

The Convergence

Past, Present and Future

A brief History of Innovation (in the West)

Piero Scaruffi

Silicon Valley

January 2018

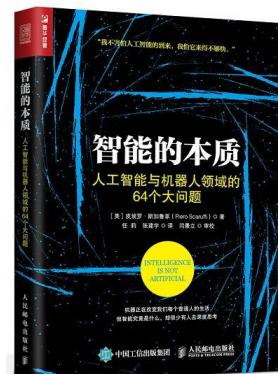
Piero Scaruffi



- 30+ years in Silicon Valley
- Written 20+ books
- Pioneered A.I. and Internet applications



- Founded international inter-university programs (LASERs, LAST)
- Interdisciplinary research at Stanford, UC Berkeley, etc



A History of Innovation

Some examples

What do these places have in common?

- ❑ Mainz, Germany, 1456
- ❑ Manchester, England, 1776
- ❑ New England, USA, 1834
- ❑ Hanover, Germany, 1866
- ❑ Detroit, USA, 1900s
- ❑ Cambridge, Britain, 1940s
- ❑ Silicon Valley, today

There is a need...

There is a society...

... and then some technologies converge...

A History of Innovation

1. Mainz, Germany



A History of Innovation

1. Mainz, Germany, 1456

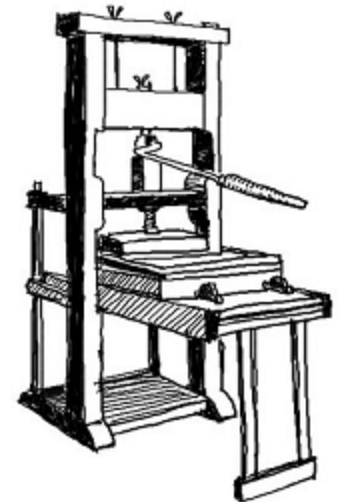
- Need:
 - Boom of universities and commerce has greatly increased demand for books
- Traditional solution: manual copy
- Society:
 - Mainz: Germany's wine capital
 - Frankfurt: Germany's largest fair
 - Rhein river: main trading route (north to south Europe)
 - Paper-mill (Nuremberg)



A History of Innovation

1. Mainz, Germany

- Johannes Gutenberg's Printing Press (1456)
 - Wood block engraving +
 - Raised letters (coinage) +
 - Wine press +
 - Paper +
 - Oil-based inks +
 - Goldsmithing



A History of Innovation

1. Mainz, Germany

Printing Press

The effect: The multiplication of knowledge

A History of Innovation

2. Manchester, England, 1776



A History of Innovation

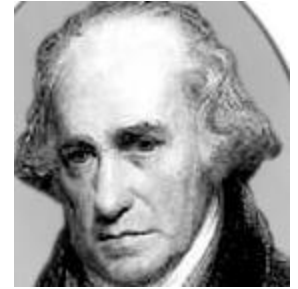
2. Manchester, England

- Need: pumping water out of coal mines (boom of factories causes high demand for iron and iron has to be smelt with coal)
- Traditional solution: horses
- Society:
 - Birmingham's Lunar Society promotes the importance of machines (James Watt's steam engine, William Murdoch's gaslight, John Wilkinson's cast-iron boat...)
 - Water mills
 - Liverpool's port
 - 200 years of clock-making

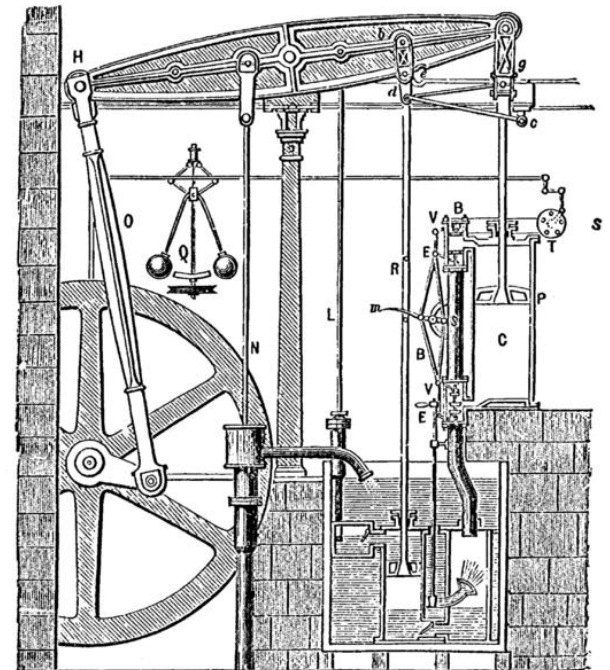


A History of Innovation

2. Manchester, England



- James Watt's steam engine (1776)
 - Mill engineering +
 - Clock engineering +
 - Evangelista Torricelli's barometer +
 - Robert Boyle's vacuum pump +
 - Denis Papin's piston and cylinder



A History of Innovation

2. Manchester, England

Printing Press

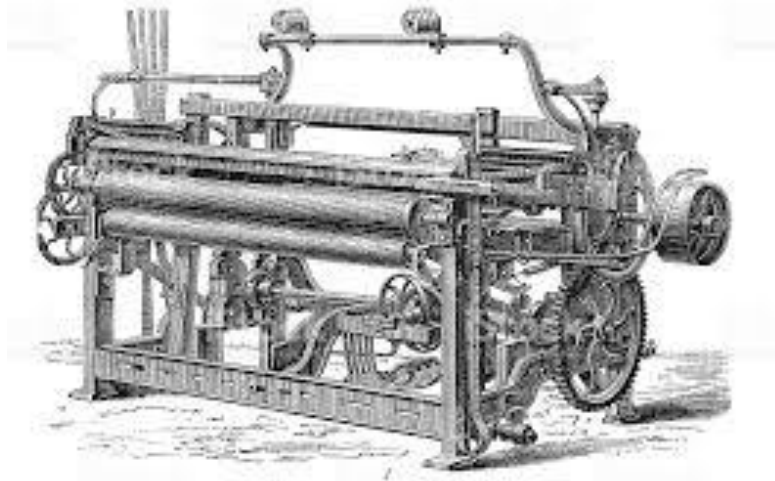
The effect: The multiplication of knowledge

Steam Engine

The effect: The multiplication of goods

The 1st Industrial Revolution

1. Mechanized factory (mechanical loom)



A History of Innovation

3. Hanover, Germany, 1866



A History of Innovation

3. Hanover, Germany

- Need: more powerful engine for transportation
- Traditional solution: steam engine

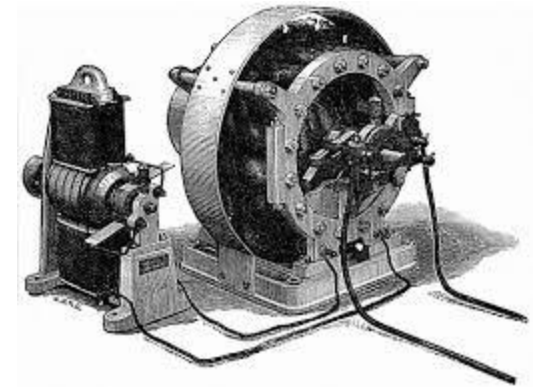


- Society:
 - A separate kingdom, not British and not Prussian
 - Communist Manifesto (1948)
 - Gründerzeit
 - Social democracy (first independent workers' party)
 - Alexander von Humboldt's education reform in Prussia

A History of Innovation

3. Hanover, Germany

- Werner Siemens' dynamo – electric motor (1866)
 - Iron technology +
 - Electromagnets (Joseph Henry) +
 - Battery (Alessandro Volta)



A History of Innovation

3. Hanover, Germany

Printing Press

The effect: The multiplication of knowledge

Steam Engine

The effect: The multiplication of goods

Electric motor

The effect: The multiplication of energy

A History of Innovation

4. Detroit, USA, 1900s



A History of Innovation

4. Detroit, USA, 1900s

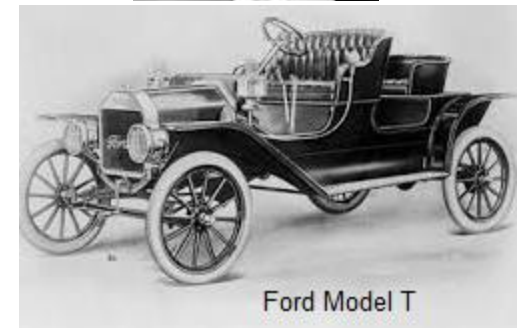
- Need: personal transportation
- Traditional solution: horse-drawn carriage
- Society:
 - Michigan is the center for carriage and wagon manufacturing thanks to its forests
 - Great Lakes trade
 - Detroit is “the Far West” in the 19th century
 - German, Dutch, Polish, Irish immigrants + French Canadians + Blacks
 - Progressivism (Detroit mayor Hazen Pingree’s reform coalition)



A History of Innovation

4. Detroit, USA

- Detroit's car
 - Bicycle technology (steel tubes, differential gearing, chain drive, rubber tyres) +
 - Carriage/ wagon design +
 - Electrical machinery (Charles Kittering's electric starter) +
 - Synthetic paint (General Motors)
- and later:
 - Radio
 - A/C
 - ...



A History of Innovation

4. Detroit, USA

Printing Press

The effect: The multiplication of knowledge

Steam Engine

The effect: The multiplication of goods

Electric motor

The effect: The multiplication of energy

Automobile

The effect: The multiplication of transportation

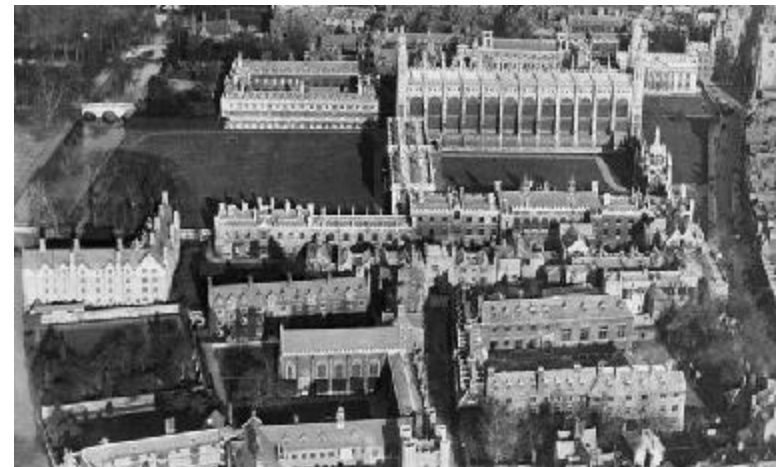
The 2nd Industrial Revolution

1. Mechanized factory (mechanical loom)
2. Automated factory (assembly line)



A History of Innovation

5. Cambridge, Britain, 1940s



A History of Innovation

5. Cambridge, Britain, 1940s

- Need: fast code-breaking for World War II
Traditional solution: “programmers” (mathematicians)



- Society:
 - Bletchley Park
 - Ratio Club

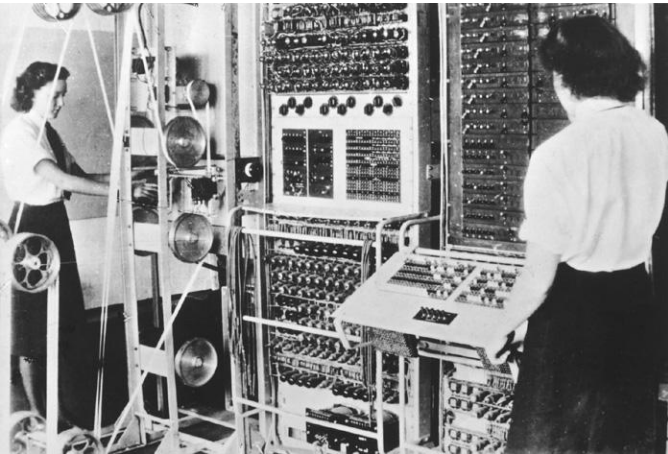
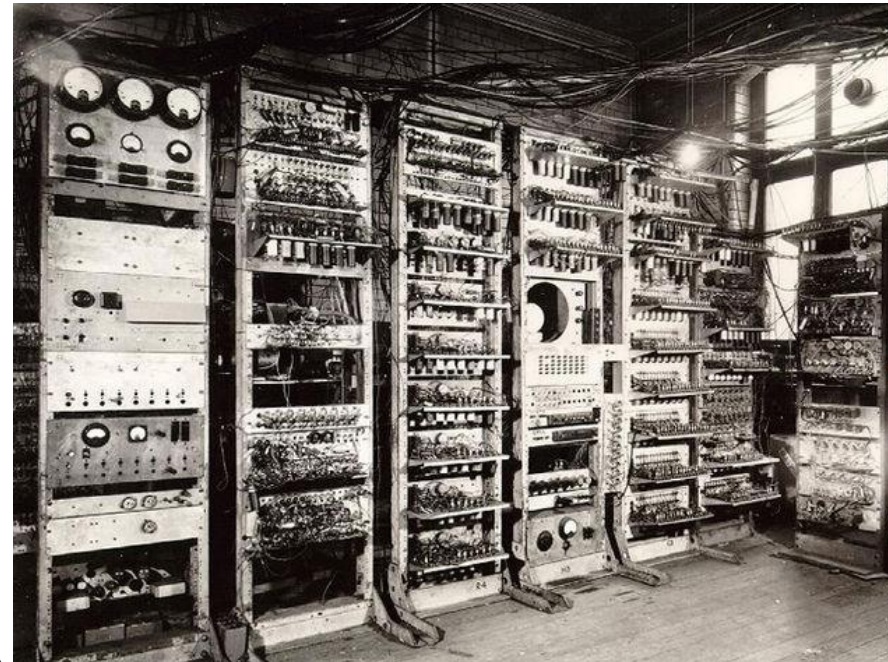


A History of Innovation

5. Cambridge, Britain

- The digital electronic programmable computer
 - Logic (Alan Turing) +
 - Information Theory (Claude Shannon) +
 - Cybernetics (Norbert Wiener) +
 - Vacuum tubes (electronics) +
 - Cathode-ray tubes +
 - Teletype printer

The EDSAC (1949)



Colossus (1943)

A History of Innovation

5. Cambridge, Britain

Printing Press

The effect: The multiplication of knowledge

Steam Engine

The effect: The multiplication of goods

Electric motor

The effect: The multiplication of energy

Automobile

The effect: The multiplication of transportation

Computer

The effect: The multiplication of services

P.S.: Cambridge was a truly amazing place

1948: Alan Turing's "Intelligent Machinery" (later better known for the "Turing Test")



A. M. Turing (1950) *Computing Machinery and Intelligence*. *Mind* 49: 433-460.

COMPUTING MACHINERY AND INTELLIGENCE

By A. M. Turing

I. The Imitation Game

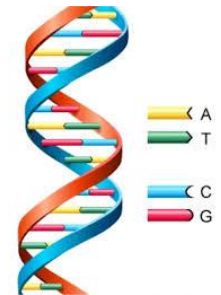
I propose to consider the question, "Can machines think?"

1953: Francis Crick and James Watson discover the double helix of DNA



James Watson and Francis Crick

Rosalind Franklin



The 3rd Industrial Revolution

1. Mechanized factory (mechanical loom)
2. Automated factory (assembly line)
3. Computerized factory (numeric control)



FIGURE 7.2 NC system showing machine tool and controller. (Courtesy of Bridgeport Machines Division of Tiedman Inc.)

A History of Innovation after 1950

Needs:

- ❑ Embedded computation (computation in every device)
 - ❑ Personal computation (computation at home)
 - ❑ Global communication (communicate with everybody)
 - ❑ Global access (access everything from one device)
 - ❑ Bioinformatics (computation for health)



A History of Innovation

6-10. Silicon Valley



Silicon Valley in 1950



The Society: Why Silicon Valley?



The Society: Why Silicon Valley?

- The technology, the money and the brains were on the East Coast and in Europe
- The great universities were on the East Coast (MIT, Harvard, Moore School, Princeton, Columbia), and in Europe (Cambridge)
- The electronic giants were on the East Coast (Bell Labs, RCA Labs, IBM Labs, GE labs...)
- Britain and Germany won most of the Nobels



The Society: Why Silicon Valley?

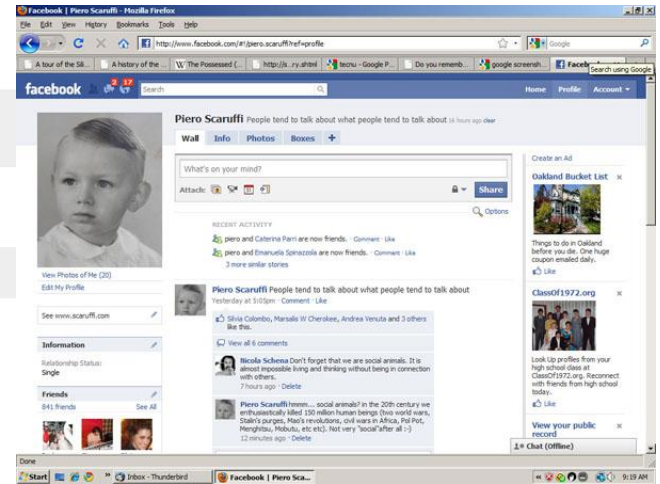
- The official history of Silicon Valley
 - Defense/DARPA
 - Fred Terman at Stanford and Stanford Industrial Park
 - William Shockley's lab
 - Fairchild/Intel/semiconductors
 - Xerox PARC, SRI Intl/computer-human interface
 - Apple, personal computing, videogames
 - Unix, Internet, Relational databases
 - The dotcoms
 - Google, Facebook, Twitter... social networking
 - Airbnb, Uber... sharing economy
 - AI, VR, Biotech...

The Society: Why Silicon Valley?

- What Silicon Valley does not do...
 - **Not** invented here: computer, transistor, integrated circuit, robots, Artificial Intelligence, programming languages, databases, videogames, Internet, personal computers, World-wide web, search engines, social media, smartphones, wearable computing, space exploration, electrical cars, driverless cars...

The Society: Why Silicon Valley?

- What Silicon Valley does best
 - Invented here: disrupting products



Silicon Valley takes inventions and turns them into disruptive technologies



The Society: Why Silicon Valley?

- The San Francisco Bay Area is a unique society that promotes **independent creative interdisciplinary** thinking



disrupting writers...



disrupting music...

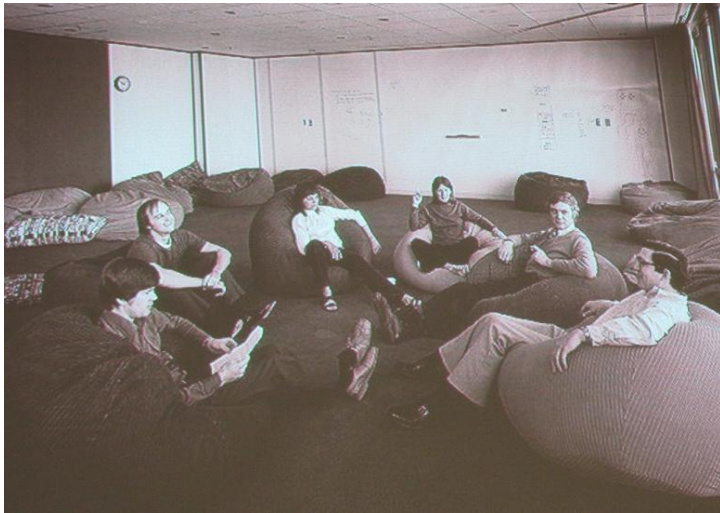


disrupting art...



The Society: Why Silicon Valley?

- The San Francisco Bay Area is a unique society that promotes **independent creative interdisciplinary** thinking



Xerox PARC (first desktop, GUI, Ethernet, etc)

The disruptors

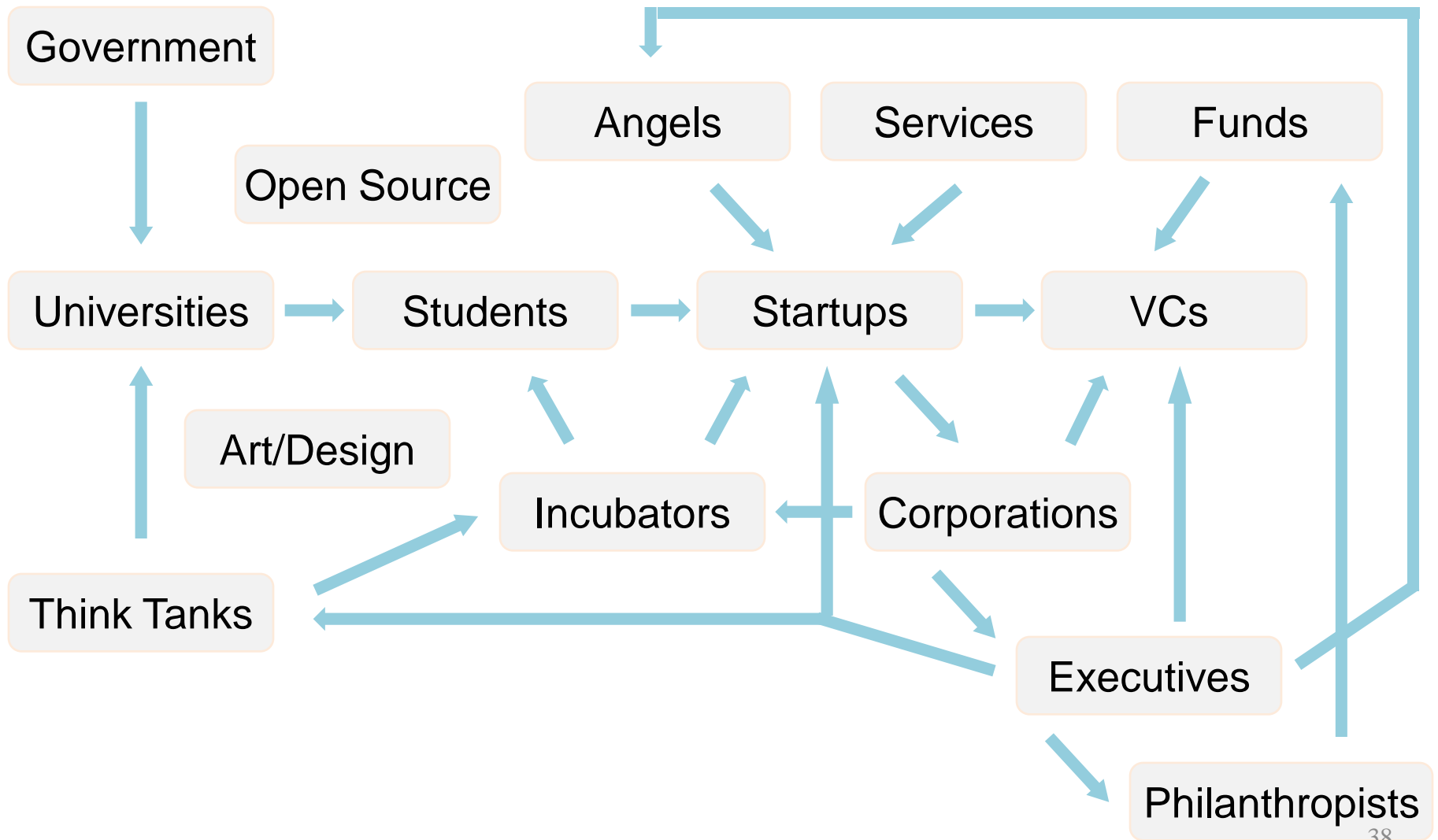


Doug Engelbart
at SRI (first
Internet and GUI
demo)



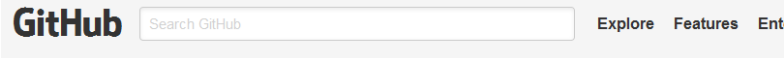
Steve Wozniak
(Homebrew Club
and Apple)

Welcome to Silicon Valley



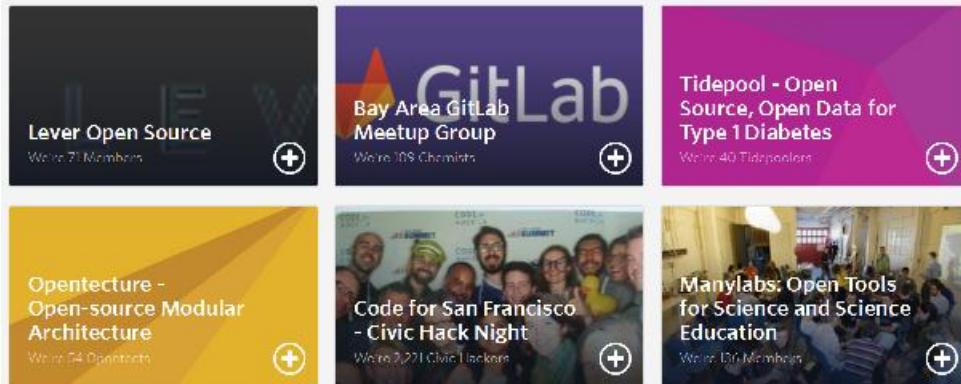
Innovation in Silicon Valley

- Open source



Explore GitHub

Trending repositories



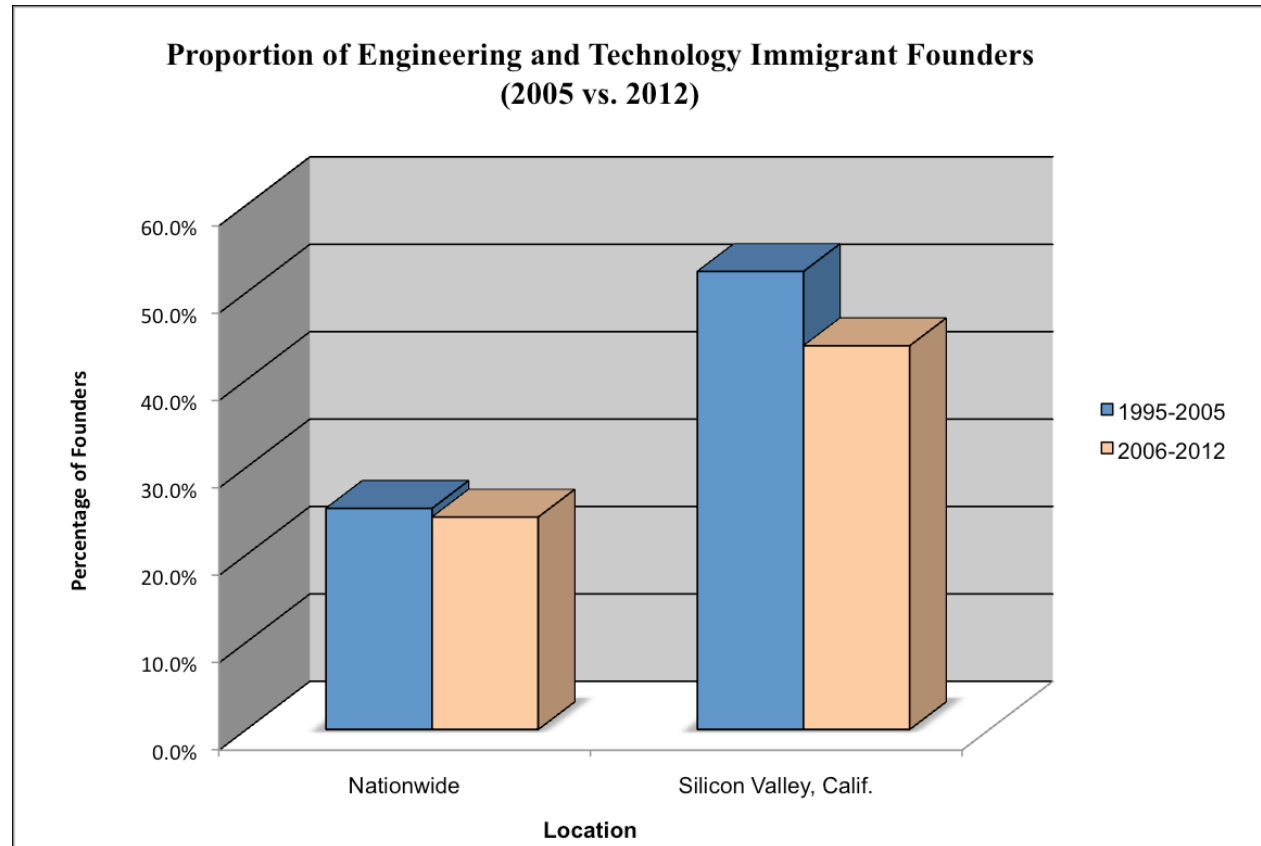
Trending

See what the GitHub community is most excited about today.



Innovation in Silicon Valley

- The contribution of immigrants



Example: who invented Deep Learning (modern Artificial Intelligence)?

Kunihiko Fukushima: Japan

Hava Siegelmann: Israel

Sepp Hochreiter: Germany

Juergen Schmidhuber: Switzerland

Yann LeCun: France

Geoffrey Hinton: Britain/ Canada

Yoshua Bengio: France/ Canada

Andrew Ng: China

Daniela Rus: Romania

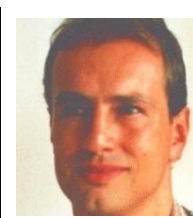
Fei-fei Li: China

Sebastian Thrun: Germany

DeepMind: Britain/ New Zealand

Ilya Sutskever: Russia

Quoc Le: Vietnam











































Innovation in Silicon Valley

- Silicon Valley specialized in “global brand value”, not in revenues

Largest companies by revenue

Wal-Mart Stores	485.65
Sinopec	433.31
Royal Dutch Shell	385.63
PetroChina	367.85
Exxon Mobil	364.76
BP	334.61
Toyota Motor	248.95
Volkswagen	244.81
Glencore	209.22
Total	194.16
Chevron	191.76

Best Global Brands 2017 Rankings **Interbrand**

01  +3% 184,154 \$m	02  +6% 141,703 \$m	03  +10% 79,999 \$m	04  -5% 69,733 \$m	05  +29% 64,796 \$m	06  +9% 56,249 \$m	07  -6% 50,291 \$m	08  +48% 48,188 \$m
09  +10% 47,829 \$m	10  -11% 46,829 \$m	11  +3% 44,208 \$m	12  +5% 41,533 \$m	13  0% 41,521 \$m	14  +5% 40,772 \$m	15  +7% 39,459 \$m	16  +3% 31,930 \$m
17  +3% 27,466 \$m	18  +8% 27,021 \$m	19  -4% 22,919 \$m	20  +3% 22,696 \$m	21  +6% 22,635 \$m	22  +1% 20,491 \$m	23  -10% 20,488 \$m	24  +11% 18,573 \$m
25  +4% 18,472 \$m	26  -9% 18,200 \$m	27  -8% 17,787 \$m	28  +2% 16,416 \$m	29  +7% 16,387 \$m	30  +11% 15,749 \$m	31  +2% 15,375 \$m	32  +11% 14,210 \$m
33  +5% 13,643 \$m	34  +1% 13,224 \$m	35  +5% 13,193 \$m	36  +1% 12,661 \$m	37  +4% 12,471 \$m	38  +2% 12,023 \$m	39  +4% 11,534 \$m	40  +1% 11,522 \$m

Innovation in Silicon Valley

- “Moonshot” projects

YESTERDAY:



The PC at Xerox PARC



The Internet at SRI Intl

TODAY:



Innovation in Silicon Valley

*The convergence of different technologies
multiplies creativity and makes the
impossible possible*

Convergence/ Disruption

- Semiconductors
 - Personal Computing
 - Dotcoms
 - Smartphone
 - Biotech

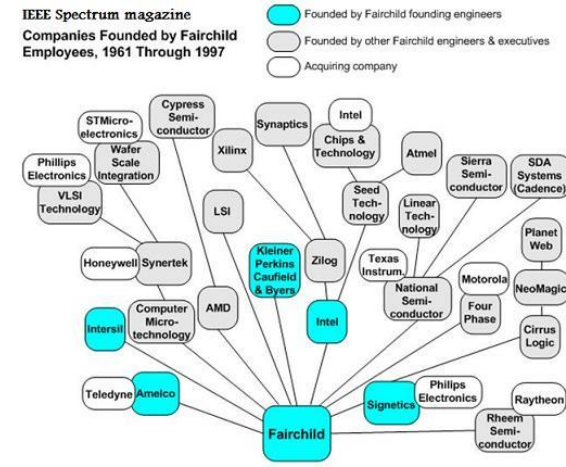
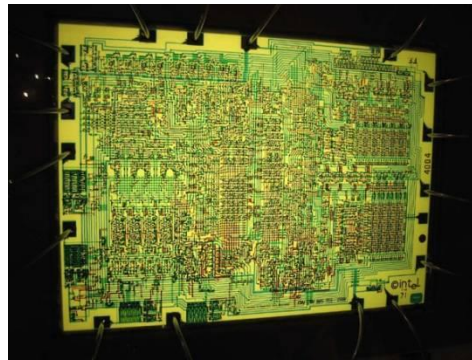
1960 1970 1980 1990 2000 2010



A History of Innovation

6. Silicon Valley

- Silicon Valley1: The Semiconductor Disruption
 - Convergence of: Electronics (Fred Terman) + Physics (William Shockley, Robert Noyce, Jean Hoerni, Federico Faggin) + Chemistry (Gordon Moore, Andrew Grove) + Photography (planar process) + Material science (Sheldon Roberts) + Mechanical engineering (Eugene Kleiner) + Mathematics (Marcian Hoff)



A History of Innovation

7. Silicon Valley

- Silicon Valley 2: The Personal Computing Disruption
 - Convergence of: computer + CRT video + office automation + gaming + cassette tape + modem + email + ...



A History of Innovation

8. Silicon Valley

- Silicon Valley 3: The “Dotcom” Disruption
 - Convergence of: computer + fiber optics + Internet + document management + brick & mortar economy



A History of Innovation

9. Silicon Valley

- Silicon Valley 4: The Smartphone Disruption
 - Digital convergence of the **2000s**: Information Technology + Telecommunication + Mobile phone + GPS + Digital camera + Entertainment



A History of Innovation

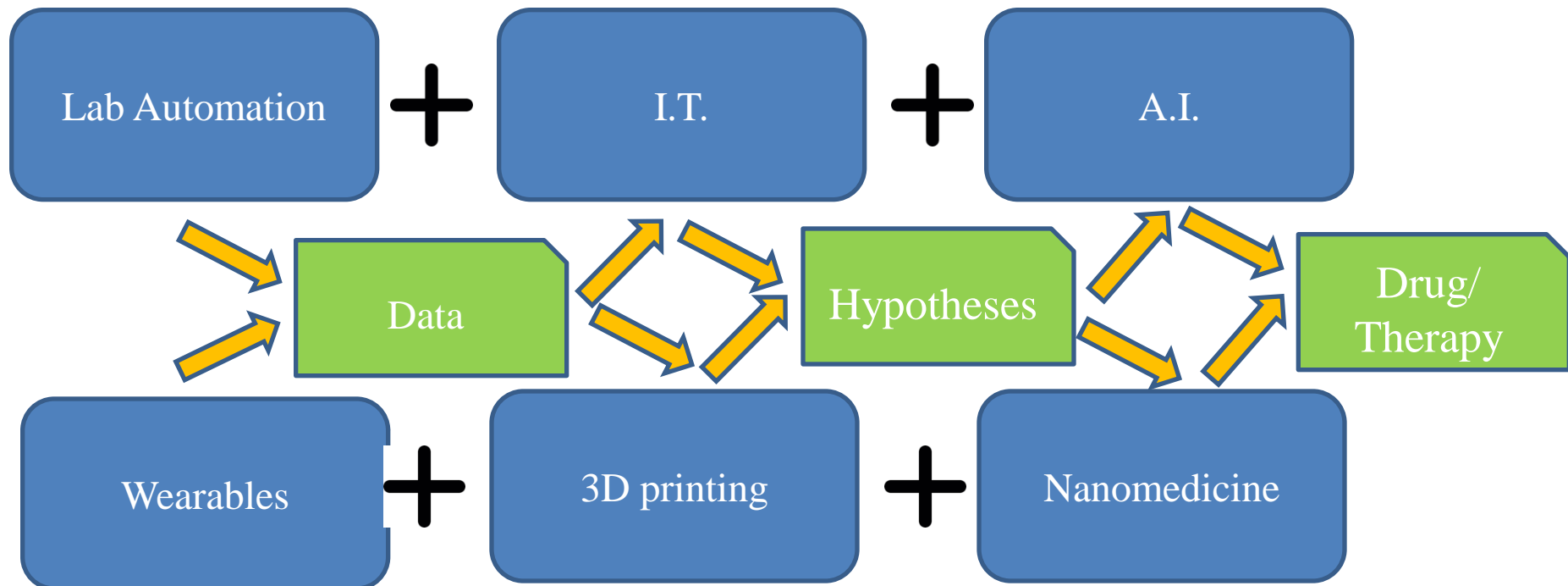
10. Silicon Valley

- Silicon Valley 5: The Biotech Disruption
 - Convergence of: Information Technology + Lab Automation + Big Data + A.I. + Wearables + Genetics
- ❖ Personal Genomics
- ❖ Genome editing (TALEN, CRISPR)
- ❖ Gene therapies (CAR-T)
- ❖ “Designer babies” (PGD, IVG)

A History of Innovation

10. Silicon Valley

- Silicon Valley 5: The Biotech Disruption
 - Convergence of: Information Technology + Lab Automation + Big Data + A.I. + Wearables + Nanotech + 3D printing



A History of Innovation

6-10 Silicon Valley, USA

Printing Press: The multiplication of knowledge

Steam Engine: The multiplication of goods

Electric motor: The multiplication of energy

Automobile: The multiplication of transportation

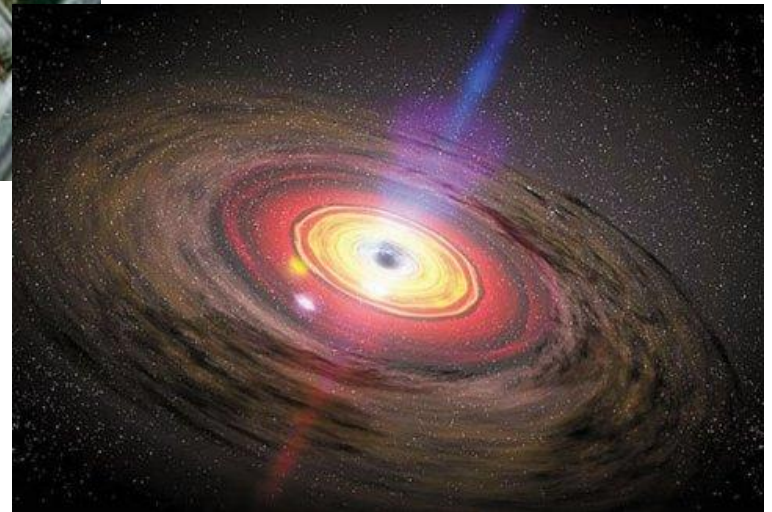
Computer: The multiplication of services

Silicon Valley: The multiplication of digitization



The Future of Innovation

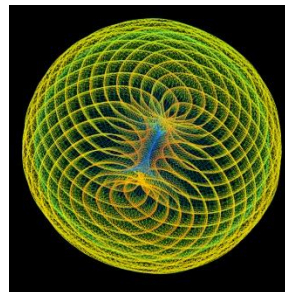
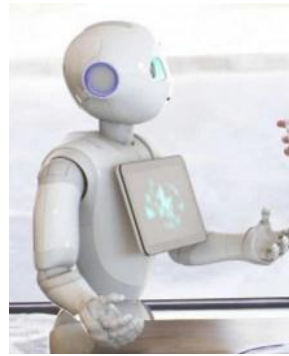
- The three-dimensional convergence...



Technologies that will shape the 21st century



- Artificial Intelligence
- Virtual Reality
- Nanotech
- Biotech
- 3D Printing/ Wearables
- Space/drones
- Internet of Things
- Fintech/Blockchain
- Big Data
- Sharing Economy

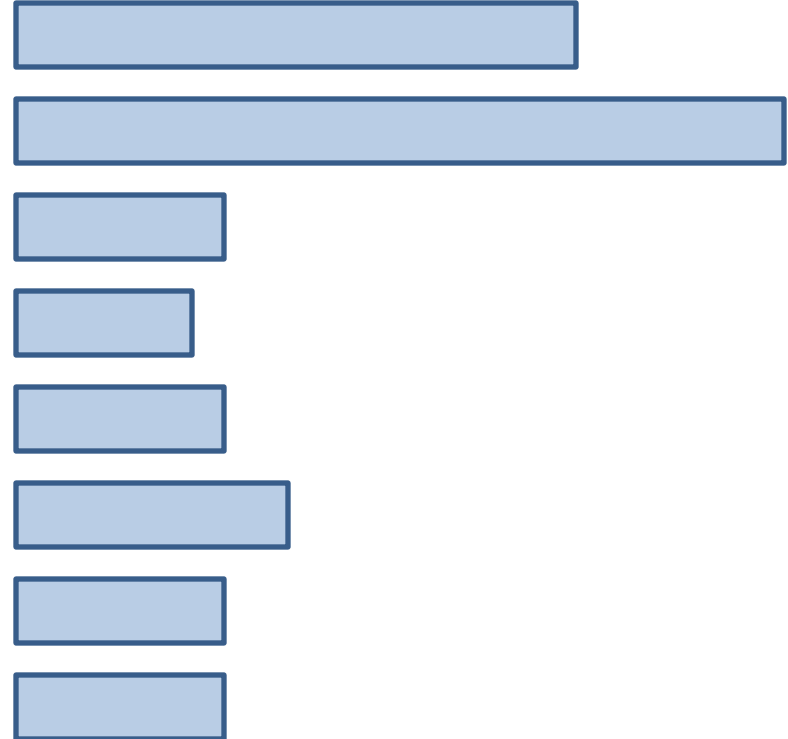


2016

Nvidia Tesla P100 for deep learning

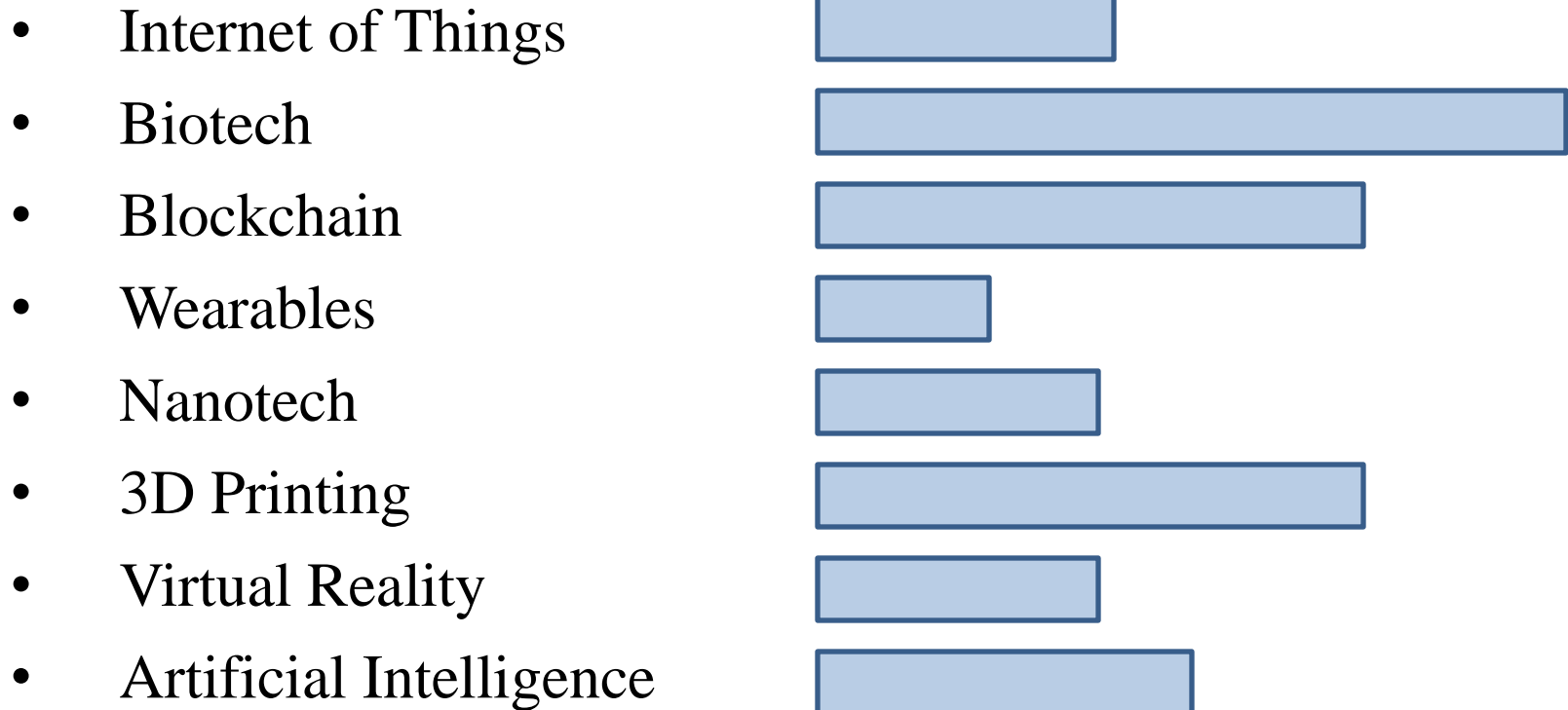
Business Opportunity

- Internet of Things
- Biotech
- Blockchain
- Wearables
- Nanotech
- 3D Printing
- Virtual Reality
- Artificial Intelligence



My personal opinion:
business opportunity in the
next 5 years

Disruptive Potential



My personal opinion:
disruptive potential

The 3D Convergence

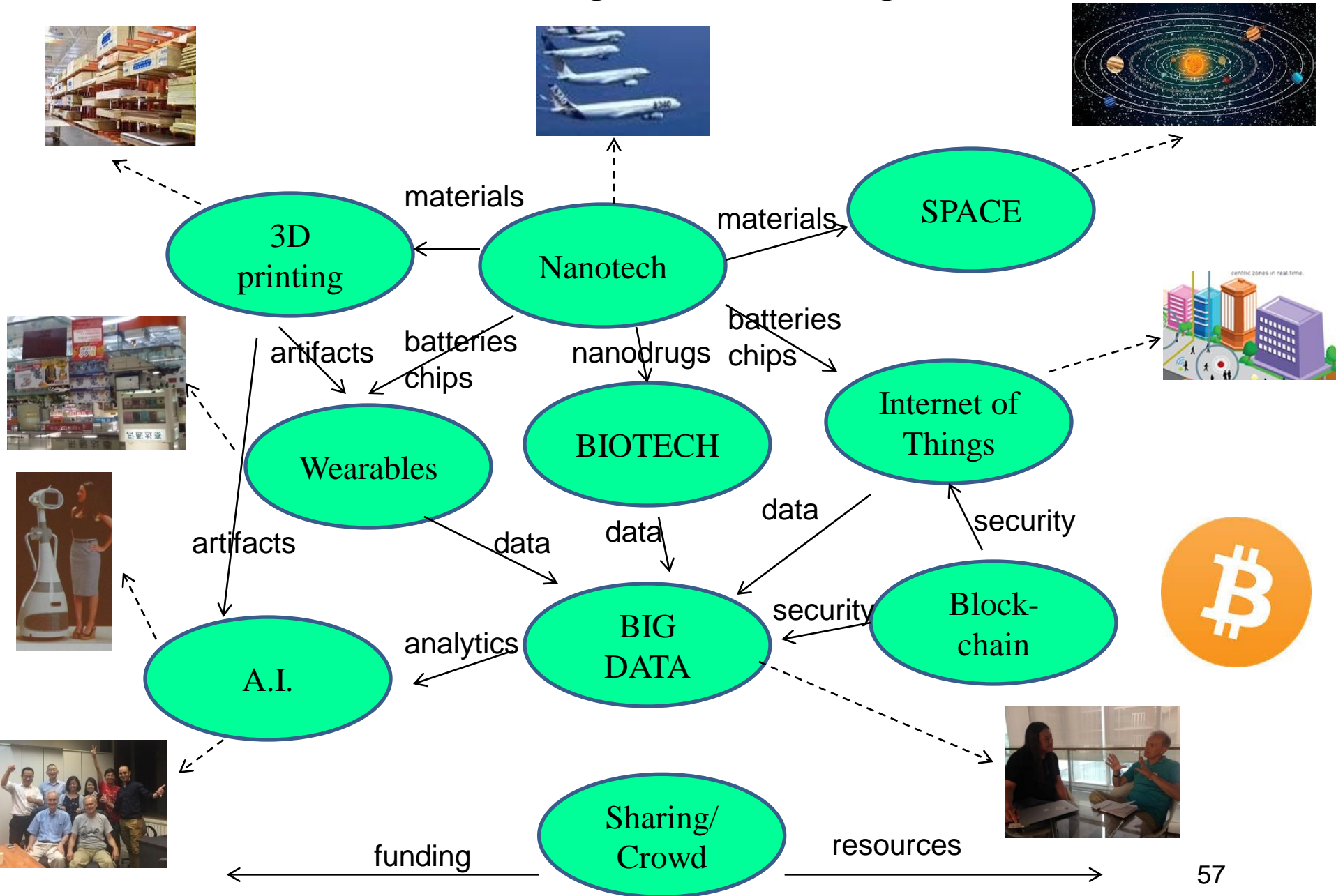
Three parallel kinds of convergence:

1. What happens when these technologies interact?
2. Coexistence of the digital and physical world
3. Art and Humanities/ Science and Tech

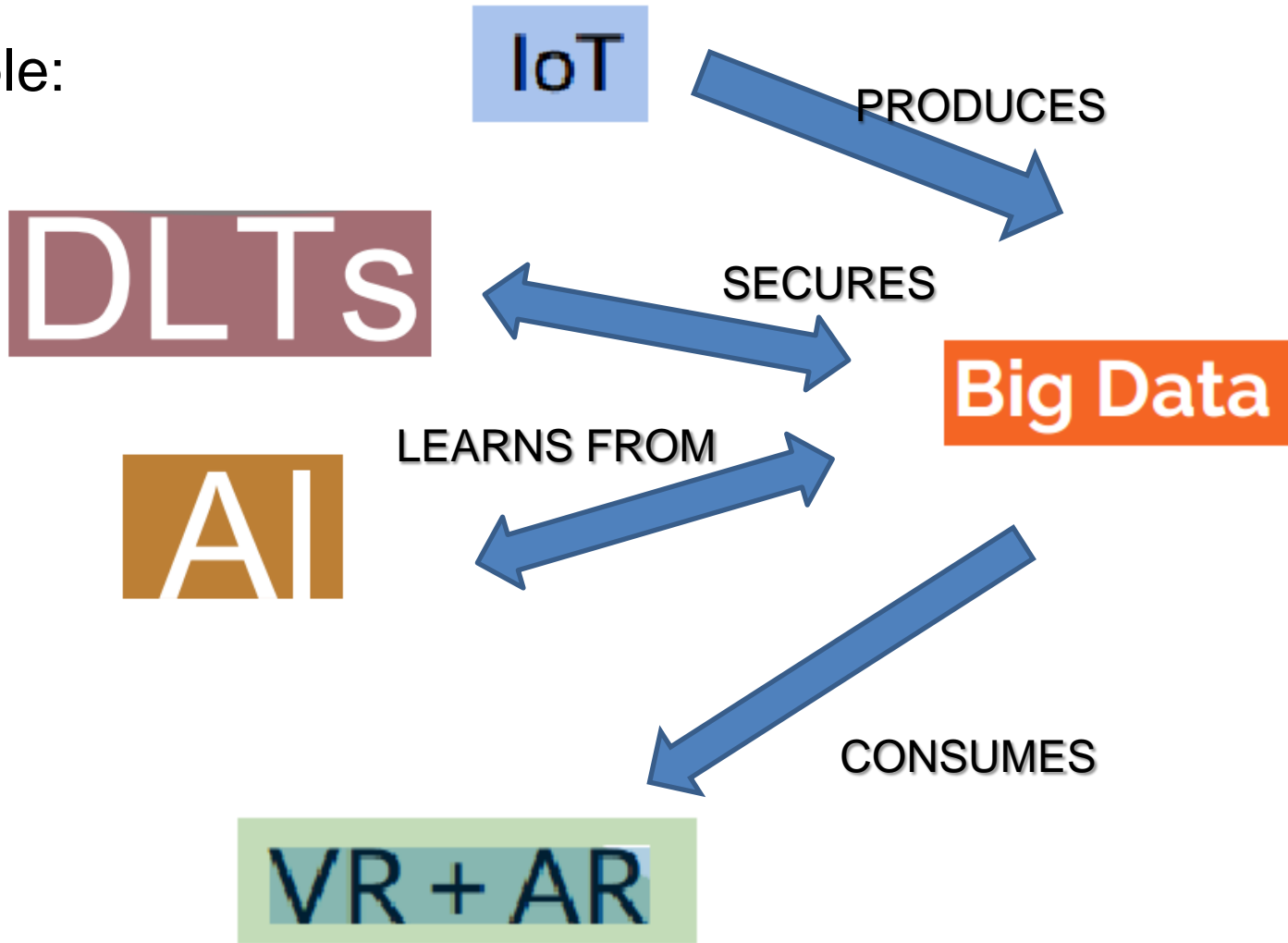


The place that masters the "convergence" will enjoy a strategic advantage

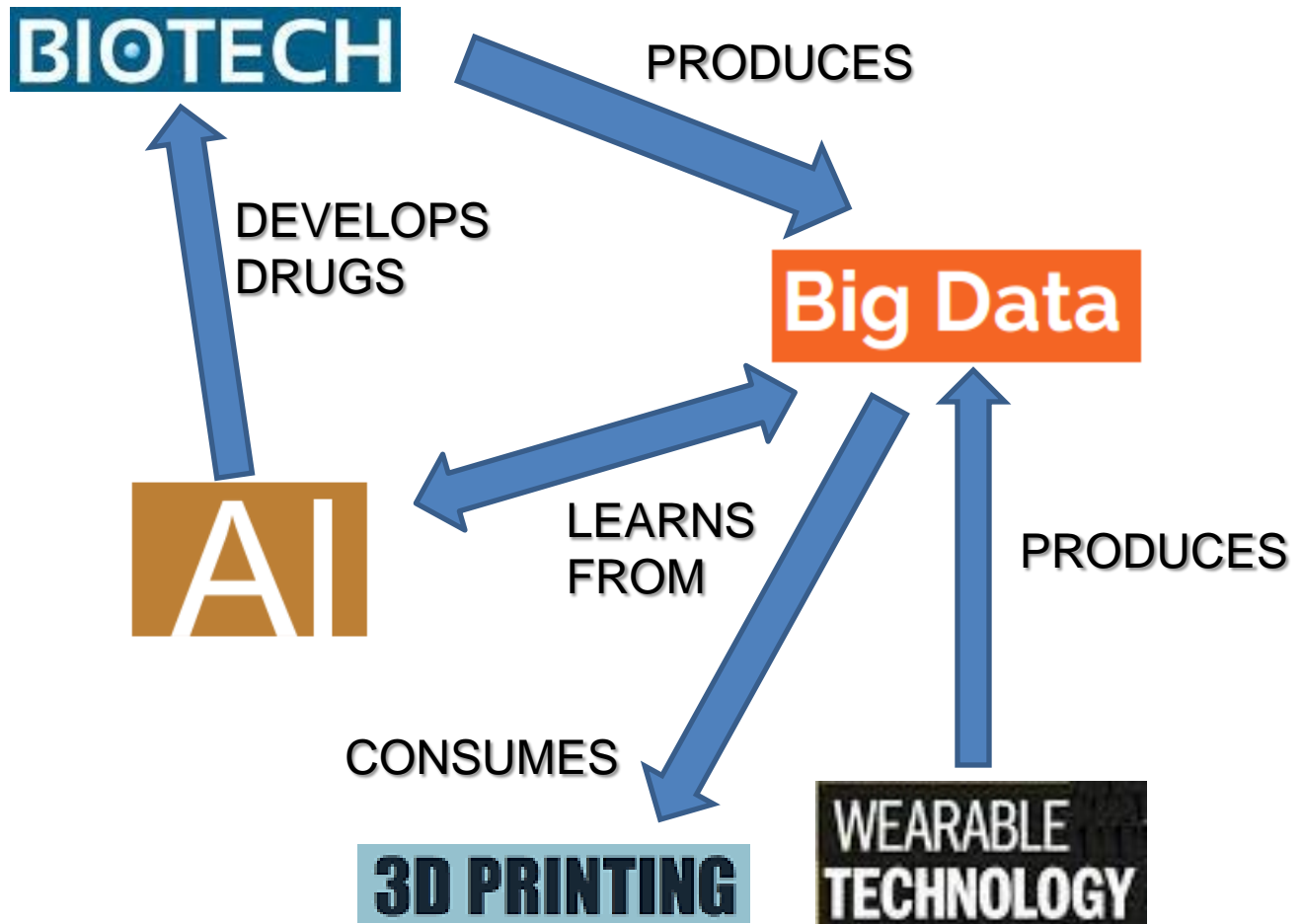
1. The Technological Convergence



Example:



Example:



Technological Convergence

- Digital convergence of the **2000s**: Information Technologies + Telecommunication + Consumer Electronics + Entertainment =



Technological Convergence

- Post-digital convergence of the **2020s**: AI + VR + Nanotech + Biotech + 3D Printing + IoT + Big Data + ... =



The 4th Industrial Revolution

1. Mechanized factory (mechanical loom)
2. Automated factory (assembly line)
3. Computerized factory (numeric control)
4. Internet factory (IoT + Big Data + A.I. + ...)

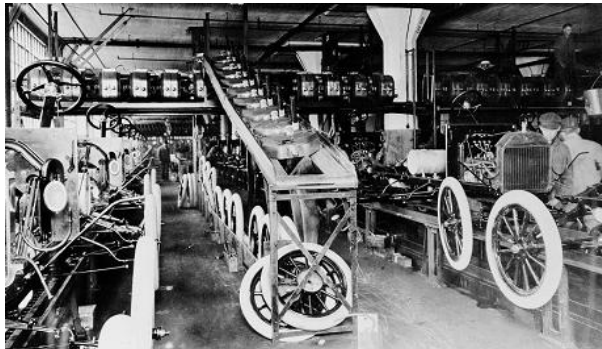
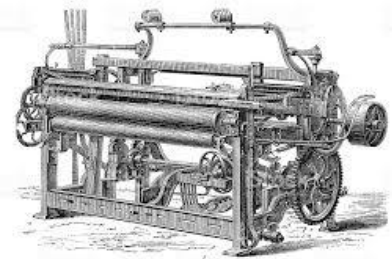


FIGURE 7.2 NC system showing machine tool and controller. (Courtesy of Bridgeport Machines Division of Textron Inc.)



Austin Kitchen

The 3D Convergence

Three parallel kinds of convergence:

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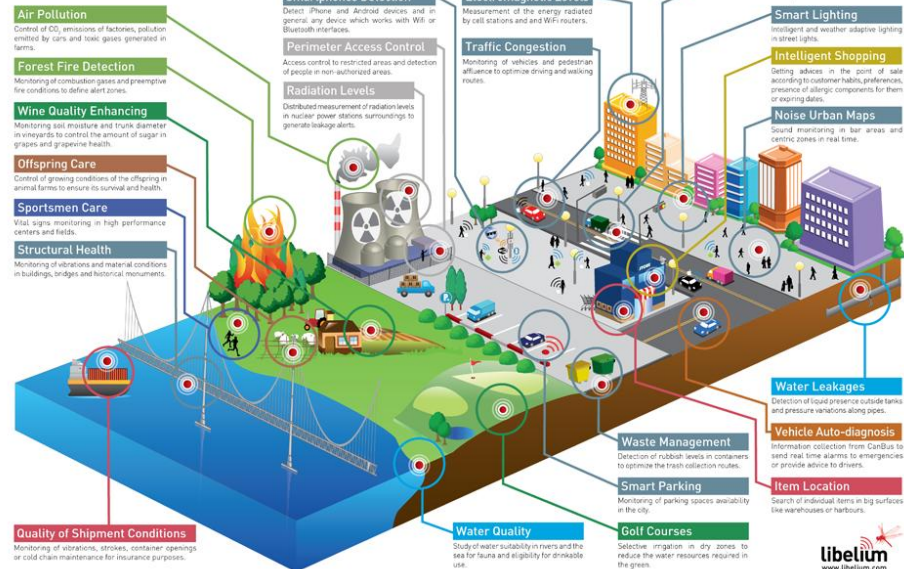


*The place that masters the "convergence"
will enjoy a strategic advantage*

2. The Digital-Physical Convergence



Libelium Smart World



2. The Digital-Physical Convergence Beyond Smart Cities

Cities are not just buildings, streets and cars...
There are also people!





Social science
Neuroscience
Computer Science
Political Science

Biology
Artificial Intelligence
Design
Game Theory



Beyond the Smart City: Positive Engagement

- Improving the existing “positive engagement” (“peace”) **generates new wealth** for the city
- People’s ability to create new wealth directly depends on how “**good**” they can be to each other
- Cities are engines of positive engagement

Beyond the Smart City: Positive Engagement

- Augmented Intelligence for insoluble problems (“wicked problems” or “messes”)
 - Horst Rittel and Melvin Webber: “wicked problems” (1972)
 - Russell Ackoff: “messes” (1974)
 - Wicked problems are not isolated, they are sets of problems, each one influencing others



Robert E. Horn



Visiting Scholar
Stanford University

- Brief bio
- CV
- Recent speeches & articles
- hornbob@earthlink.net

Visual Analytics for Public Policy

A research program to model, communicate, and resolve complex issues

What is visual analytics?

NASA Project on Strategic Science Policy



GLOBAL STRUGGLE OF NARRATIVES Project



Discriminate Force Project



National Missile Defense Debates



Genetically Modified Food Project



HUMAN COGNOME Initiative National Science Foundation



Social Messes

Helping groups get started and stay on the same page in dealing with seemingly intractable "wicked" problems
For more info



What are Social Messes?

Social Mess Projects

Summaries of My Current Work

Thinking Bigger Thoughts

Connecting the Smudges

My other interests and writings

Visual language, human-computer interface, knowledge mapping

Philosophy, cognitive science, artificial intelligence

Information Mapping®, structured writing, reusable learning objects, hypertext

Simulation gaming /scenarios

Educational research & methods

Argumentation mapping

Art and information design

Electronic democracy, governance

INFO-MURALS / PUBLIC ART

STRATEGY for dealing with RADIOACTIVE WASTE



ARGUMENTATION MAPS about RADIOACTIVE WASTE



Avian Flu Pandemic Scenario Info-Mural



Are Info-Murals New Genre? A New Article

STRATEGIC POLICY OPTIONS for GLOBAL CLIMATE CHANGE

Current project - watch this space



CARNEGIE TRUST Info-Mural Convention on the Rights of the Child watch this space

My Primary Tools (These Days)

Book

Visual Language



To order

Visual Analytics™ Workshops

Visual Thinking and Visual Communication



For more info

Mess Mapping™ Process



For more info

Argumentation Mapping for Public Policy Debates



For more info

Posters

Can Computers think?



To order

Info-murals

For Public Policy

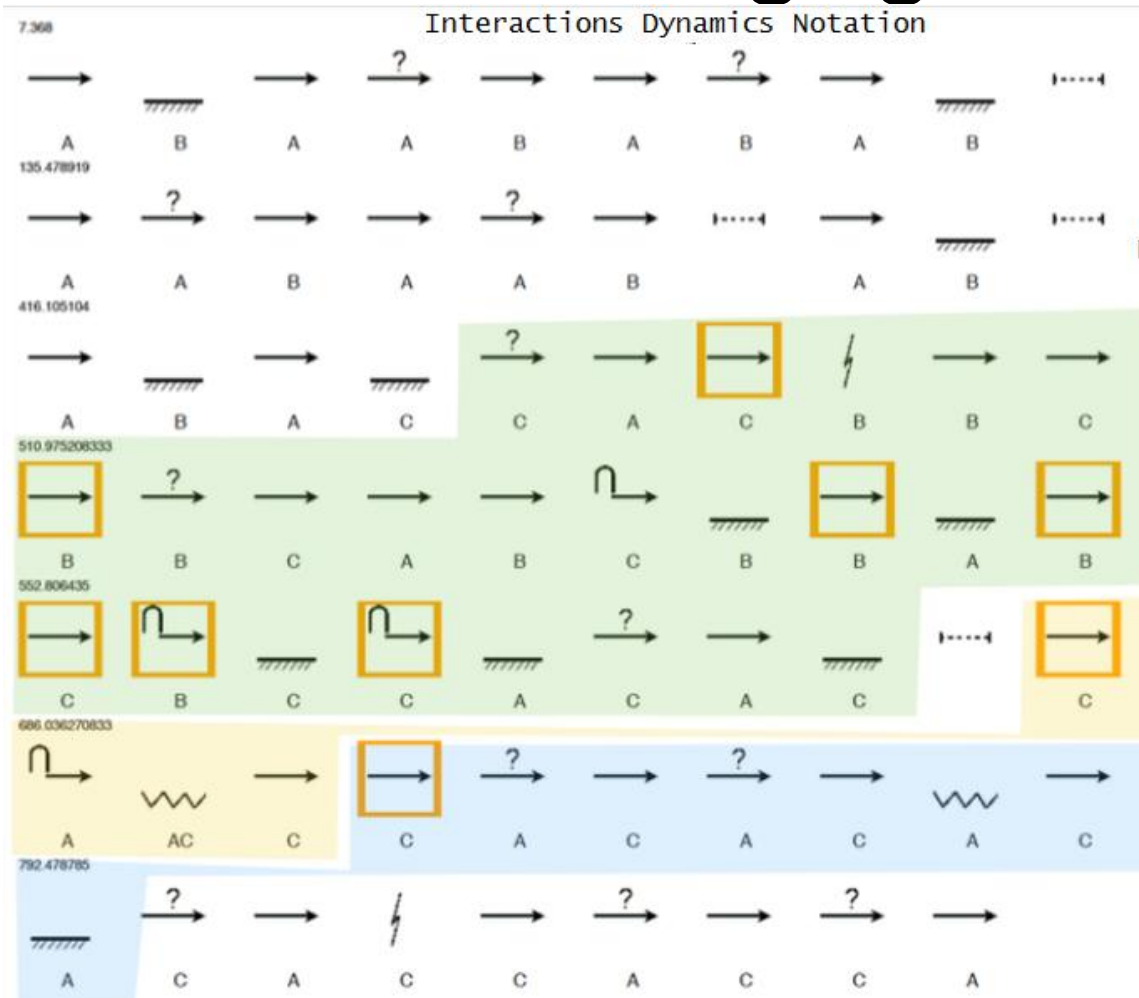


For more info

History of Cybernetics and Systems Science Info-Mural

My publishers
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XPLANE

Beyond the Smart City: Positive Engagement



Neeraj Sonalkar

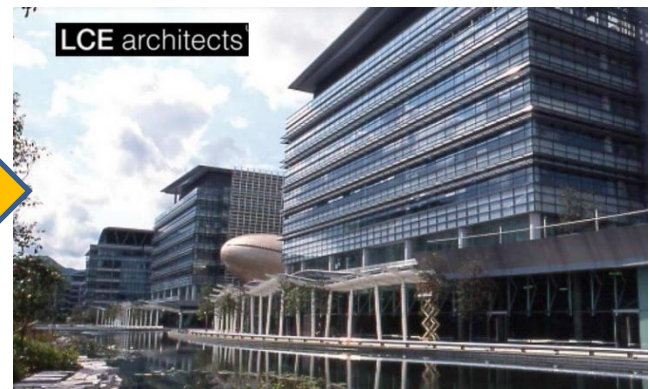
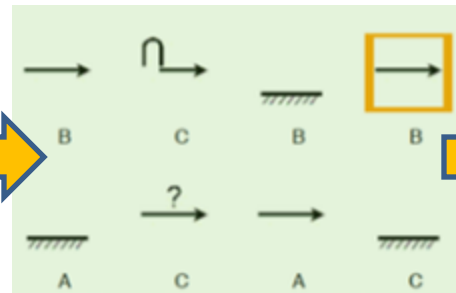
Interaction sequence 1

Interaction sequence 2

Interaction sequence 3

2. The Digital-Physical Convergence Beyond Smart Cities

- From Computational Social Science to Technology Park:
 - A methodology to discover needs in society
 - A factory of hundreds of startups
 - A social innovation park



The 3D Convergence

Three parallel kinds of convergence:

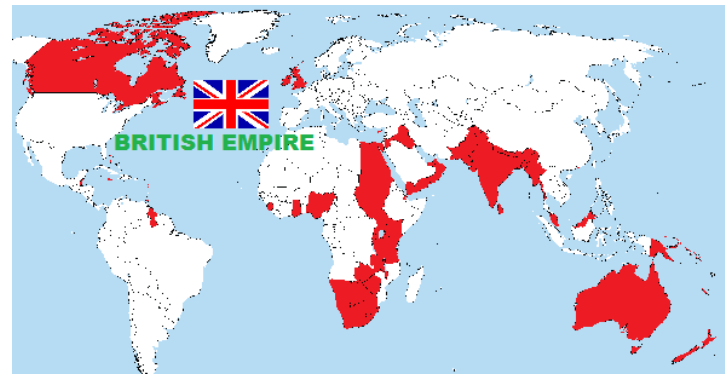
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2. Coexistence of the digital and physical world
3. Art and Humanities/ Science and Tech



The place that masters the "convergence" will enjoy a strategic advantage

3. Art/Tech/Science Convergence

- Leonardo ISAST (Frank Malina, 1967)
- Djerassi Artists in Residence program (Carl Djerassi,
- YLEM (Trudy Reagan & Howard Pearlmutter, 1981)
- UC Berkeley's ATC (Ken Goldberg, 1997)
- Zero1 (Andy Cunningham, 2000)
- LASERs (Piero Scaruffi, 2008)
- BAASICS (Selene Foster and Christopher Reiger, 2011)
- LAST festival (Piero Scaruffi, 2014)



Leonardo Art/Science Evenings

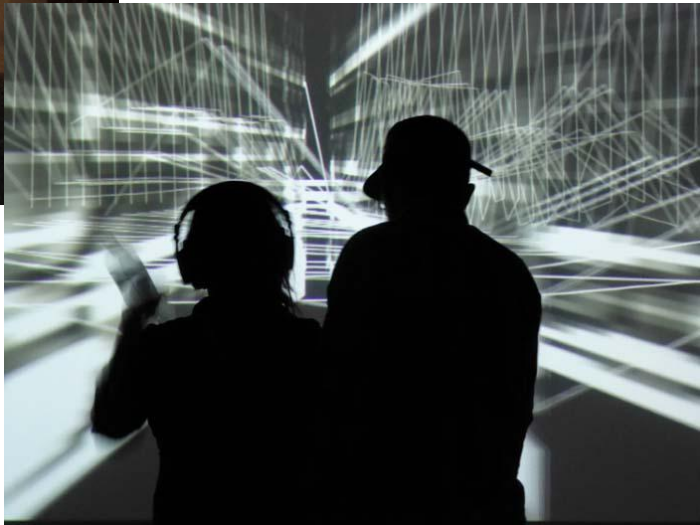
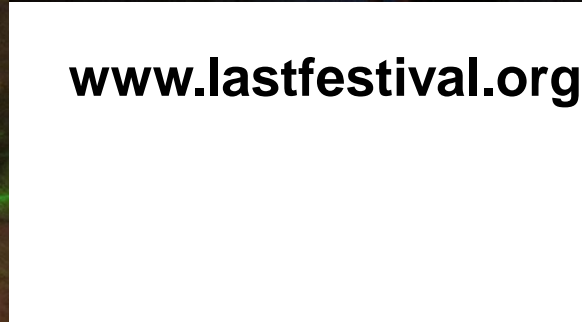
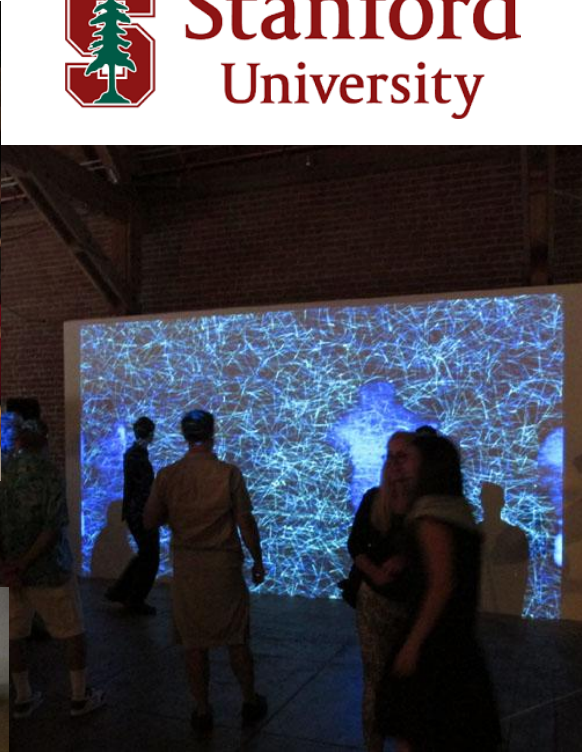
www.lasertalks.com





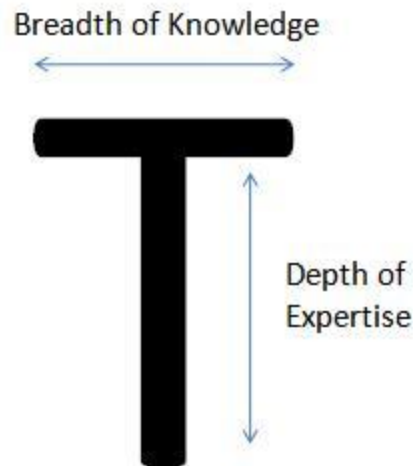
The LAST Festival

Life Art Science Technology festival



3. Art/Tech/Science Convergence

- The future is interdisciplinary: Sociologists + Economists + Artists/Designers + Scientists + Engineers
- The traditional specialist is not well suited for this future of converging disciplines.



Art/Tech/Science Convergence

- 1,000 years ago China was inventing everything and the West was copying



Art/Tech/Science Convergence

- Scholar-official of the Song dynasty: the universal man, combining the qualities of scholar, poet, painter, statesman
- A very interdisciplinary spirit
- The “T” person

Breadth of Knowledge



Depth of Expertise



The Future of Convergence



Carnegie Mellon University

Interdisciplinary Programs

My Prediction: the Science of Longevity



L

Longevity

Record of longevity: Jeanne Calment
died at the age of 122 in 1997



1	Jeanne Calment ^[1]	122 years, 164 days
2	Sarah Knauss ^[2]	119 years, 97 days
3	Lucy Hannah ^[3]	117 years, 248 days
4	Marie-Louise Meilleur ^[4]	117 years, 230 days
5	Violet Brown ^[5]	117 years, 189 days
6	Emma Morano ^{[5][6]}	117 years, 137 days
7	Nabi Tajima ^[5]	117 years, 119 days
8	Misao Okawa ^[5]	117 years, 27 days
9	María Capovilla ^[7]	116 years, 347 days
10	Susannah Mushatt Innes ^[5]	116 years, 311 days

L

Longevity

1993: Cynthia Kenyon (UCSF): disabling Daf-2 gene

1999: Leonard Guarente (MIT) identifies the longevity gene in yeast, sir2

2010: Rochelle Buffenstein (Univ of Texas): NRF2 protects the body against aging


2012: the hydra is “immortal” due to the FoxO gene (Kiel Univ)

2016: Manfred Kayser (Erasmus Medical Centre): MC1R is responsible for looking older




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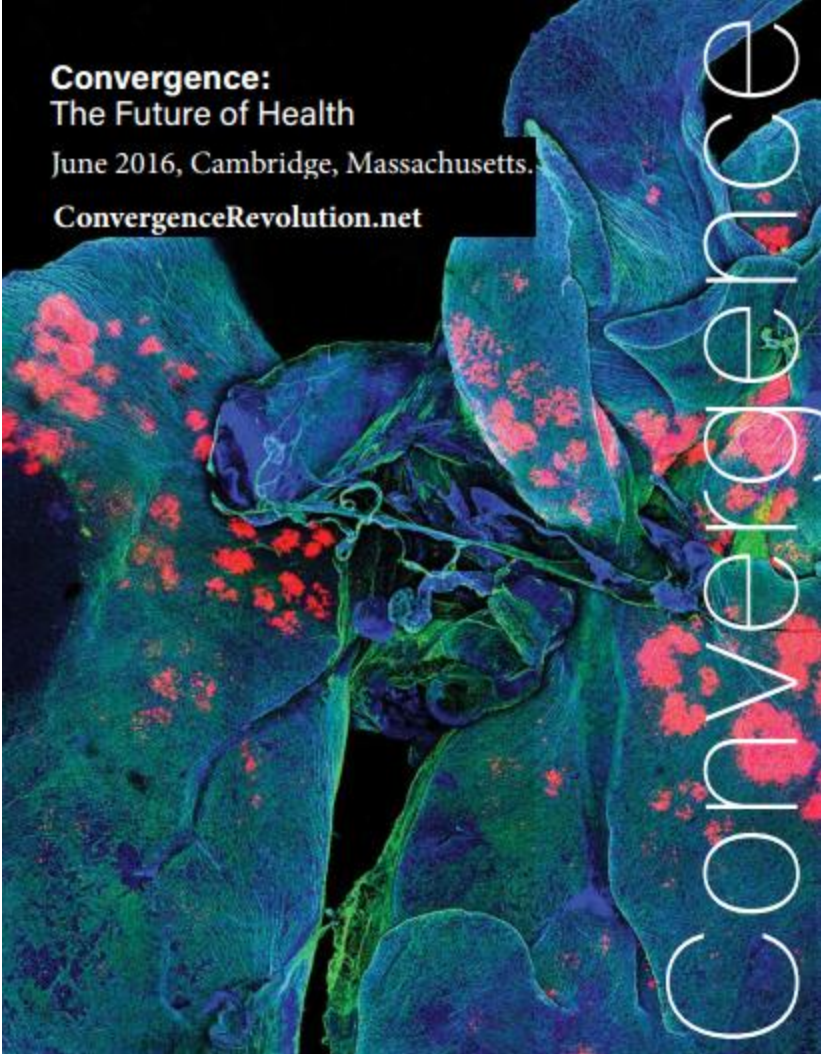
Longevity



The Third Revolution:



The Convergence of
the **Life Sciences**,
Physical Sciences,
and **Engineering**



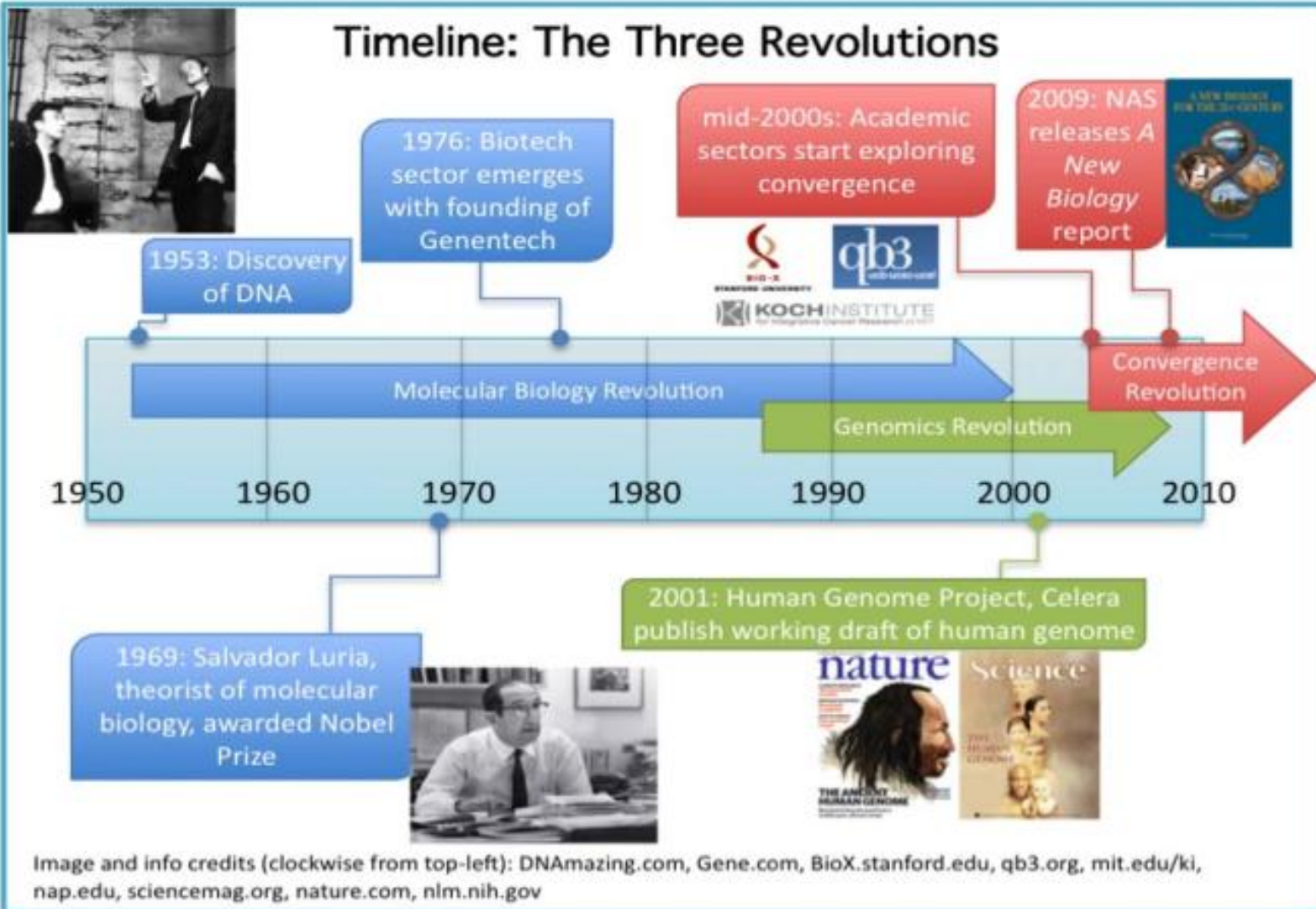
Convergence:
The Future of Health
June 2016, Cambridge, Massachusetts.
ConvergenceRevolution.net

Convergence

L

Longevity

Timeline: The Three Revolutions



Source:
MIT (2011)