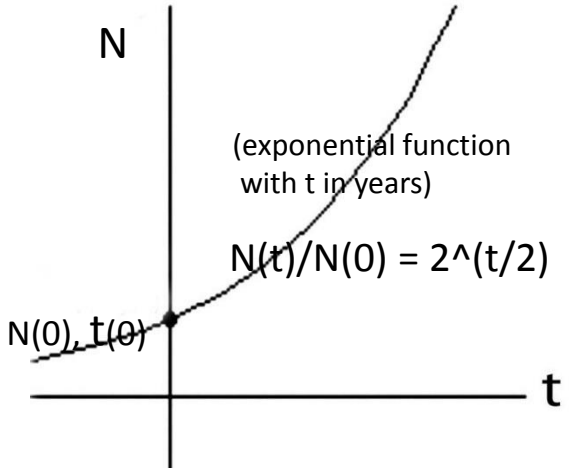
’76: How to cope with VLSI complexity?

’77: Inventing scalable VLSI design rules.

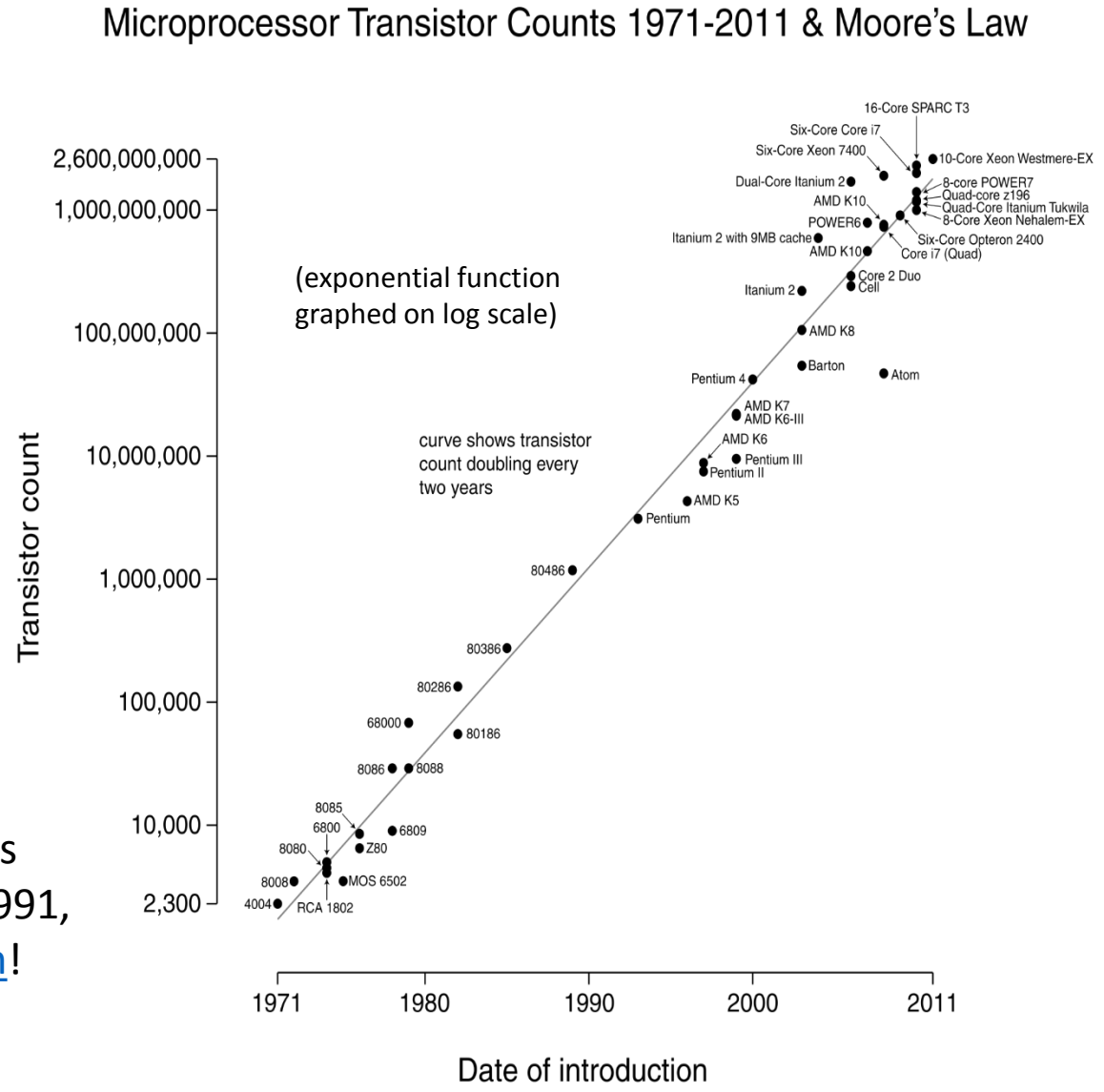
’78: Launching the VLSI methods at MIT!

’79: Launching the VLSI courses via MPC79!!

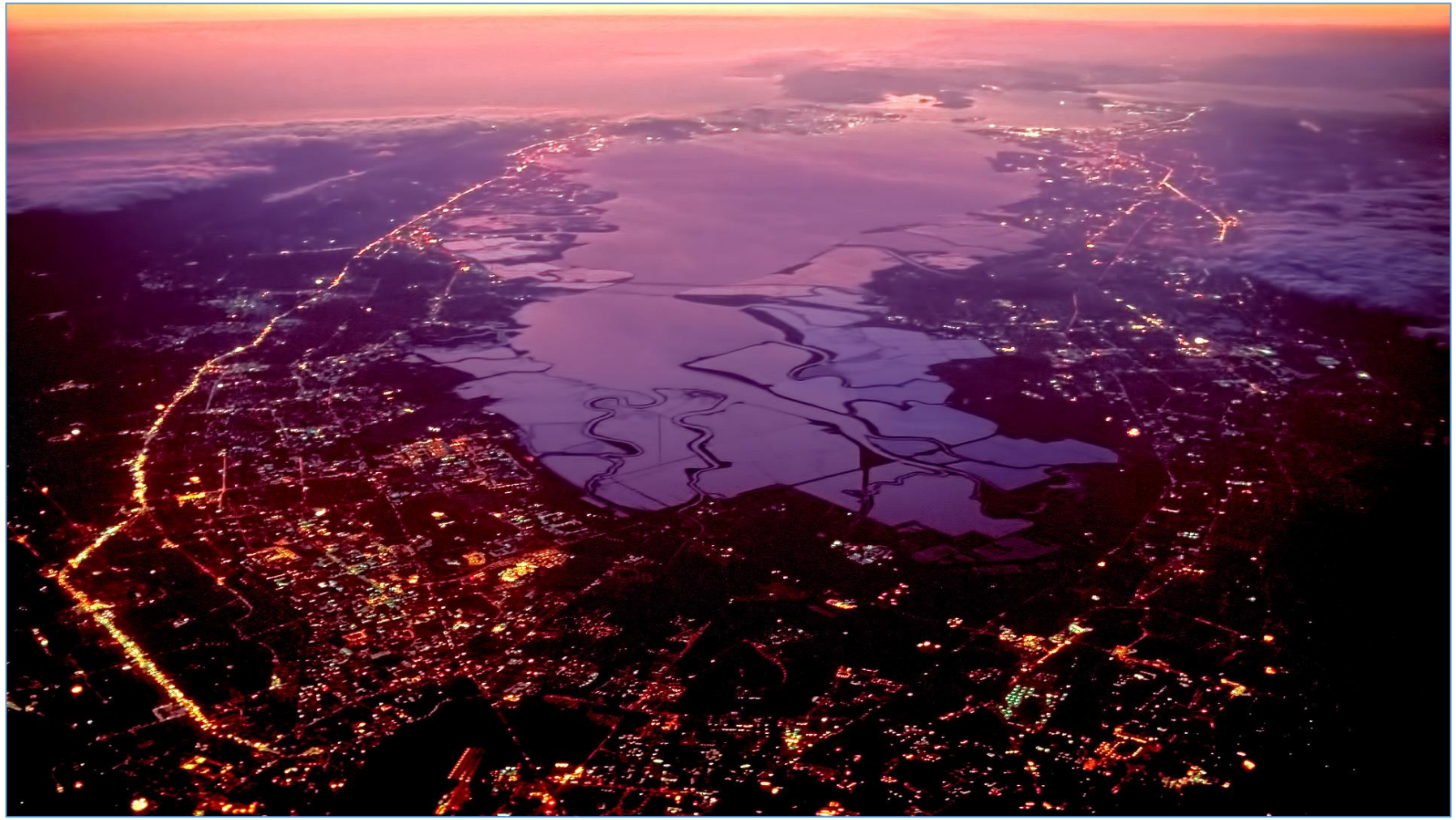
Over the past 40 years or so, Moore's Law stayed on track all the way:



Starting with several thousand in 1971, the number of transistors on a chip passed one million by 1991, and by 2011 passed several billion!



Visualizing exponentiation and compounding ‘techno-social interest’ . . .



Link

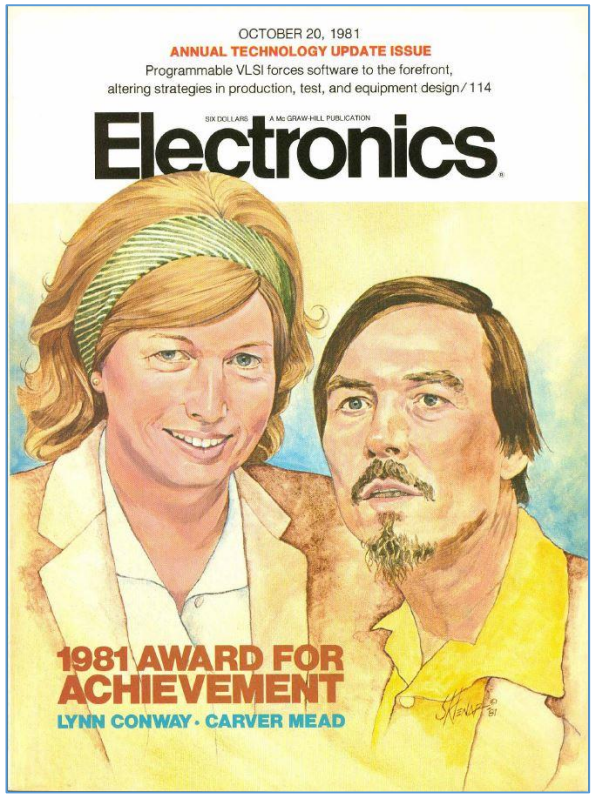
Let’s now go back and follow the high-tech community’s reactions to the “Mead-Conway” innovations during the ensuing decades:

Link

Key people sensed ‘something significant’ had happened, and Mead & Conway began receiving major recognition in the 1980s:

Electronics Award for Achievement ‘81

Pender Award, Moore School ‘84
Wetherill Medal, Franklin Institute ’85
NAE, Mead ‘84
NAE, Conway ‘89. . .



However, from ‘89 through the 90s and 00s, Mead received these increasingly major recognitions, while Conway’s role was erased*:

NAS ‘89
American Academy of Arts and Sciences ‘91
EDAC Phil Kaufman Award ‘96
IEEE John Von Neuman Medal ‘96
ACM Allen Newell Award ‘97
MIT Lemelson Award ‘99 ($500,000)
Fellow Award, Computer History Museum ‘02
National Medal of Technology ‘02
NAE Founders Award ‘03
Inventors Hall of Fame, at Computer History Museum Gala ‘09

**Most of these awards were for innovations that were Conway’s*

As a result, by 2009 the erasure was complete:

Chip inventors getting their due at Hall of Fame induction

By Mike Cassidy, San Jose Mercury News

Apr. 30, 2009 --The 50th birthday celebration of the integrated circuit kicks off in Silicon Valley this weekend, and frankly, I'm a little overwhelmed . . .

On Saturday night, the National Inventors Hall of Fame is inducting this year's class. The sold-out ceremony (at the Computer History Museum) is in Silicon Valley for the first time, because the Ohio-based hall is honoring 15 who are responsible for breakthroughs in semiconductor technology -- the technology that put the "silicon" in Silicon Valley . . . In a way, it's as if the valley's founding fathers are coming together to be honored in person and posthumously.

Inductees Gordon Moore, co-founder of Intel and namesake of Moore's Law, and Carver Mead, chip design pioneer and all-around brainiac, will be at the ceremony. So will lifetime achievement honoree Andy Grove, Intel's former CEO . . .

With Andy Grove, Gordon Moore and Carver Mead taking center stage:

INTEGRATED CIRCUIT

HONORING THE PEOPLE WHO HELPED PIONEER COMPUTER CHIP TECHNOLOGY

Andrew "Andy" Grove, top left, who cofounded Intel, will be given a lifetime achievement award.

Besides cofounding Fairchild Semiconductor and Intel, Gordon Moore, top right, will be honored for devising Moore's Law, which accurately predicted that the number of transistors built into each computer chip would double every two years, though he initially thought the doubling would occur annually.

Carver Mead, left, will be honored for devising the so-called VLSI method for designing chips.

INNOVATORS TO BE INDUCTED INTO HALL AS PART OF 50TH CELEBRATION

By Steve Johnson
Mercury News

To celebrate the 50th anniversary of the integrated circuit, the National Inventors Hall of Fame will honor 16 people who helped pioneer computer-chip technology during a sold-out ceremony Saturday at the Computer History Museum in Mountain View.

Andy Grove, who cofounded Intel and formerly served as the Santa Clara chip maker's chief executive and chairman, will be given a lifetime achievement award.

Among the others being honored is Gordon Moore. Besides cofounding Fairchild Semiconductor and Intel, he devised Moore's Law, which accurately predicted that the number of transistors built into each computer chip would double every two years, though he initially thought the doubling would occur annually.

Also to be honored are:

■ Carver Mead. By devising the so-called VLSI method for designing chips, he helped to develop the standards and tools that permitted tens of thousands of transistors to be packaged onto semiconductors.

See INVENTORS, Page 2

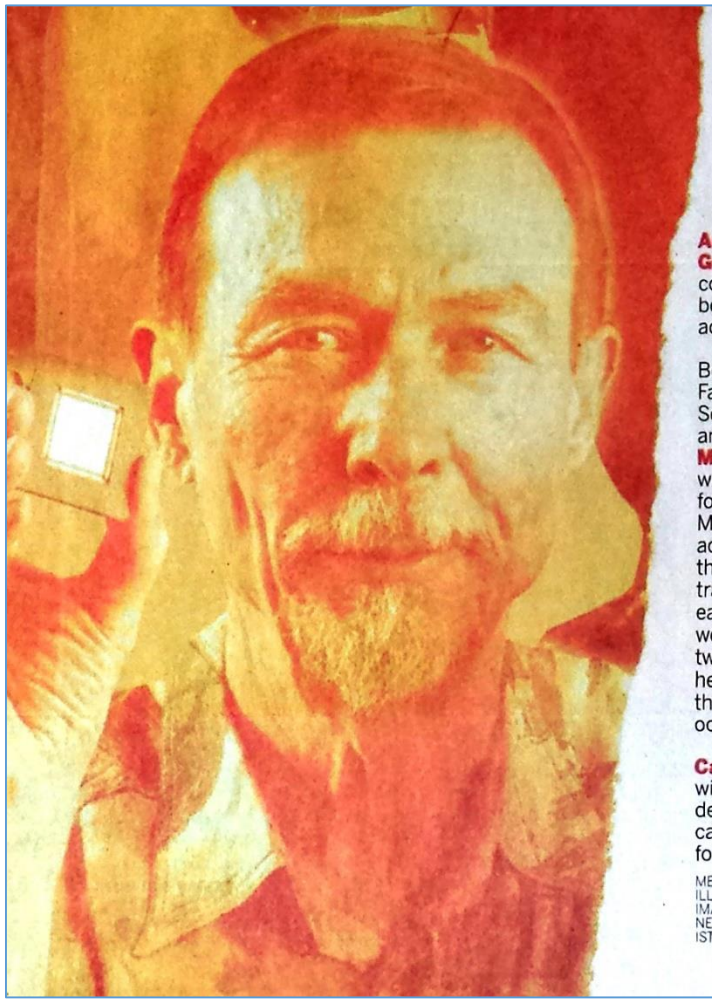
Freethinkers shaped the valley

Honoring an era of innovation

MIKE CASSIDY
Silicon Valley Dispatches

SALUTE TO THE SEMICONDUCTOR

San Jose Mercury News April 30, 2009



Andrew "Andy" Grove, top left, who cofounded Intel, will be given a lifetime achievement award.

Besides cofounding Fairchild Semiconductor and Intel, Gordon Moore, top right, will be honored for devising Moore's Law, which accurately predicted that the number of transistors built into each computer chip would double every two years, though he initially thought the doubling would occur annually.

Carver Mead, left, will be honored for devising the so-called VLSI method for designing chips.

MERCURY NEWS PHOTO ILLUSTRATION WITH IMAGES FROM MERCURY NEWS ARCHIVES AND ISTOCKPHOTO.COM

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See INVENTORS, Page 2

BTW, Conway wasn't invited and didn't even know it was happening . . .

Recent investigations into and reporting on what happened,
Hoping to regain some of my legacy along the way . . .

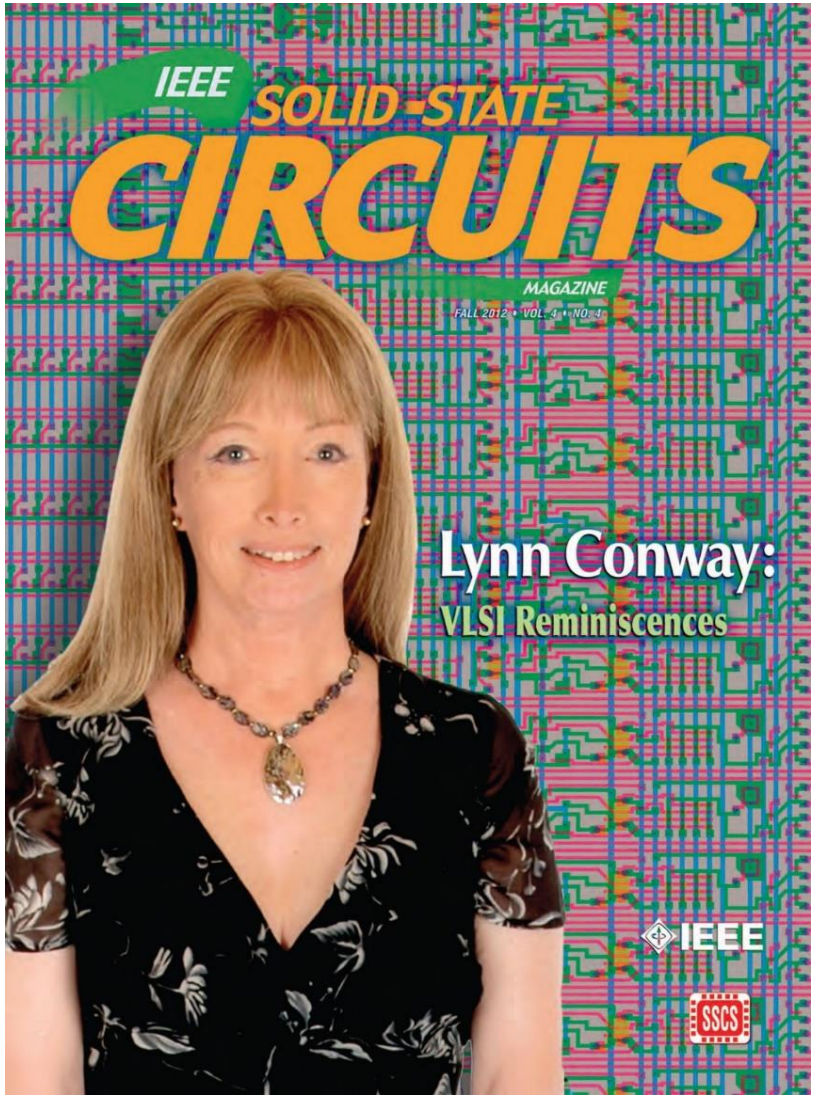
Link

The story of my investigations in recent years is quite a saga, yet to be told . . .

To make a long-story short:
I uncovered, documented and archived
all sorts of fascinating data and evidence.

All that led me to write and publish my "Reminiscences of the VLSI Revolution" in the Fall 2012 IEEE *Solid State Circuits Magazine*.

It was the first time I'd stepped openly forward to tell the whole story . . .



Reports re the investigation to understand what happened and reclaim my life-legacy:

Compilation of the VLSI Archive, 2009-2012

Publication of my IBM-ACS Reminiscences, 2011

Publication of my VLSI Reminiscences, 2012

Publication of The Many Shades of 'Out', 2013

Publication of my MIT Reminiscences, 2014

Evidence that 'it's begun':

Fellow Award, Computer History Museum, 2014

IEEE/RSE James Clerk Maxwell Medal, 2015

A Counter-Intuitive Explanatory-Conjecture:

Visualizing *Mathew Effects*, *Matilda Effects* and now *Conway Effects!*

Link

Throughout this case study we've observed the following effects in play:
(i) the "Matilda effect" (repression of contributions of women scientists)
(ii) the "Matthew effect" (eminent scientists get more credit)

Note that these effects involve "self-fulfilling prophecies", described by Merton as:

". . . a *false* definition of the situation evoking a new behavior which makes the original false conception come *true*. This specious validity of the self-fulfilling prophecy perpetuates a *reign of error*. For the prophet will cite the actual course of events as proof that he was right from the very beginning."

But is that all that's happening? Or are other forces also in play?

After closely investigating these events, I sensed something more subliminal, more fundamental happening at a social level . . . and it involves no errors, no conspiracies, no repressions, **and no 'bad guys'**:

CONJECTURE: almost all people are blind to innovations, especially ones made by 'those others' whom they do not expect to make innovations.

Since for most people, 'those others' = 'almost all people', few people ever witness or visualize innovations, even ones made right in front of their eyes (including sometimes those made by themselves!).

They instead look for tells and cues from others when constructing internal-orientations towards 'novelties' they stumble upon . . . and not just whether or not to accept or reject a novelty, but also whether to even notice it in the first place!

From this perspective, the Mathew and Matilda Effects are derivatives of the newly-conjectured **"Conway Effect"**, which affects 'all outsiders'.

Visualizing the Conway Effect in action:

Students in MIT'78 thought they were learning "how chips were designed in Silicon Valley" (the course was, in effect, a giant MIT hack!). They simply "did it", without realizing they were learning radically new methods.

The astonished reaction amongst Silicon Valley cognoscenti then led to intense interest in reverse engineering "how MIT did this", causing other research universities to immediately want to offer such courses.

Similarly, folks using MPC79 took it for granted and simply "used it".
No one realized MPC79 was an even larger paradigm-shifting-hackathon to launch the modern world of "fabless design" + "silicon foundries" + "internet-based e-commerce infrastructure."

What might MPC79 participants been thinking?

Since MPC79 used the ARPANET, many thought DARPA “did it.”

Thus when DARPA funded the transfer of MPC79 technology to USC-ISI, many users thought “MOSIS” had been “created by DARPA” . . .

And similar government supported MOSIS-like services soon sprang up in other countries!

The VLSI revolution thus swept through high-tech community without anyone realizing that it had been deliberately generated, much less how that was done and who did it.

Although the “VLSI Book by ‘Mead’” became iconically-connected with these large-scale socio-technological events, Mead himself was never able to explain what happened . . .

Meanwhile, Conway remained in the shadows up until 2012, when she finally was able to emerge and explain how it happened . . .

The Conway Effect: Almost all people are blind to innovations, especially those made by people whom they don't expect to make innovations.

As a result, innovations diffuse via social-processes involving subliminal subgroup noticings, mimickings, rejections, adoptions, adaptations, tradings and displacements.

Credits for innovations as social tokens are separately subliminally assigned, gathered, seized, gained, granted, bartered, etc. . . .

These crediting-processes are modulated by visibility, status, prestige, class, power, location, credentials, prejudice, popularity, influence, money and accident . . .

The visibility of crediting for (as opposed to visualizations of) innovations sustains both the crediting-processes and the ongoing-blindness to the underlying innovations.

Corollary: It's possible to trigger large paradigm-shifts, right out in the open, without people having a clue what you're doing!

Questions to Ponder!

Have you noticed an innovation this week?

Have you made an innovation this week?

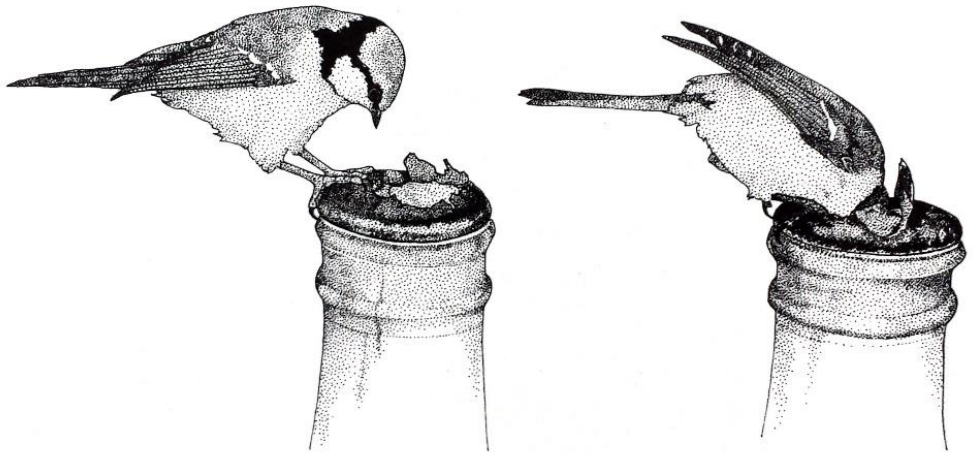
What is an innovation?

How to think abstractly about such things?

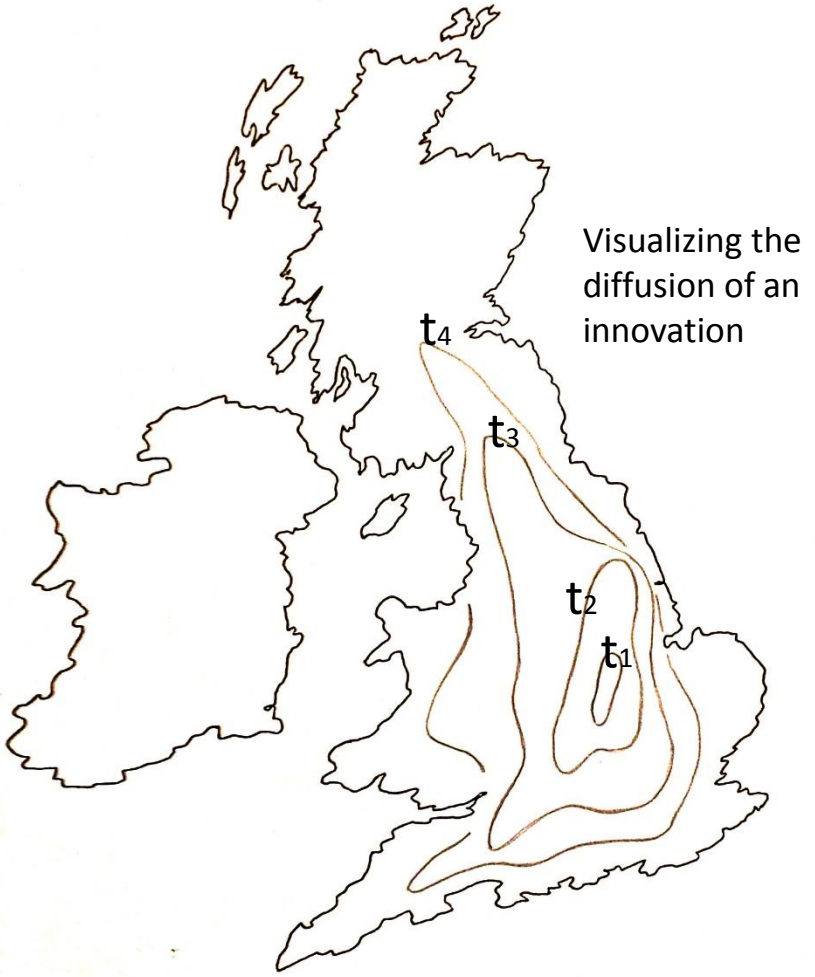
Insights from the evolution of culture in animals . . .

Glimpses into Emerging Techno-Social Dynamical-Systems . . .

Thought Experiment!



John Tyler Bonner, *The Evolution of Culture in Animals*, Princeton University Press, 1980, p.183-4.



Visualizing the diffusion of an innovation

Thought experiment!

“The most remarkable of such examples comes from the work of the Japanese Monkey Center where macaques were isolated in groups on small islands, and differences in the behavior patterns of different island populations arose by cultural evolution . . .

The greatest achievement is that of Imo, the female genius among the macaques.

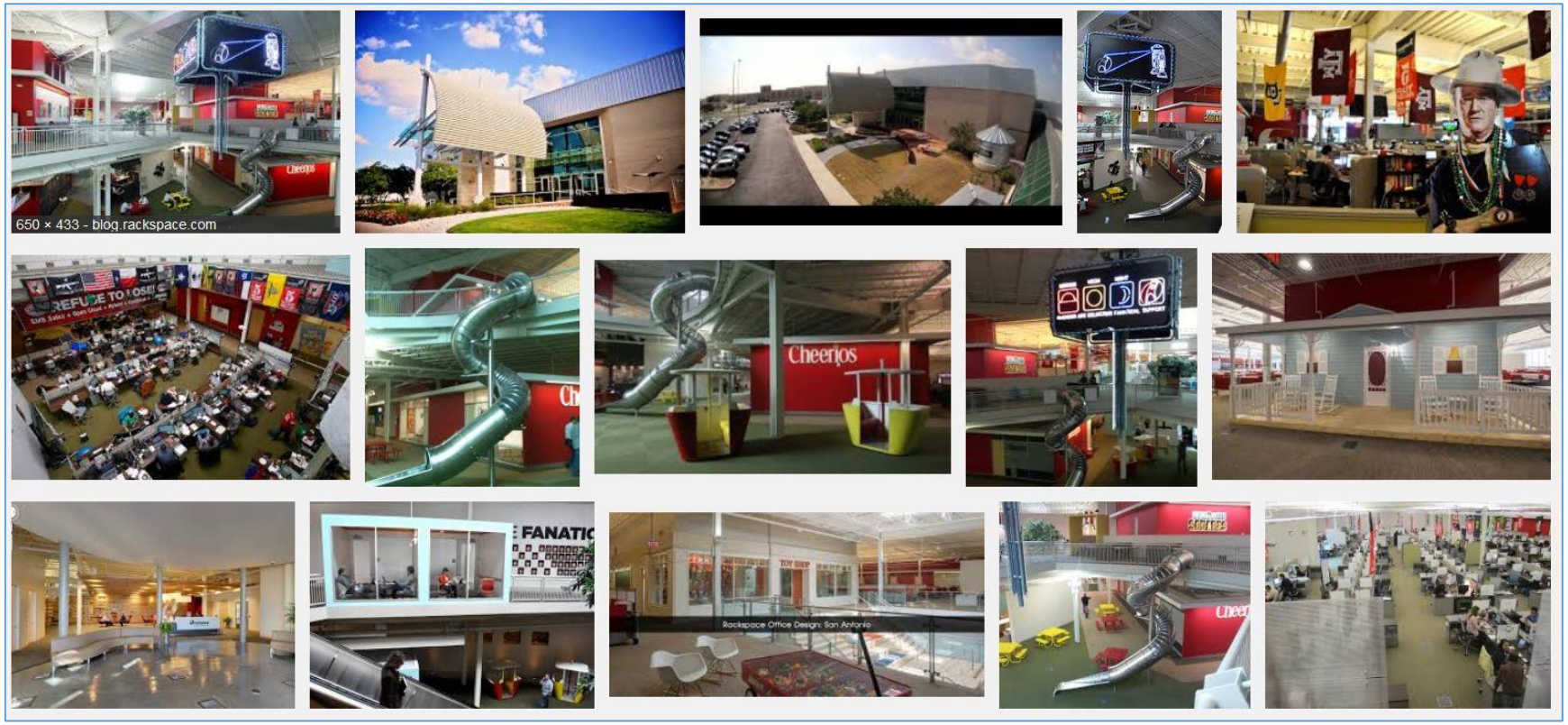
At the age of two she invented washing the sand off sweet potatoes before eating them, and at a later date she found a way of separating wheat from sand by throwing the mixture in the water and skimming off the wheat from the surface.

These discoveries spread slowly through the colony, although in general the older individuals were the last to acquire the new tricks.”*

*John Tyler Bonner, *The Evolution of Culture in Animals*, Princeton University Press, 1980, p.184.

Source

Thought Experiment: Inside Rackspace's Headquarters



Rackspace Castle, 1 Fanatical Place, Windcrest, TX

Glimpses into Techno-Social Systems in the emerging Social Age . . .

Our Travels Through Techno-Social Space-Time:
Envisioning Incoming Waves of Technological Innovation

Lynn Conway
Professor of EECS, Emerita
University of Michigan, Ann Arbor

2016 Magill Lecture
Fu Foundation School of
Engineering and Applied Science,
Columbia University
March 23, 2016

Note: This slideshow is posted online for later reference:
http://ai.eecs.umich.edu/people/conway/Memoirs/Talks/Columbia/2016_Magill_Lecture.pptx
[V 3-21-2016]

Lynn Conway, "Our Travels Through Techno-Social Space-Time: Envisioning Incoming Waves of Technological Innovation", 2016 Magill Lecture, Columbia University, March 23, 2016

Jesse Adams, "Magill Lecture: Visionary Engineer Lynn Conway BS'62, MS'63 Heralds Dawn of the Techno-Social Age", Columbia Engineering, April 7, 2016

Readings:

Ken Shepard, “Covering”: How We Missed the Inside-Story of the VLSI Revolution”, *IEEE Solid State Circuits Magazine*, FALL 2012, pp. 40-42. (more)

Chuck House, “A Paradigm Shift Was Happening All Around Us”, IEEE Solid State Circuits Magazine, FALL 2012, pp. 32-35. (more)

Lynn Conway, “Reminiscences of the VLSI Revolution: How a series of failures triggered a paradigm shift in digital design”, *IEEE Solid State Circuits Magazine*, FALL 2012, p. 8-31. (more)

Lynn Conway, “The Many Shades of Out”, *Huffington Post*, July 24, 2013.

Paul Penfield, "The VLSI Revolution at MIT", *2014 MIT EECS Connector*, Spring 2014, pp. 11-13.

Lynn Conway, "MIT Reminiscences: Student years to VLSI revolution", *lynnconway.com*, March 11, 2014.

Computer History Museum: “Lynn Conway, 2014 Fellow, For her work in developing and disseminating new methods of integrated circuit design”, April 2014.

Nicole Casal Moore, “Life, Engineered: How Lynn Conway reinvented her world and ours”, The *Michigan Engineer*, FALL 2014, pp. 42-49.

Catharine June, “Lynn Conway to receive 2015 IEEE/RSE James Clerk Maxwell Medal”, *Michigan Engineering News*, December, 15, 2014.

IEEE and the Royal Society of Edinburgh, “James Clerk Maxwell Medal ceremony at the Royal Society of Edinburgh”, YouTube, Nov. 12, 2015.

Magnus Linklater, “‘Life in stealth’ of microchip genius who migrated to a new identity: Lynn Conway beat transgender bias and began a revolution”, *The Times* (UK), Nov. 14, 2015.

END

http://ai.eecs.umich.edu/people/conway/Memoirs/Talks/Rackspace/2016_Rackspace_Pride_Talk.pptx
http://www.slideshare.net/LynnConway1/an-unexpected-woman-the-inside-story-behind-the-vlsi-revolution
www.lynnconway.com; conway@umich.edu

EPILOGUE: Excerpts from Lynn's 2016 Magill Lecture

"Our Travels Through Techno-Social Space-Time: Envisioning Incoming Waves of Technological Innovation"

2016 Magill Lecture, Columbia University, March 23, 2016

As we travel through space-time . . . be sure to keep these words in mind:

Link

“The farther backward you can look, the farther forward you can see.”

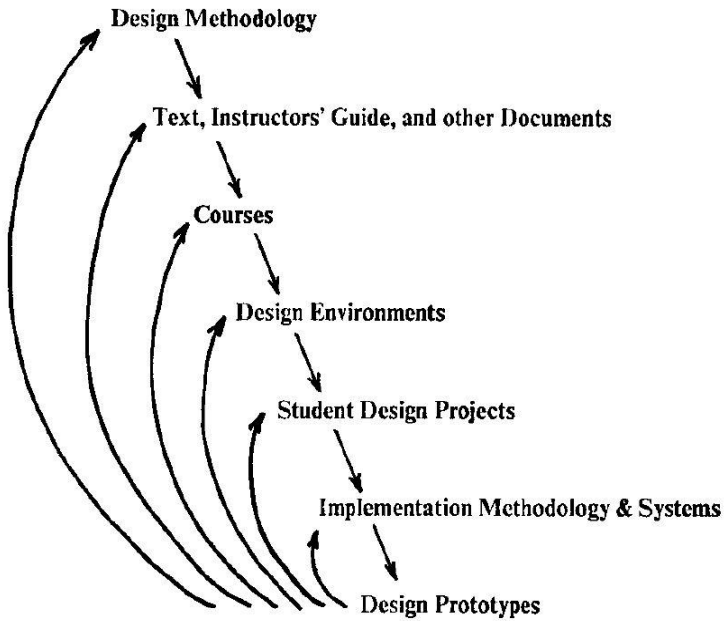
— Winston Churchill

As we turn 180^{o} and look ahead . . . we can glimpse another huge incoming wave of innovation . . . It’s out there now, just beyond the social-time-horizon . . .

One thing for sure: This is the “Big One”! . . .

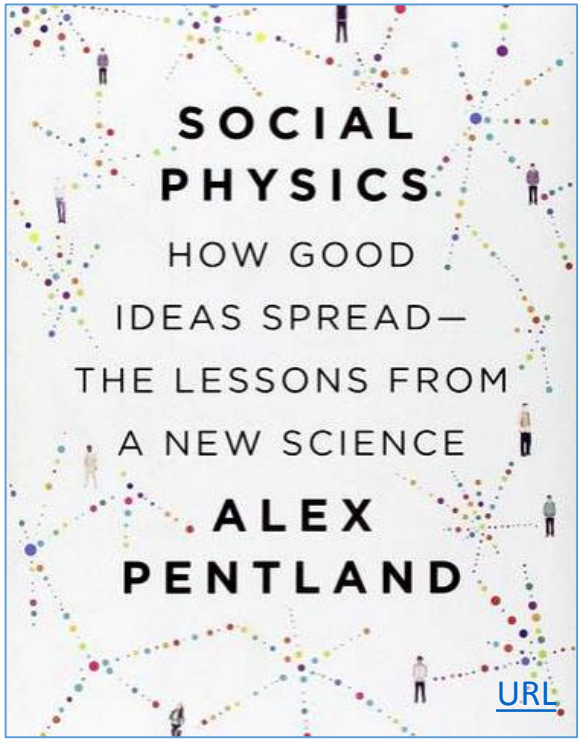
URL

Ex: To envision the masses of ideas now cycling in techno-social motion, recall how we diagrammed the nested-social-evolutionary-processes of the VLSI revolution.
Only now, vastly more such processes are running in parallel and cross-fertilizing.
And a new science is beginning to explore and map-out what's happening . . .



The MPC Adventures (p. 16) Xerox PARC 1981.

Figure 8. The Joint Evolution of the Multi-Level Cluster of Systems



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Epidemic Processes are already providing mathematical frameworks for partly-modeling techno-social dynamical-systems:

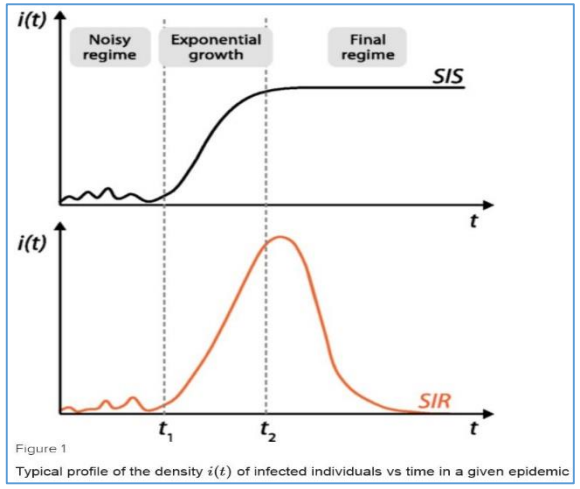


Figure 1
Typical profile of the density $i(t)$ of infected individuals vs time in a given epidemic

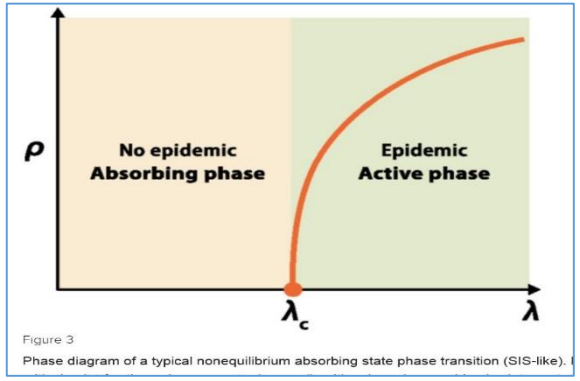


Figure 3
Phase diagram of a typical nonequilibrium absorbing state phase transition (SIS-like).

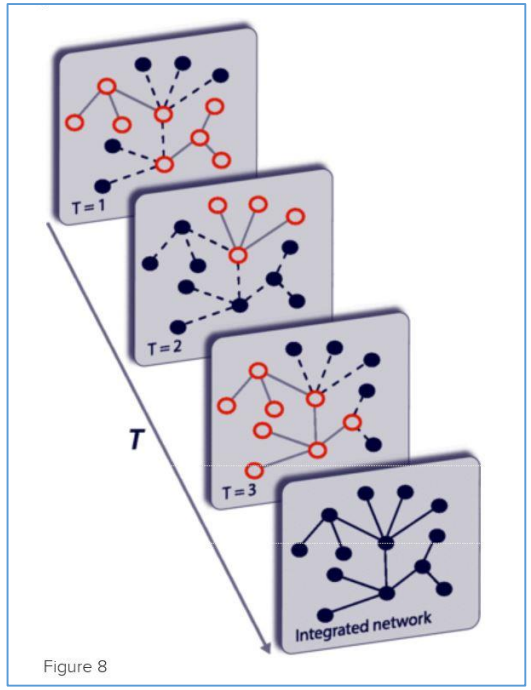
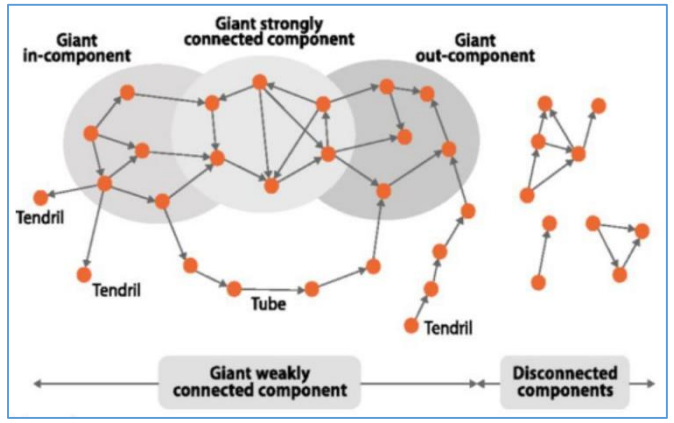
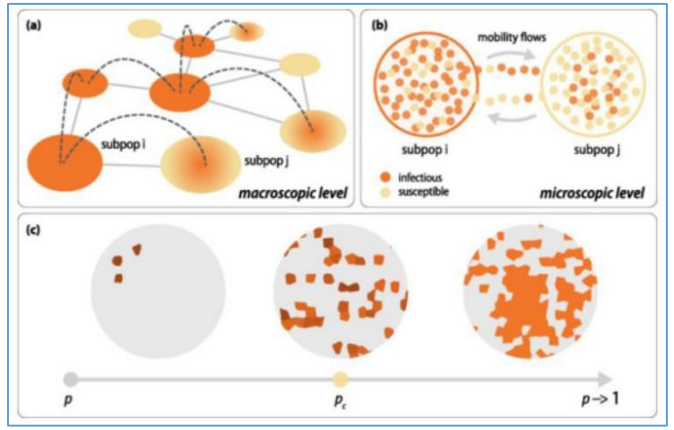


Figure 8

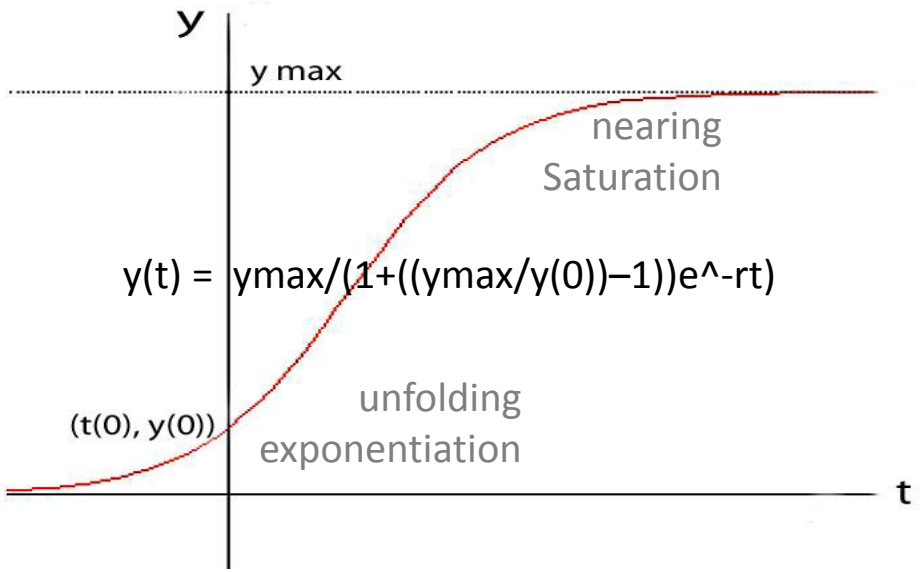




From: "Epidemic processes in complex networks" by Pastor-Satorras, et al, *Rev. Mod. Phys.* 87, 925 – 8/31/15

See also recent work in CNNs, LVars, etc.

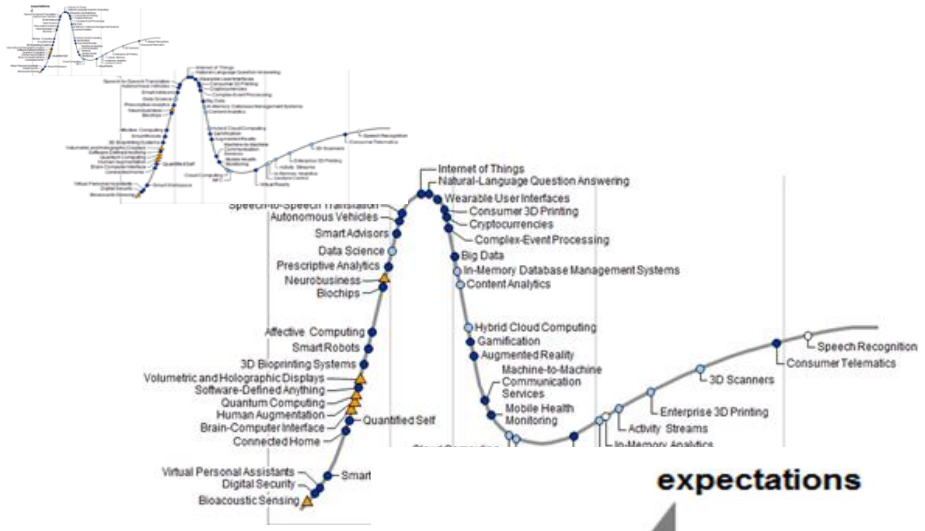
Now, note that the big incoming wave is way more than a few nested logistic ‘epidemic’ processes where each looks something like this:



And even in this simple case, each 2D slice hides tons of what “composes the wave”*

*For more insight into this all this, see Van Quine’s discussion of “the river” in *From A Logical Point of View, Ch.IV.*

Let’s re-slice and zoom into our incoming wave in $4D^{+}$ to gain a better perspective



Meta-ethnomethodology:

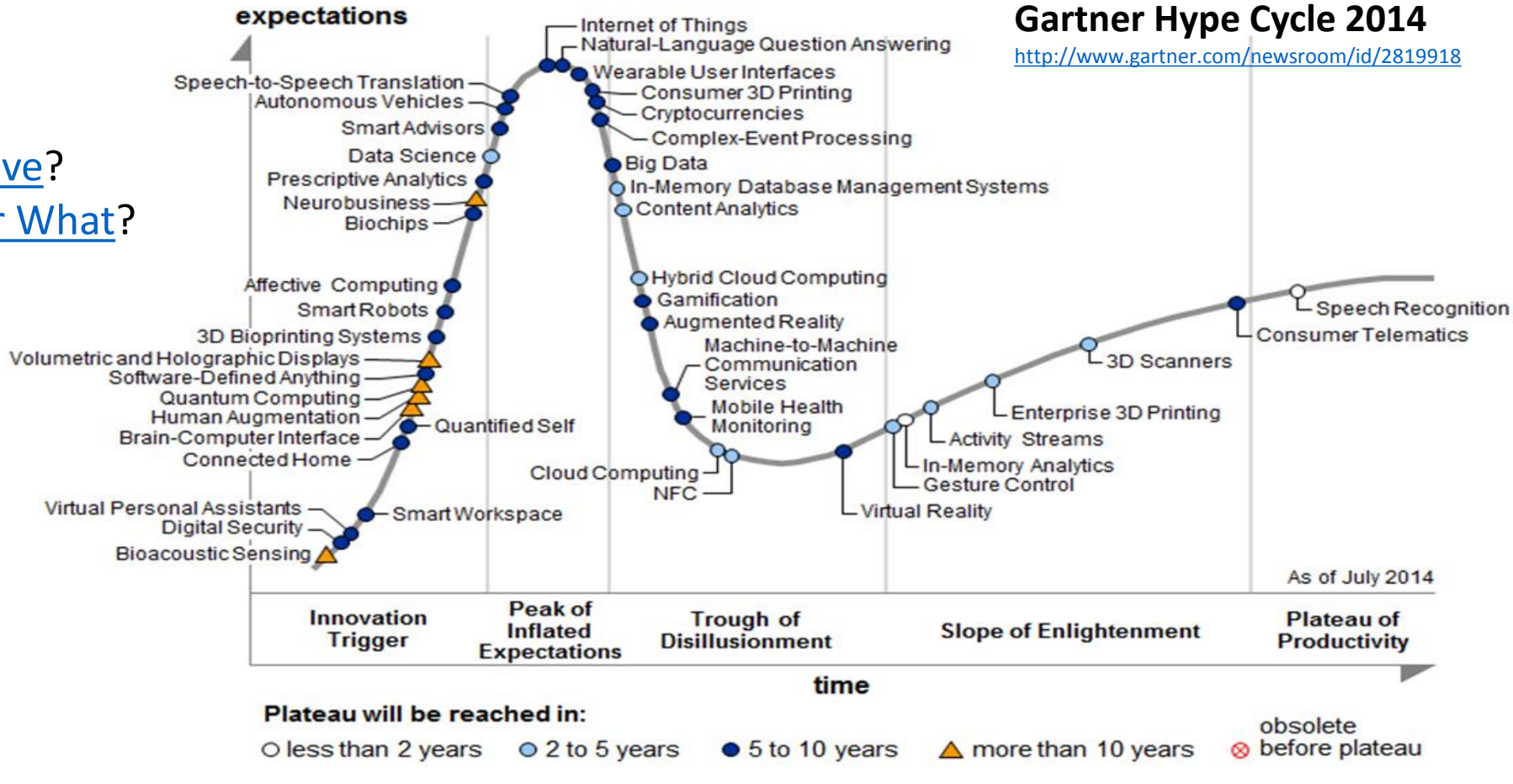
Envisioning the incoming wave of innovation as a time-series of "GHC profiles"(i.e., $2D^+$ slices thru the $3D^+$ wave at increments in time) . . .

Is this a Traveling Wave?
A Standing Wave? Or What?

This stunning video* hints at ways to think about what it all means . . .

*"Water," by Morgan Maasen
http://vimeo.com/90429499

Gartner Hype Cycle 2014
http://www.gartner.com/newsroom/id/2819918



Zooming-in, these processes seem remarkably similar to the workings of the alchemists, i.e., the labyrinths of techno-social processes that evolved and eventually "self-abstracted" into the sciences of chemistry and materials.

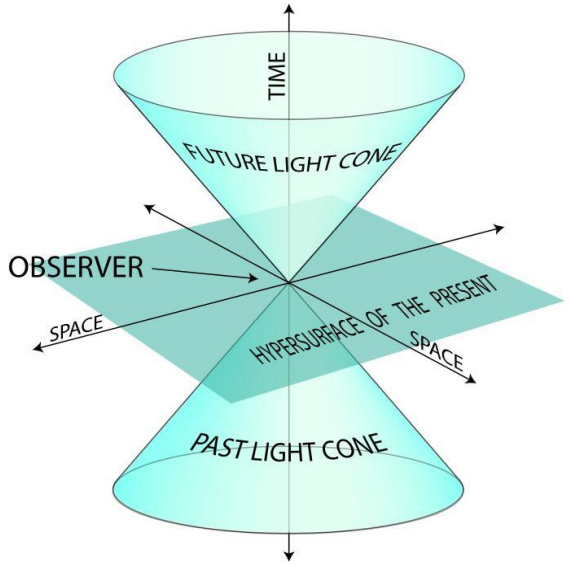
Especially see work at Columbia and Princeton on reenacting the unfolding of medieval European alchemy, in a deep form of hands-on, techno-social reverse-engineering of what happened back then:

The Making and Knowing Project
by Pamela Smith, Columbia (video).

Decoding Alchemy freshman seminar
by Jennifer Rampling, Princeton.

See also Scientiae and the Society for the History of Alchemy and Chemistry (SHAC)

Zooming out, such processes can be visualized as actions partially-bounded within regions of enhanced Minkowski-like $4D^{+}$ techno-social space-time diagrams:



To practice visualizing 4D space-time see Online Resources on 4D like Curved Spaces and 4D Draw

In Conclusion, a Conjecture about possible futures:

By cooperatively generating and sharing ideas for doing **ever-more** with **ever-less**, the incoming wave of techno-social innovation has the stunning potential of:

(1) Sustainably providing **ever-increasing** infrastructural functionality and life experiential-amplification per person,

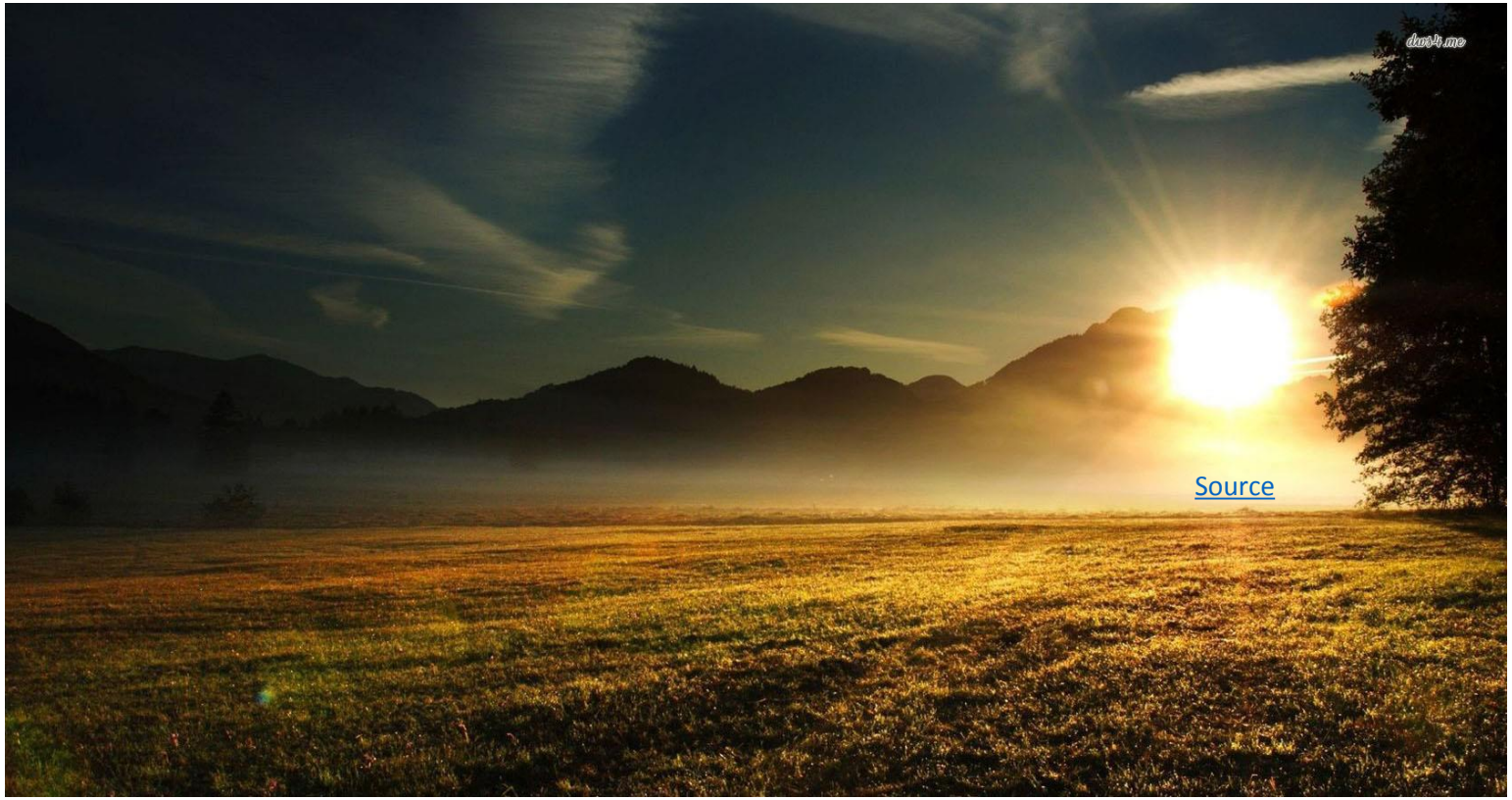
(2) While consuming **ever-decreasing** energy and material resources per person

(3) Thus beginning the **reigning-in** of our unsustainable over-use of planet earth

(4) While simultaneously **opening-up** unprecedented explorations of the greatest frontier . . . the frontier of **what it's possible to do**!

Thus we Begin another Renaissance, as we Enter the Techno-Social Age.

Finally, a personal perspective on “Our Travels Through Time”. . .



“If you want to change the future, start living as if you’re already there!”

– Lynn Conway