Stanford & Silicon Valley

Seeds of the Chain of Events: Clues for Today

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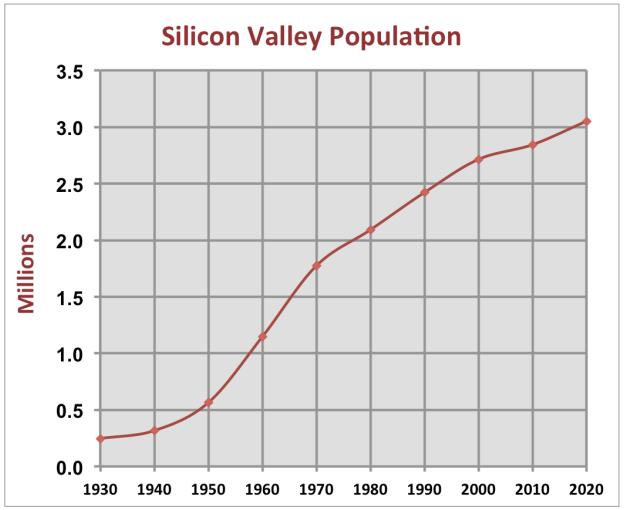
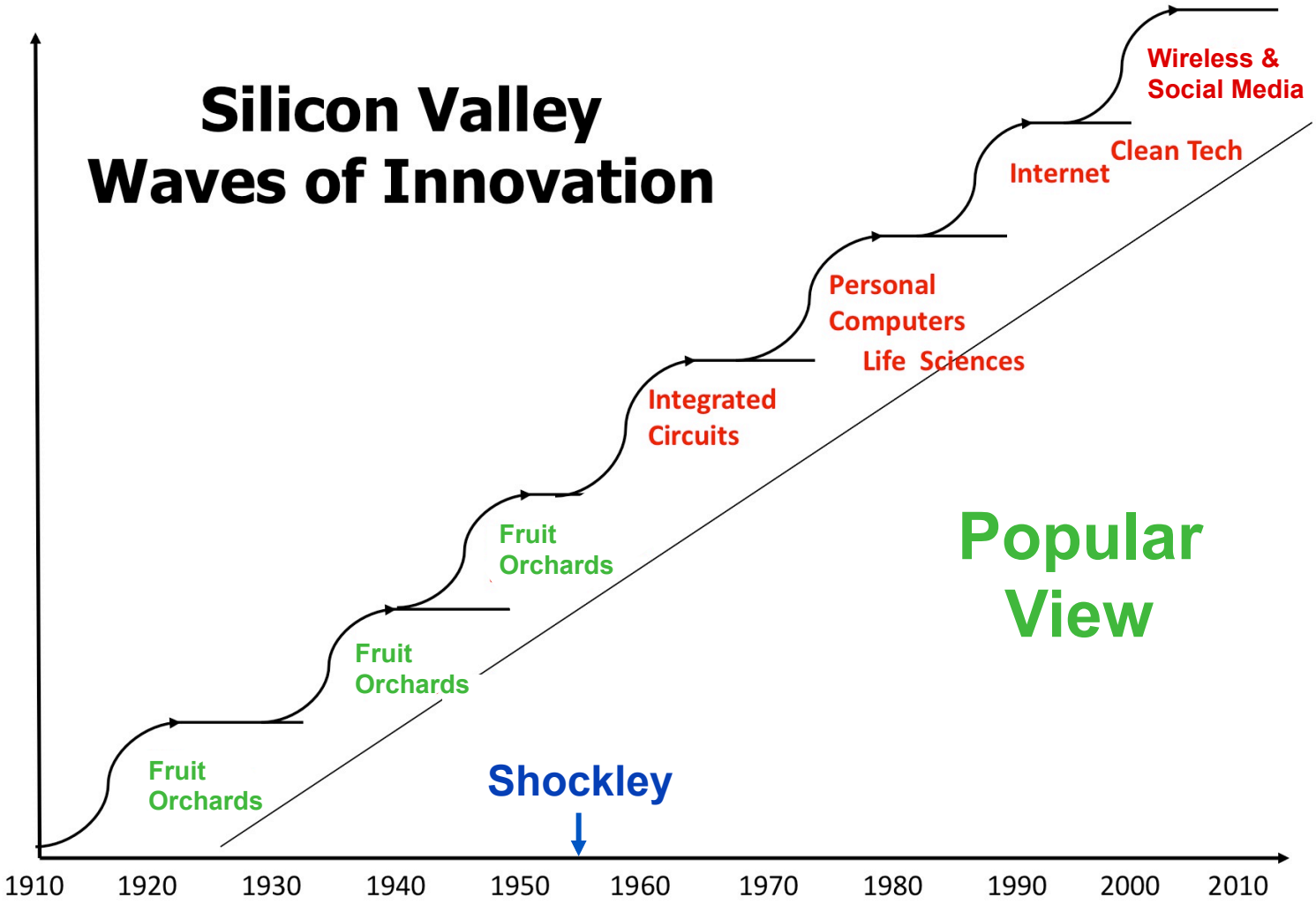
Nov. 10, 2020 ©

W6YX Virtual Meeting

Silicon Valley: Big Started Small

- **Recognized success, its economy > most nations**
  - **Most valuable companies, eminent research university**
  - **Wireless is key: Mobile accounts > world population, + WiFi**
- **How did this happen? It took 100 years**
  - **Started small: 1930s origins, just a few entities & individuals**
  - **Radio for Pacific shipping, microwaves for physics ➔ radar**
- **Environment then: A period of great change**
  - **Depression (Stanford ↓), then WWII**
  - **Patent monopoly, but new physics**
- **Why here? Cooperative culture**
  - **Origin: Amateur radio**
  - **Fostered waves of innovation**
    - Adapted to new opportunities





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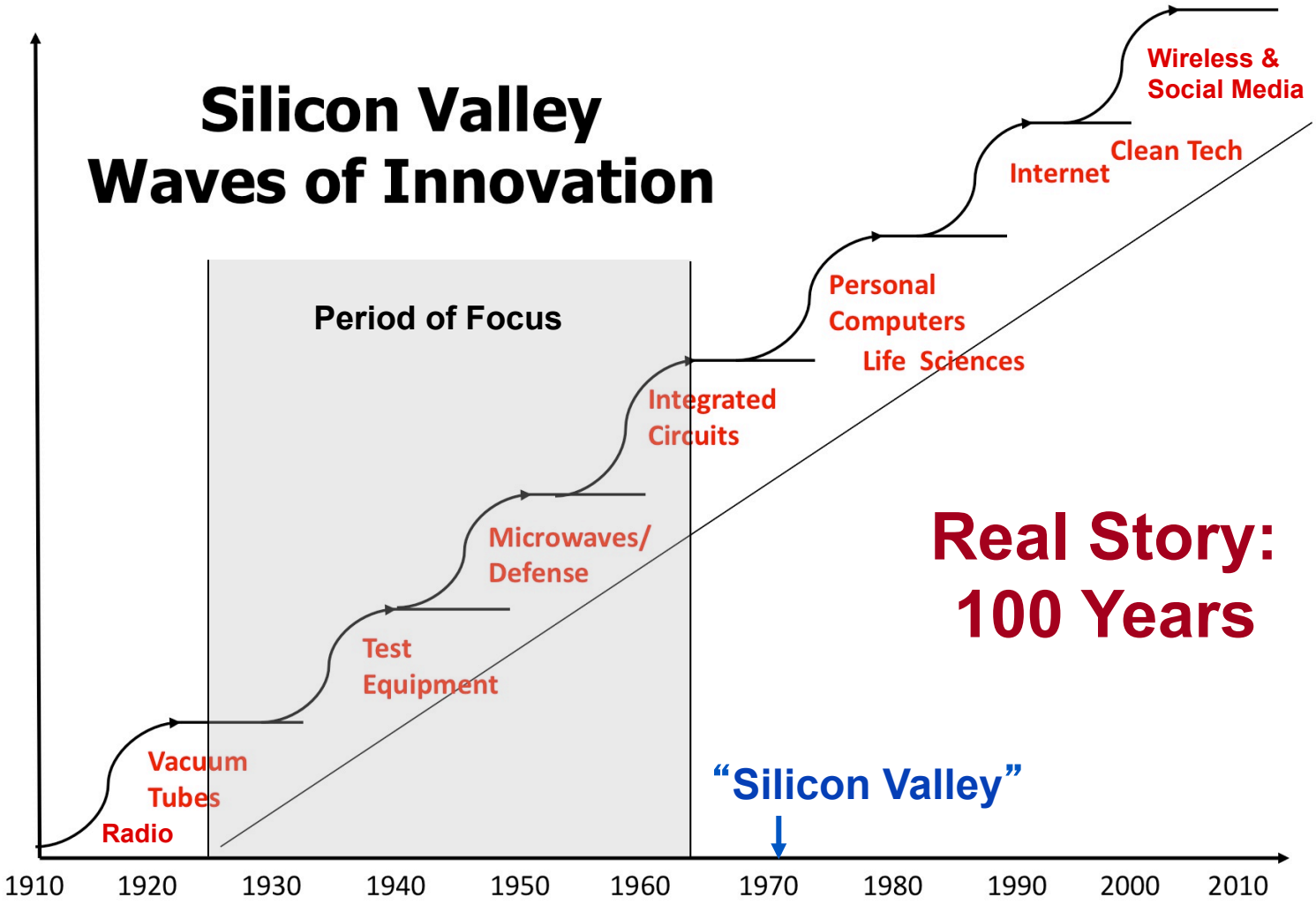

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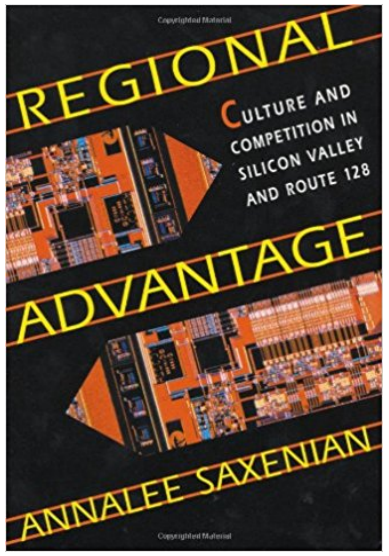
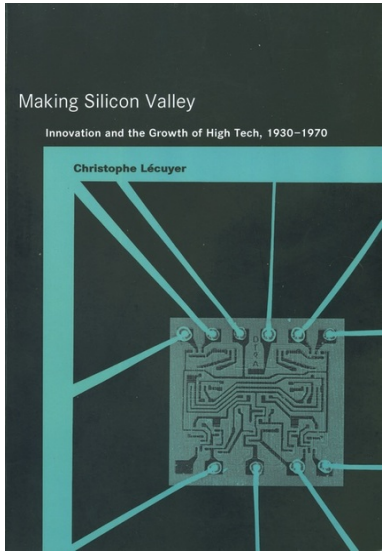
Regional Advantage: The Culture

- **Culture: Entrepreneurs Collaborate**
  - OK to risk, change jobs, fail
  - Employees as partners, owners
  - Reliance on younger managers
  - Local support industry
- **Stanford-industry partnership**
  - Technology, entrepreneurship, patents
  - Microwave inventors: Bell Labs, MIT & Stanford
- **Defense & NASA seed funding**
- **History of willing venture finance**
  - Sponsors reinvest & mentor
- **Climate & Land: room to grow**
- **100-year history of success**
  - Over many product life cycles





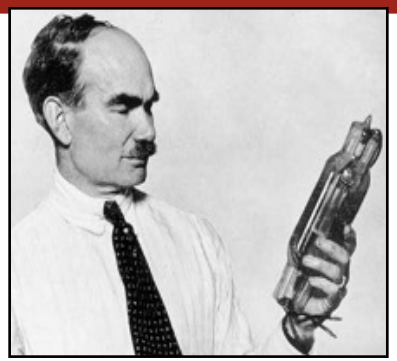
Stanford University

Who Were the Pioneers?

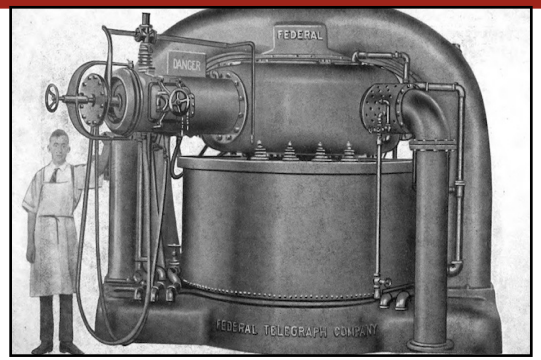
Who?	What?
Cy Elwell	Stanford, founded Federal Telegraph 1909
Ralph Heintz 6AUC	Stanford BS, Heintz & Kaufman, vacuum tubes
Fred Terman 6AE	Stanford prof + WWII Radio Res. Lab (RRL)
Charles Litton 6AO	Stanford BS/MS: Vacuum tube volume mfg. technology, mentor, instructor; Federal spinoff
Bill Eitel 6UF J. McCullough W6CHE	Eimac: Heintz spinoff, vacuum tubes
W.W. Hansen 6CSY	Stanford PhD/prof: "Founder of microwave electronics," initiated linear accelerators
Russell Varian	Stanford BS/MS, Hansen roommate, inventor
David Packard 9DRV Bill Hewlett	Stanford BS/MS/RA, HP founders

What Did They Contribute?

Cy Elwell	**Federal: Poulson arc, de Forest tube, HF radio**
Ralph Heintz 6XB	**Gammatron invention, trained Eitel & McCullough, legal defeat of RCA**
Fred Terman 6AE	**Communications ➔ Stanford, lab, EE texts, aided Hansen microwave, WWII RRL "mgmt. postdoc," postwar staff/$ ➔ Stanford**
Charles Litton 6AO	**Invented glass lathe, instructed & bought tube glass for all, sponsors Packard**
Bill Eitel 6UF **J. McCullough W6CHE**	**Rugged ham power tubes ➔ 2 million tubes for WWII radar**
W.W. Hansen 6CSY	**Invents cavity resonator, klystron, linear accelerator, Doppler radar, NMR; $ ➔ Stanford; WWII Rad Lab/Sperry, postwar Microwave Lab**
Russell Varian	**Family patent tradition ➔ Stanford, invented klystron, founds Varian Assoc. 1948**
David Packard 9DRV **Bill Hewlett**	**Stanford RAs under Terman, Varian & Litton; oscillator patent, found HP 1939**



de Forest



Federal Poulson Arc

Heintz

Litton

Eitel

Hewlett and Packard

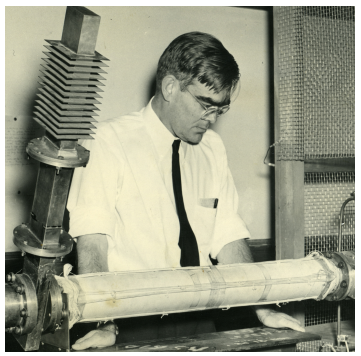
Terman

Hansen

Cavity Resonator

Varian, Hansen with Klystron

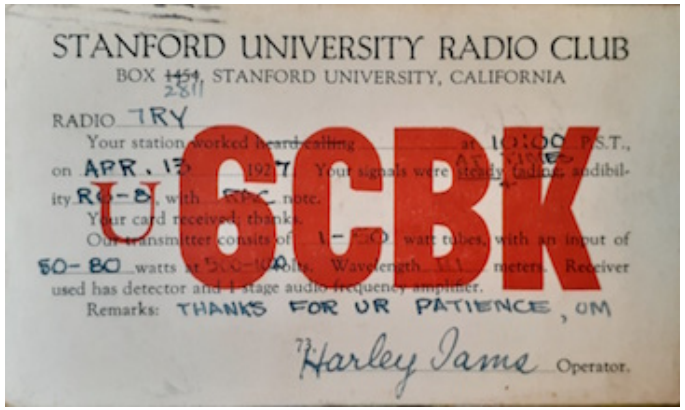
1st Doppler Radar



1st Linear Accel.

Role of Stanford Amateur Radio Club

- **Marconi spark ➔ Poulson arc ➔ Shortwave**
  - › **Hams confined to "200 meters & down," discover it's better**
- **Hoover, Jr., Litton, Packard: Active members**
  - › **Hoover, Jr. 6XH: 1927 International Radiotelegraph Conf.**
    - See C. P. Yeang, "Hobbyist experts," H. Aitken, *Continuous Wave*
  - › **Packard: "No HP but for amateur radio and the club"**
- **Terman, Villard: Faculty advisors**
- **Ham radio launched my own career**



Where Are We Headed?

- Does the Silicon Valley model still work?
  - Original culture & microwaves certainly helped me
  - Continuing new ideas & capital, but institutionalized
  - Complaints: Arrogant , insensitive, expensive & crowded?
- Product life-cycle trends
  - Few ➜ many Big ➜ tiny Fixed ➜ mobile Novel ➜ commodity
  - Hardware ➜ software: Apps on existing infrastructure
- Communications >> Transport
  - Lower energy, instant, simultaneous multiple locations
  - Examples: Zoom, work at home, digital economy
- Wireless is key to mobility, instant communications
  - Internet of Things (IoT): Wireless-centered
  - Nanodevices: Trillions, run on harvested energy

Lessons for the Future

- **Pandemic & its impact on society & economy**
  - **Suddenly changing many things**
  - **Discontinuities create opportunities**
    - Newton to family farm in 1660 plague, discoveries re light, gravity
  - **Do new opportunities parallel 1930s?**
- **Silicon Valley: Monopolies, less cooperative culture**
  - **Can culture be restored or look elsewhere?**
- **Stanford: Now eminent, more conservative**
  - **Less liberal invention & patent policies**
  - **Maintains entrepreneurial focus**
- **Apply lessons from past to guide strategic choices**
  - **What to study, how to find mentors, sponsors**
  - **New opportunities from discontinuities**
  - **Find a supportive culture**

Links for Reference

- **The Uses of Amateur Radio**
  - https://w6yx.stanford.edu/images/Talks/The_Uses_of_Amateur_Radio_Rev2_sm.pdf
- **A Personal View of Silicon Valley: The Central Role of Radio**
  - https:///www.dropbox.com/s/uldazyc0802agni/Radio%20Club%20of%20America_b.pdf?dl=0
- **Microwaves from Stanford to Silicon Valley**
  - https://ethw.org/w/images/9/9c/Presentation20160210-Leeson.pdf
- **Microwaves and Silicon Valley**
  - https://www.dropbox.com/s/30wnmsu8jd64zwl/Microwaves%20and%20Silicon%20Valley_sm.pdf?dl=0
- **“Two Days in August”**
  - https://www.dropbox.com/s/nbrm8rbezcjvgu5/Two%20Days%20in%20August5.pdf?dl=0
- **"Role of Defense Funding in the Making of Silicon Valley”**
  - http:// sccgov.iqm2.com/Citizens/FileOpen.aspx?Type=4&ID=146564&MeetingID=7397, pp. 163-165
- **Gillmor "The 'Prehistory' of Silicon Valley”**
  - https://www.dropbox.com/s/jnsaqbd8atj2juu/The%20%22Prehistory%22%20of%20Silicon%20Valley.pdf?dl=0
- **Wesling "The Origins of Silicon Valley: Roots in Ham Radio”**
  - http://www.pwesling.com/docs/1902-wesling.pdf
- **Blank "Secret History of Silicon Valley”**
  - https://steveblank.com/secret-history/
- **“Silicon Valley Was Built On Tubes of Glass”**
  - https://hackaday.com/2017/11/02/silicon-valley-was-built-on-tubes-of-glass/

Additional References

- Norberg, “The Origins of the Electronics Industry on the Pacific Coast”
  - https://ieeexplore.ieee.org/document/1454590
- Leslie “How the West Was Won: The Military and the Making of Silicon Valley”
  - https://ethw.org/w/images/0/0b/Leslie%2C_How_the_West_Was_Won.pdf
- Leslie "Playing the education game to win: the military and interdisciplinary research at Stanford,”
  - https://www.jstor.org/stable/27757596
- Leslie and Kargon, "Selling Silicon Valley: Frederick Terman’s model for regional advantage,”
  - https://jhu.pure.elsevier.com/en/publications/selling-silicon-valley-frederick-termans-model-for-regional-advan-3
- Adams "Regionalism in Stanford's contribution to the rise of Silicon Valley;" “Before the garage: the innovation system that produced Silicon Valley;” “Stanford and Silicon Valley: Lessons on becoming a high-tech region;” “Stanford University and Frederick Terman's blueprint for innovation in the knowledge economy;” “Follow the money: Engineering at Stanford and UC Berkeley during the rise of Silicon Valley;” “Growing where you are planted: Exogenous forces and the seeding of Silicon Valley”
  - http://faculty.salisbury.edu/~sbadams/research.htm
- Adams "Arc of Empire: The Federal Telegraph Company, the U.S. Navy, and the Beginnings of Silicon Valley”
  - https://www.cambridge.org/core/journals/business-history-review/article/arc-of-empire-the-federal-telegraph-company-the-us-navy-and-the-beginnings-of-silicon-valley/8E97CE58CB8D6DE9FF741D1D2C1BD3E6

Books and Courses

- C. Lécuyer, *Making Silicon Valley: Innovation and the Growth of High Tech*, 1930-1970 (MIT Press, 2006)
- T. J. Sturgeon, "How Silicon Valley Came to Be," in *Understanding Silicon Valley: The Anatomy of an Entrepreneurial Region*, ed. Martin Kenney (Stanford: Stanford University Press)
- A. Saxenian, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128* (Cambridge, Mass.: Harvard University Press, 1994)
- C. S. Gillmor, *Fred Terman at Stanford: Building a Discipline, a University, and Silicon Valley*. (Stanford, CA: Stanford University Press, 2004)
- Course: Perspectives on Silicon Valley
  - https://www.owlnet.rice.edu/~Cyrus.Mody/History_417.htm

- Author Note: There are many other presentations, papers, books and online references about the history of Silicon Valley. The author acknowledges access to many more than are listed here, as well as in-person access to archives at Stanford, MIT, National Archives, Hagley Library, and other online archives too numerous to detail here. Also, discussions with authors and archivists are gratefully acknowledged, as is the opportunity to experience personally over sixty years of the emergence of Silicon Valley.