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16th American-African-European Spring and Autumn School:

"Investigating the Interrelation of Culture, Creativity, Innovation and Sustainable Development in the Age of Disruption"

Lecture: Introduction to the Interrelation of Culture, Creativity, Innovation and Sustainable Development in the Age of Disruption

Prof. Dr. Stefan Hüsig

Chair for Innovation Research and Technology Management

19.03.2025

Heizhaus, Straße der Nationen 62, CUT, Germany

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Agenda

- Do We Live in an Age of Disruption?
- Interrelation of Innovation and Sustainable Development
- Interrelation of Culture, Creativity & Innovation

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Agenda

- **Do We Live in an Age of Disruption?**
- Interrelation of Innovation and Sustainable Development
- Interrelation of Culture, Creativity & Innovation

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Do We Live in an Age of Disruption?



Phillip H. Phan and Geoffrey Wood, 2020: Doomsday Scenarios (or the Black Swan Excuse for Unpreparedness). *AMP,* **34**, 425–433.

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Building on the 3rd ARTEM OCC‘s Leitmotiv Created in 2019

- 3rd ARTEM OCC: Creativity, Innovation and Sustainability **in the Age of Disruptions**: Dealing with Global Challenges through Trans- and Interdisciplinary Approaches



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Special Issue: Int. J. Technology Management, Vol. 88, Nos. 2/3/4, 2022

CONNECTING CREATIVITY, INNOVATION AND SUSTAINABLE DEVELOPMENT IN THE AGE OF DISRUPTIONS

Guest Editors

Professor Stefan Huesig

Chemnitz University of Technology,
Innovation Research and Management of Technology
Germany

Professor Klaus-Peter Schulz

ICN Business School ARTEM
France

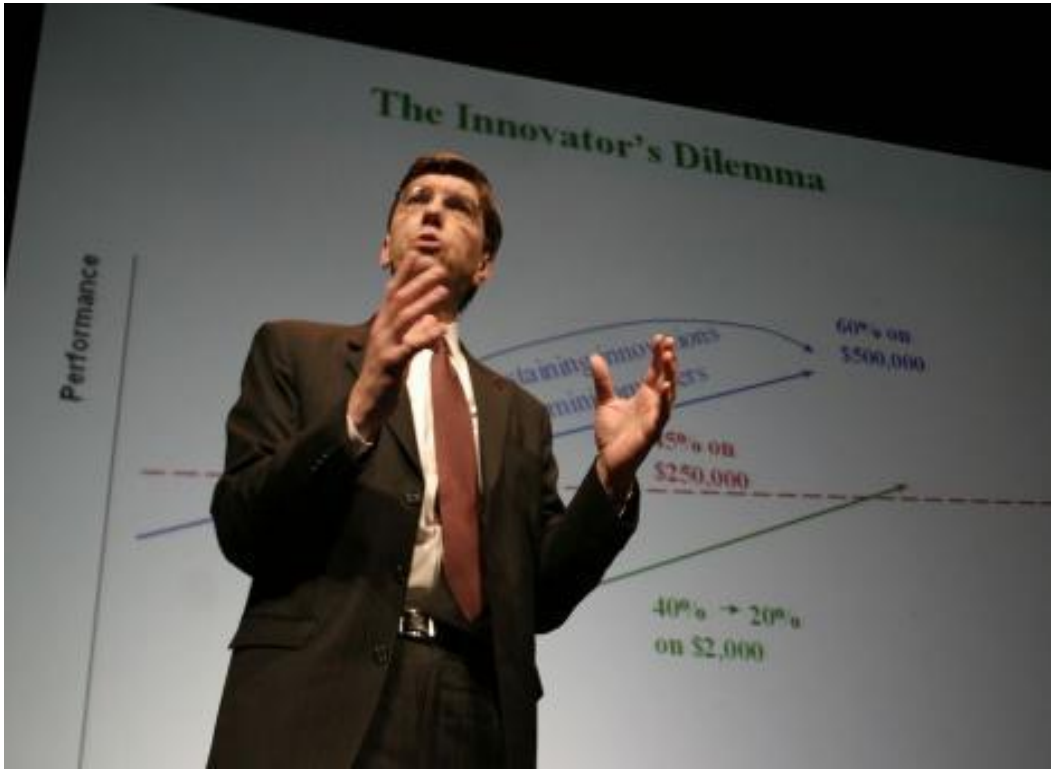
What is Disruption?

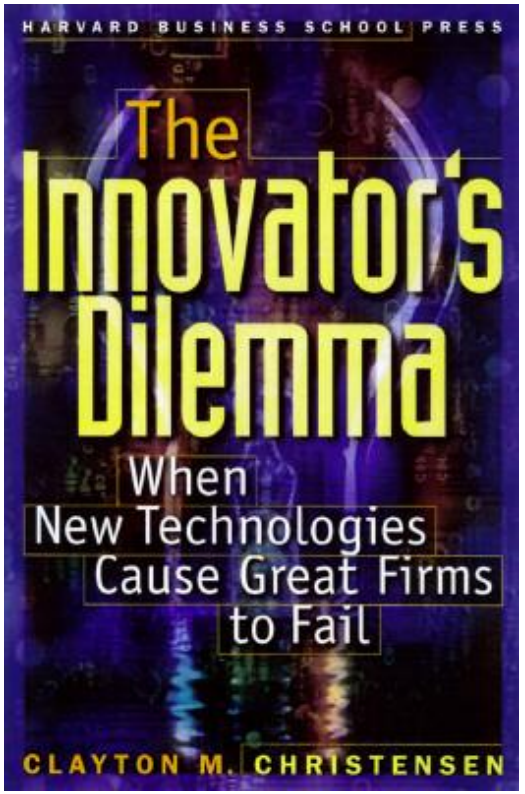
- Disruption in this context should be considered two-fold (Hüsig/Schulz 2022)
  - as “Christensen Effect” (Christensen et al., 2015; Huesig, 2012)

What is Disruption?

- Clayton M. Christensen
- Harvard Business School - 1997

Died on January 23, 2020, aged 67





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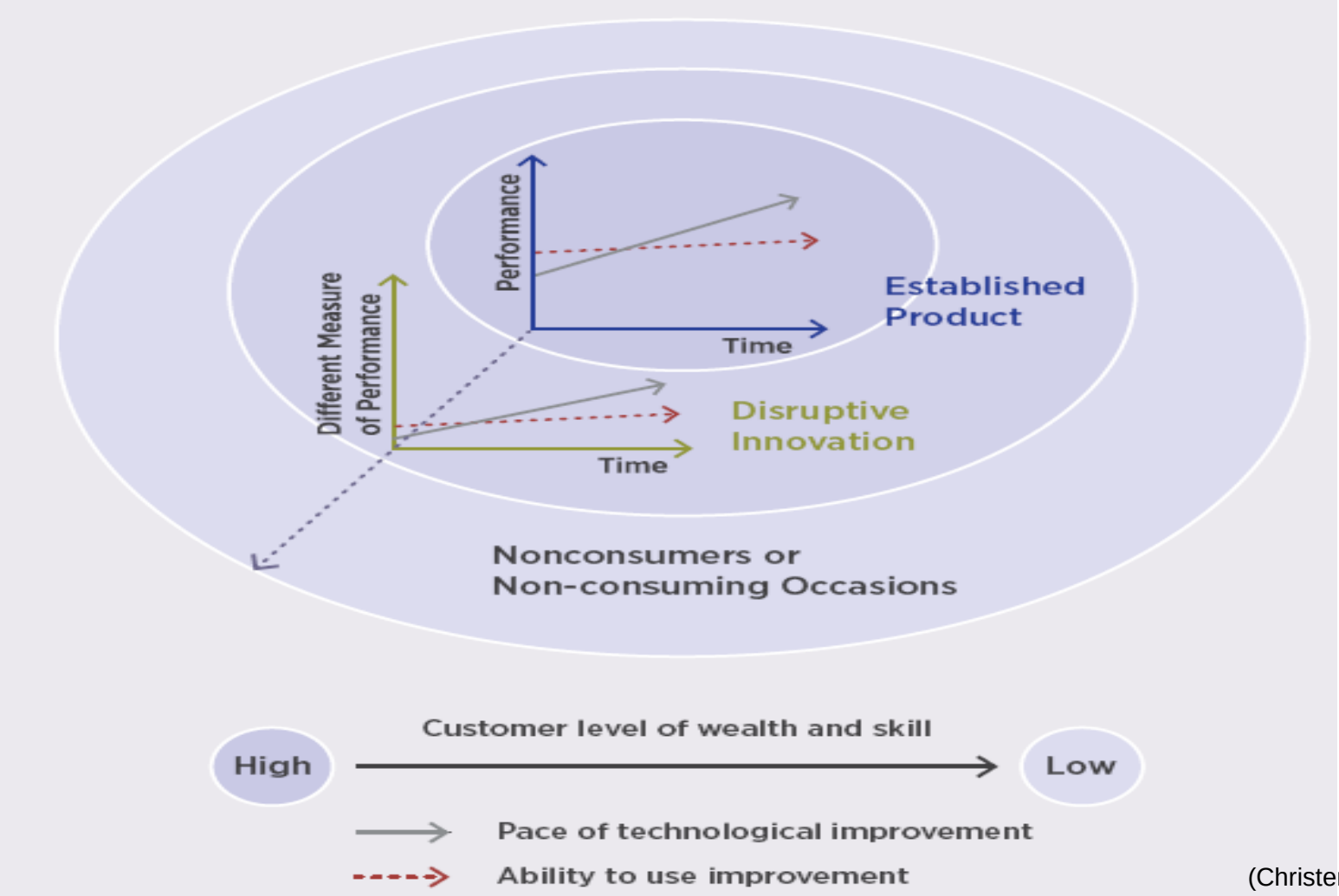
What is Disruption?
(Also known as “Christensen Effect”)

“**Disruption**” describes a process whereby a smaller company with fewer resources is able to successfully challenge established incumbent businesses. Specifically, as incumbents focus on improving their products and services for their most demanding (and usually most profitable) customers, they exceed the needs of some segments and ignore the needs of others. Entrants that prove disruptive begin by successfully targeting those overlooked segments, gaining a foothold by delivering more-suitable functionality—frequently at a lower price. Incumbents, chasing higher profitability in more-demanding segments, tend not to respond vigorously. Entrants then move upmarket, delivering the performance that incumbents’ mainstream customers require, while preserving the advantages that drove their early success. When mainstream customers start adopting the entrants’ offerings in volume, disruption has occurred.

Christensen et al. 2015, 46

Updated Disruption Theory



(Christensen et al. 2013)

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What is Disruption?

- Disruption in this context should be considered two-fold (Hüsig/Schulz 2022)
  - as “Christensen Effect” (Christensen et al., 2015; Huesig, 2012)
  - as events that require a complete rethinking of existing practices (e.g. COVID-19 crisis, transitions in energy, monetary (Blockchain) and transport systems, deglobalisation and digitalization (Hüsig, 2020)

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Why We Might Live in an Age of Disruption?

- The **age of disruption** coined and proposed by Hüsig (2019/2020)
- Dramatic events and new opportunities, although signaled through preliminary indicators, require radical action and immediate reorientation.
  - E.g. financial crises, ongoing wars, migrant streams,…
- To navigate through such an uncertain **era of ferment** in societies and many industries, and to innovate radically (Hüsig/Schulz 2022)
  - dissolve disciplinary and functional boundaries,
  - connect formerly unconnected knowledge and application fields, foster systemic, creative and critical thinking,
  - overcome thought barriers, and break existing paradigms

→ novel/renewed **ideas & ideologies** try to offer **orientation**

→ **New combinations** frequently emerge

→ These challenges and growing **uncertainty** also produce **resistance**, **anxiety and turmoil in and between societies**.

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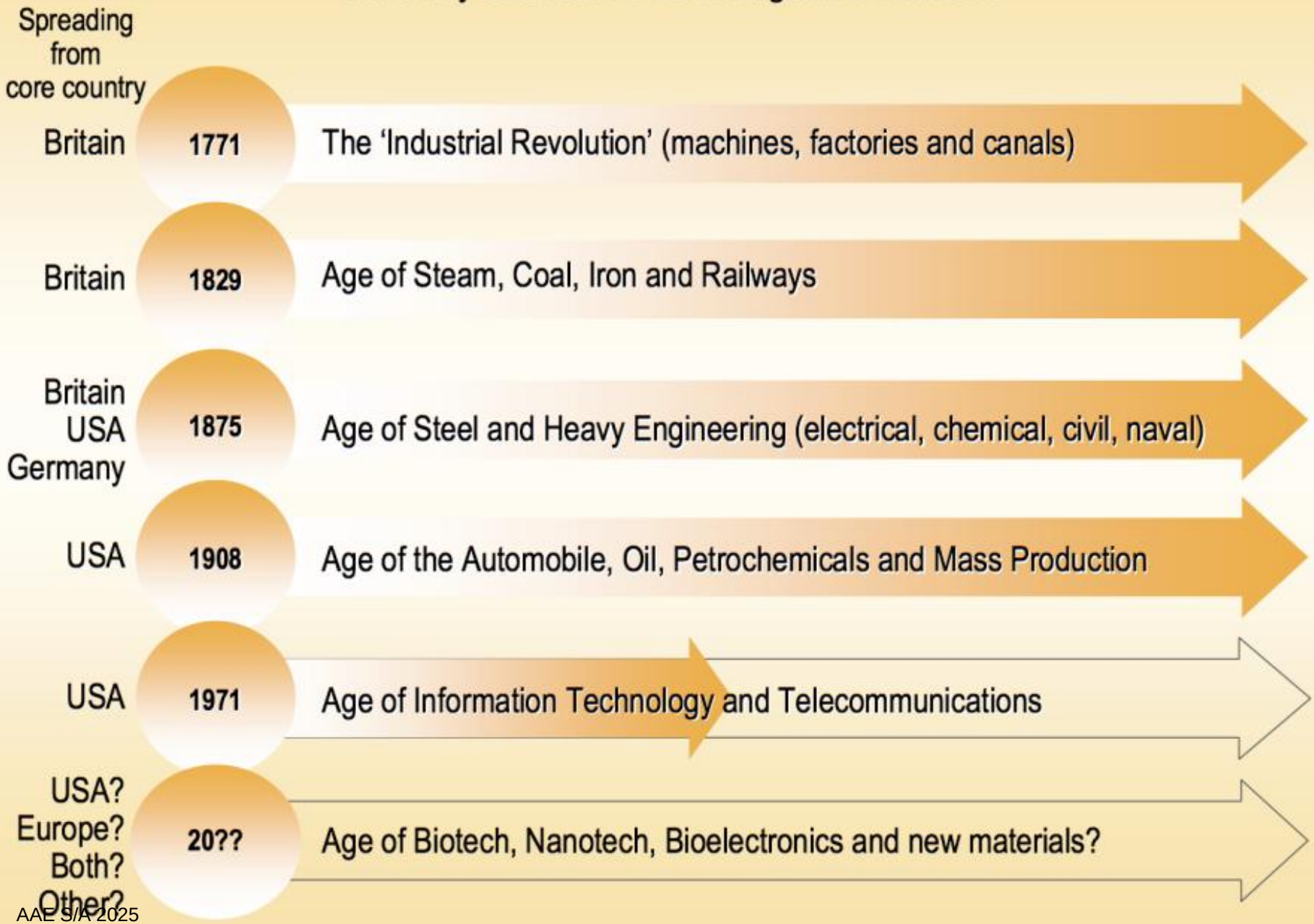
Why We Might Live in an Age of Disruption? → Theorizing

“[T]here is no new thing under the sun.”—
Ecclesiastes 1:9, King James Bible


FIVE GREAT SURGES OF DEVELOPMENT IN 240 YEARS
driven by successive technological revolutions
Spreading from core country
Britain
1771
The 'Industrial Revolution' (machines, factories and canals)
Britain
1829
Age of Steam, Coal, Iron and Railways
Britain
USA
Germany
1875
Age of Steel and Heavy Engineering (electrical, chemical, civil, naval)
USA
1908
Age of the Automobile, Oil, Petrochemicals and Mass Production
USA
1971
Age of Information Technology and Telecommunications
USA?
Europe?
Both?
Other?
20??
Age of Biotech, Nanotech, Bioelectronics and new materials?

Levels of Technology Evolution

Level	Economics of technological practice	Frequency of change (years)	Purpose
1	*Technological paradigm*	> 100	Often non-calculative and spontaneous
2	*Technological trajectory*	10–100	First-order economizing: development of coherent and efficient technological systems
3	*Routines*	1–10	Second-order economizing: Optimization[25] of individual technical components
4	*Operation and management*	Continuous	Actual operational management

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Overview of the Four Perspectives on Technology Evolution

Perspective	Literature examples	Definition of the perspective	Definition of technology	Focus of literature	Data and methods	Core assumptions about technology evolution	Temporal scope
Technology realist	Abernethy and Clark, 1985; Tushman and Anderson, 1986; Schilling, 2002; Suarez, 2004	Technological evolution is driven by technological factors. *Includes:* S-curve theory, industry lifecycle theory, technology lifecycle theory	Technology as knowledge, predominantly stored in artifacts	Explaining competitive advantage and industry evolution. Focus on technological design.	Secondary data to trace key technological parameters. Quantitative data of markets, market share and entre-exit data, patent data. Focuses mostly on firms.	*Technological realism*: Actors' cognitive representations of the technology reflect the technology *Technological determinism*: Inherent properties of a technology have a fixed application and effect industries and organizations	Macro-cycles of economic growth; Industry lifecycles; Technology lifecycles
Economic realist	Gort and Klepper, 1982; Klepper, 1997	Technological evolution is driven by economic factors. *Includes:* Evolutionary economics, industrial economics, industry lifecycle theory	Technology as knowledge, predominantly stored in artifacts	Explaining competitive advantage and industry evolution. Focus on R&D investments and economies of scale.	Secondary data to trace key technological parameters. Quantitative data of markets, market share and entre-exit data, patent data. Focuses mostly on firms.	*Technological realism*: Actors' cognitive representations of the technology reflect the technology *Economic determinism*: The application and effect of a technology on industries and organizations are determined by economic factors, such as firm-size, market share and R&D capacity.	Macro-cycles of economic growth; Industry lifecycles;
Cognitive interpretivist	Clark, 1985; Garud and Rappa, 1994; Tripsas and Gavetti, 2000; Kaplan and Tripsas, 2008; Kahl and Grodal, 2016	Technological evolution is driven by actors' cognitive representations. *Includes:* Socio-cognitive theory, frame theory, categorization theory	Technology as the interplay between knowledge, artifacts and ways of evaluating	Firm adaptation to technological change, the commercialization of new technology, arbitrariness of the path of technological change. Focus is on categories and frames.	Qualitative archival studies, cases studies, interviews, textual linguistic analysis to capture beliefs and "frames." Focuses on firms and users.	*Technological Interpretivism*: Actors' cognitive representations do not directly represent the technology in itself due to interpretative ambiguity *Interpretative flexibility*: Ambiguity about applications and performance criteria of a technology affords multiple paths of application and effects, why technological evolution is not given prior to the fact	From emergence to taken-for-grantedness; Organizational adaptation processes; Convergence between diverse cognitive representations
Social constructionist	Yates, 1993; Hargadon and Douglas, 2001; Akrich, Callon and Latour, 2012; Dokko, Nigam and Rosenkopf, (2012); Grodal (2018)	Technological evolution as shaped by social forces, such as power, networks and politics. *Includes:* Institutional theory, actor-network theory, institutional economics	Heterogenous assemblage of technical and social linkages, resources embedded in social and power relations	The locus of innovation, co-evolution between technology and social forces. Focus is on social structure.	Historical case studies, quantitative data on technologies, organizational fields and eco-systems. Focuses on multiple audience members.	*Social constructionism:* Actors' interactions with technology cannot be reduced to the technology itself, but include the interests, network position and power of the actor *influence*: The application, path and effect of a technology is shaped by its surrounding social structures	The process of reconciling contestation; The emergence of industries or fields

Stine Grodal, Anders Dahl Krabbe, and Mia Chang-Zunino, 2023: The Evolution of Technology. ANNALS, 17, 141–180.

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Unified Model of Technological Evolution





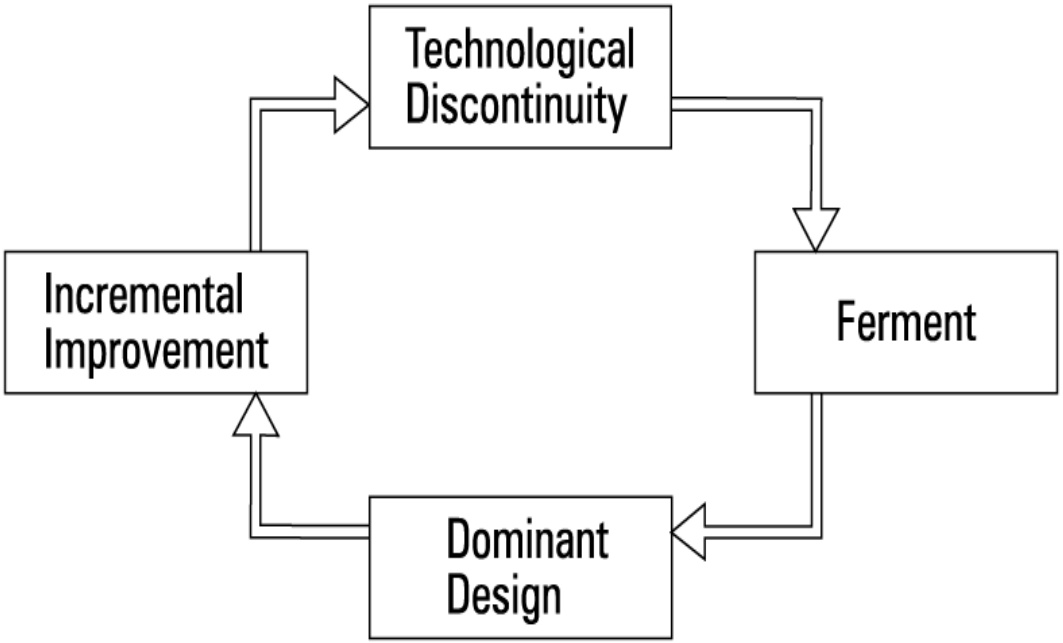
Stine Grodal, Anders Dahl Krabbe, and Mia Chang-Zunino, 2023: The Evolution of Technology. ANNALS, 17, 141–180.

Technological Discontinuities and Dominant Designs: Cyclical Model of Technological Change

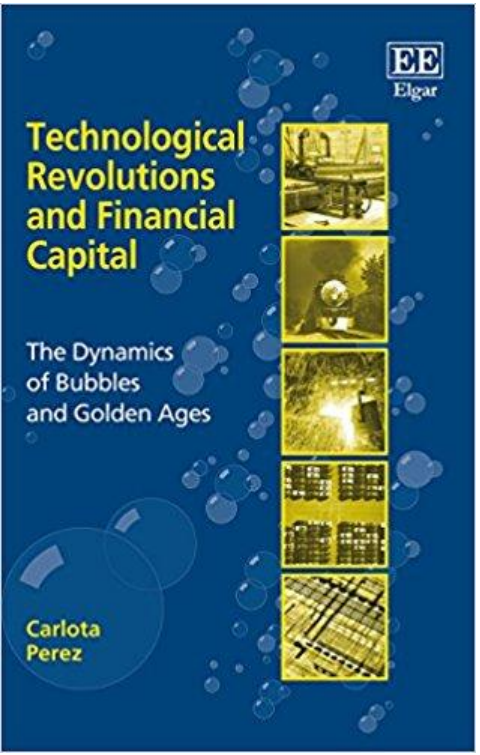


Philip Anderson
Michael L. Tushman





Source: Adapted from Tushman and Rosenkopf (1992)



Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages

by Carlota Perez



- Raphie Kaplinsky, *Technovation*
- *It was Carlota Perez in the early 1980s, who designated the major changes in technology systems, such as mechanization, electrification or computerization, as "changes of techno-economic paradigm" a designation which has since been widely adopted. In this book she offers many new insights into these complex processes of social, economic and technological change.*

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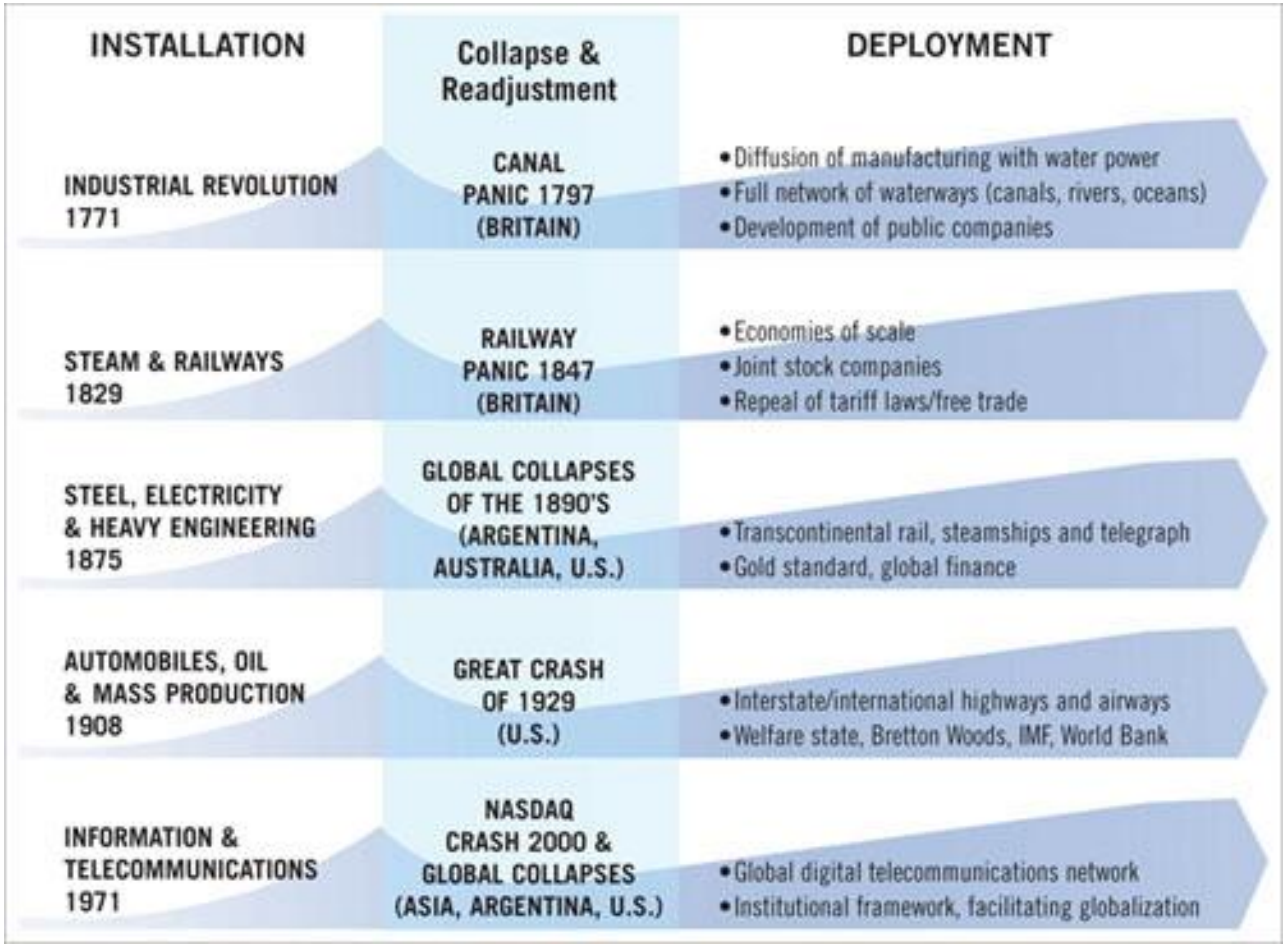
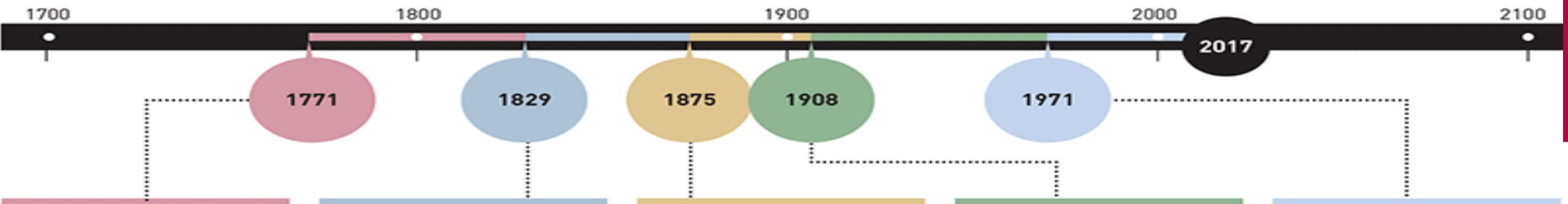
Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages



Source: Carlota Perez, www.bedfordfunding.com/focus/trends.html

Exhibit 1: Five Great Surges of Capital and Technology, 1771–2017

Key moments in each stage of the five transformations the world has experienced since the 18th century. Each begins with a revolution in technology installed with financial speculation until a panic ends in economic recession, which brings policies that foster a golden age in which business and society prosper.



Industrial Revolution

Initiated in Great Britain, this surge was launched with machines, canals, water power, turnpikes, agriculture, and the rise of the cotton industry.

1797–1800
Canal panic

1800–29
These years included the British victory in the Napoleonic Wars and the further mechanization and growth of industry and exports, including British investment in the U.S. and India.

Steam and Railways

Centered in Britain, with Europe and the U.S. catching up, this surge kicked off with steam-powered railways (1829) and the spread of the manufacturing, iron, and coal industries.

1847–51
Railway panic (1847) and revolutions in Europe (1848)

1851–75
The Crystal Palace exhibition (1851) inaugurated U.K.'s Victorian boom. Cities grew as railways connected them, and the U.K. became the workshop of the world in iron, coal, manufactured products, and machinery.

Steel, Electricity, and Heavy Engineering

The U.K. was still the center of the world, with the U.S. and Germany rising, and the Southern Hemisphere emerging. This surge, with worldwide trade and industrial giants, spawned the first era of globalization. It brought us Bessemer steel, steamships, heavy engineering (electrical, chemical, metallurgical, civil, and naval), electric power, telegraphy, canned and bottled food, and packaging.

1890–95
Argentina's Baring crisis spreading around the world in 1890, the U.S. depression of 1893, and economic collapses in many countries

1895–1908
This was the era of the Belle Époque in Europe, progressivism in the U.S., and new continental and world markets.

Oil, Automobiles, and Mass Production

This surge — which saw the U.S. become the world leader, followed by Europe and Japan — brought us cars, oil fuels, plastics, home appliances, refrigerated and frozen foods, telephone networks, broadcast radio, and TV.

The first automotive assembly line was created for the Model T (1913); mass production and Taylorism spread; and agriculture was mechanized.

1929–45
U.S. stock market crash (1929), Great Depression, political extremism (Hitler, Franco, and communism), and World War II

1945–71
The postwar boom included the rebuilding of Europe and Japan. The welfare state facilitated suburbanization and mass consumption as the American way of life; the U.S. dollar served as the gold standard. The Cold War provided military demand and spurred innovation.

Information and Telecommunications

Initiated in the U.S. and spreading to Europe and Asia (notably Japan, South Korea, China, and India), this surge was ushered in with computers, Intel's microprocessor (1971), software, the Internet, mobile phones, control instruments, and biotechnology.

It is characterized by flexible production, networked organizations, financial deregulation, the end of the Cold War (1989), and the rise of Japan and the BRICs. The 2000 dot-com crash foreshadowed the crisis to come.

2000–present
Global financial collapse and credit crunch (2007), U.S. TARP program (2008), quantitative easing, slow or no growth, rising political extremism

Eventually, a global sustainable golden age of information techology will dawn.

KEY
- Technological Revolution
- INSTALLATION
- TURNING POINT (crisis and recession)
- DEPLOYMENT (the golden age)

Source: Adapted from Carlota Perez, *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages* (Edward Elgar, 2002)

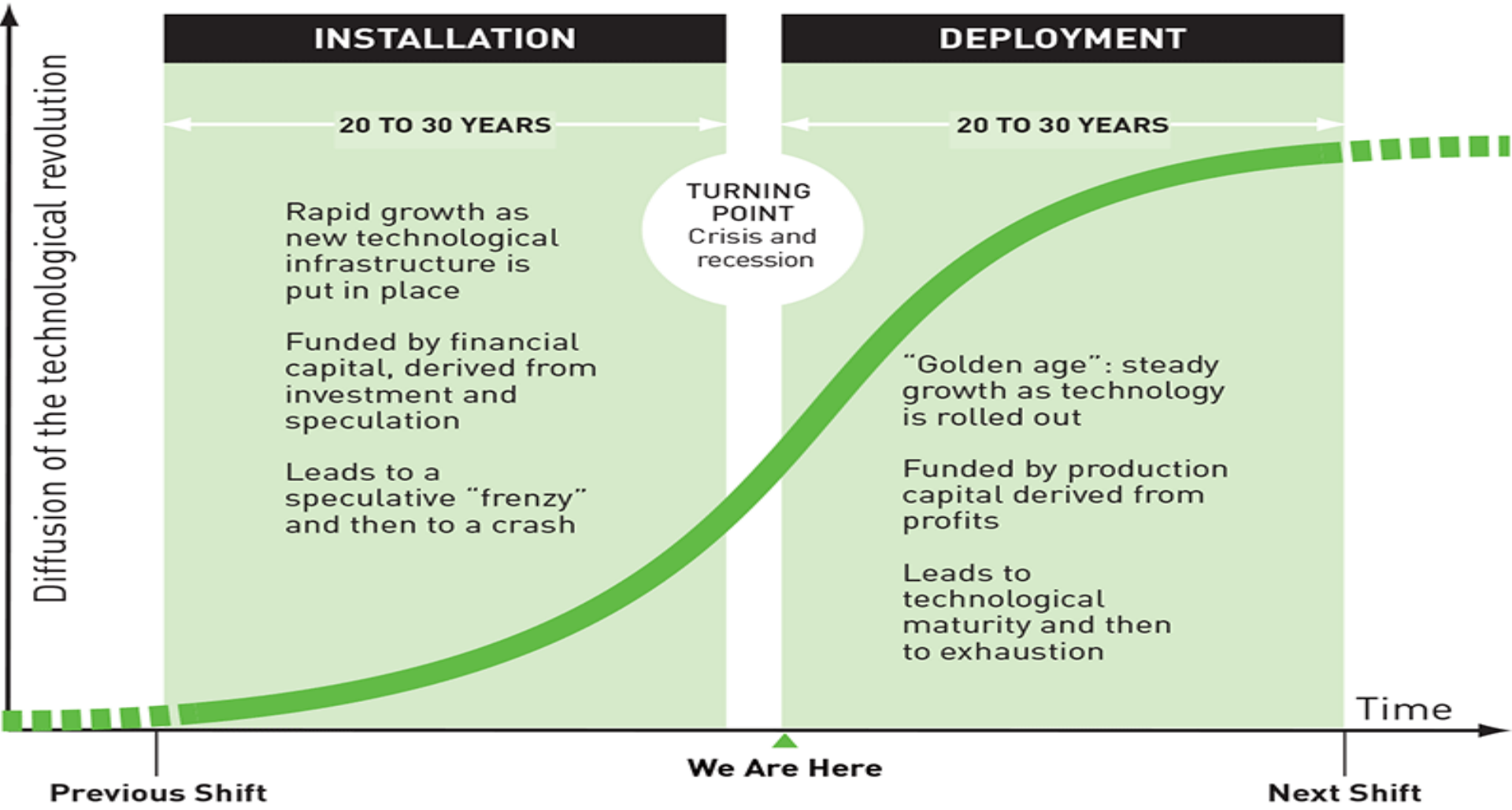
The Historical Record: Major Bubbles and Golden Ages

INSTALLATION "Gilded Age" Bubbles	Turning Point	DEPLOYMENT "Golden Ages"
1st 1771 Industrial Revolution Britain **Canal Mania**	1793-97	Great British Leap
2nd 1829 Age of Steam And Railways Britain **Railway Mania**	1848-50	The Victorian Boom
3rd 1875 Age of Steel and Heavy Engineering Britain/USA/Germany **London-funded Infrastructure buildup**	1890-95	Belle Époque (Europe) "Progressive Era" (USA)
4th 1908 Age of Oil, Autos And Mass Production USA **Roaring Twenties**	Europe 1929-33 USA 1929-43	Post-war Golden age
5th 1971 The ICT Revolution USA **Emerging markets dotcom boom financial casino**	2007-???? **We are here**	Sustainable global Knowledge-society "golden age"?

Source: Carlota Perez, "Technological Revolutions and Financial Capital: the Dynamics of Bubbles and Golden Ages" Edward Elgar, 2002

Exhibit 2: **A 60-Year Cycle of Capital**

This pattern of investment and technological development has taken place five times since the early Industrial Revolution, according to historian Carlota Perez. The green arrow at the bottom shows our position in 2010: moving into a "golden age" of steady growth.

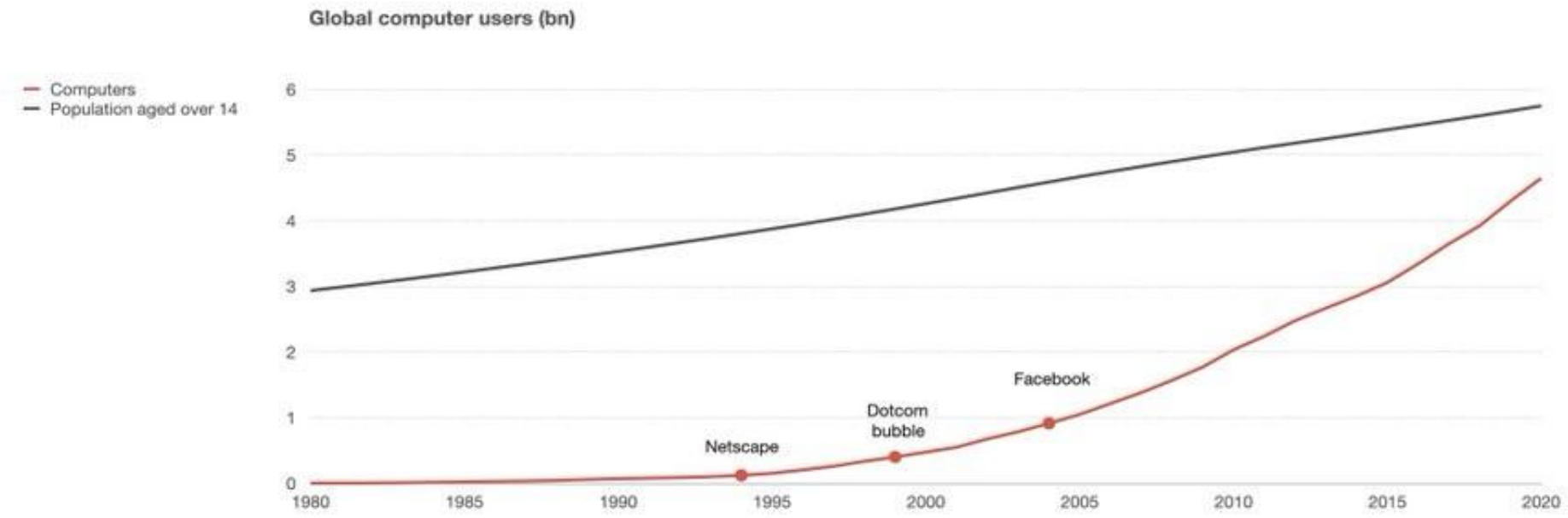


Source: Adapted from Carlota Perez, *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages* (Edward Elgar, 2002)

State of the Digitalization

Tech was very small until very recently

The number of global computer users has quadrupled even since Facebook launched in 2004



Source: Gartner, ITU, Apple, Google, CNNIC, @BenedictEvans, World Bank

Benedict Evans — October 2021 2

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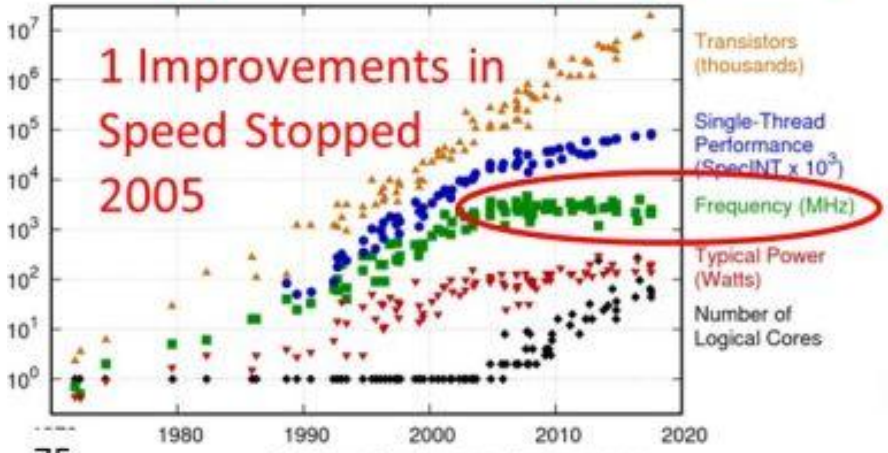
Moore's Law is also Slowing After Being a Driver of Computing

Seeing a Technology's (Microprocessors) Future in Trends







3. Advantage Changed to Design Optimization: Intel announces it will outsource chip manufacturing because advantages of doing manufacturing have declined. Users such as Apple can do design optimization better than suppliers (WSJ, Intel Not Inside, Dec 12, 2020)

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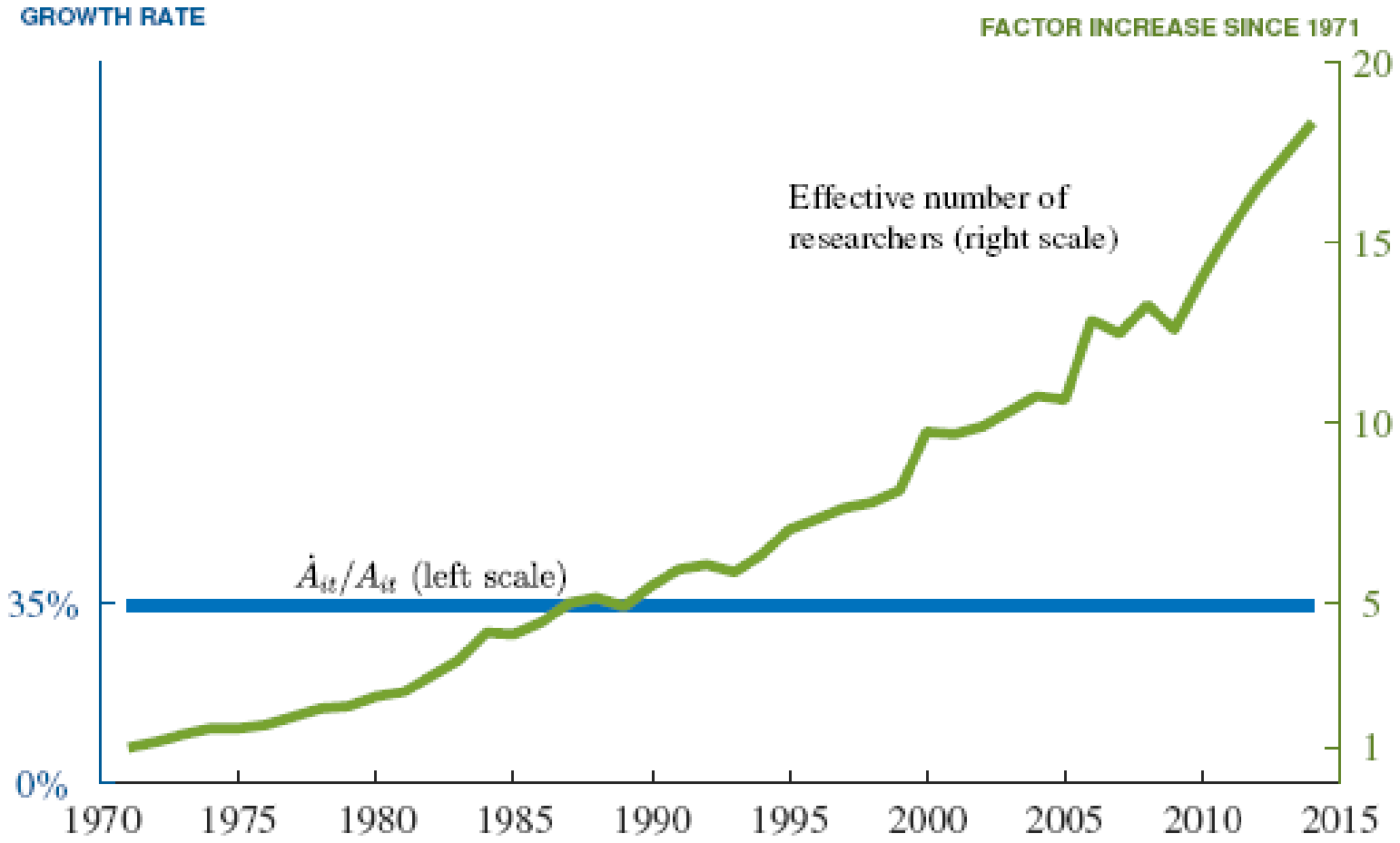
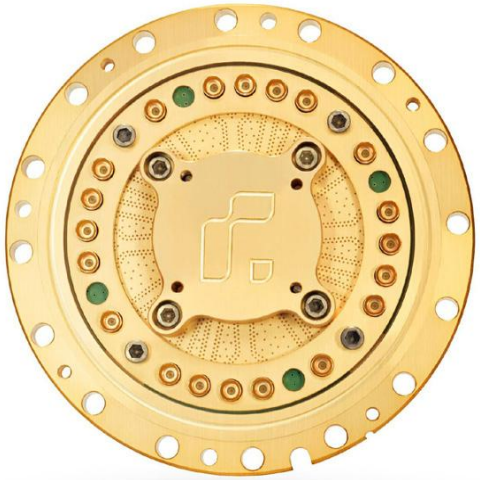
The Price of Performance Growth: The Input Side of Moore's Law has risen by a factor of 18 since 1971!

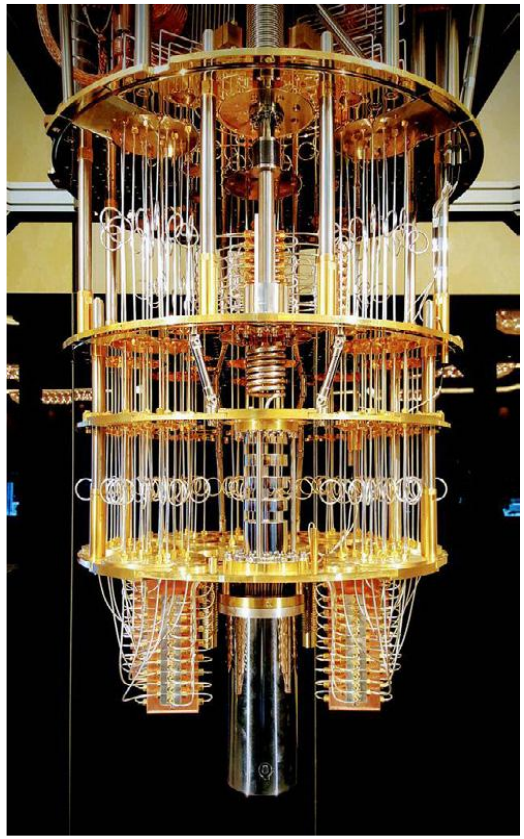


Bloom et al.2017

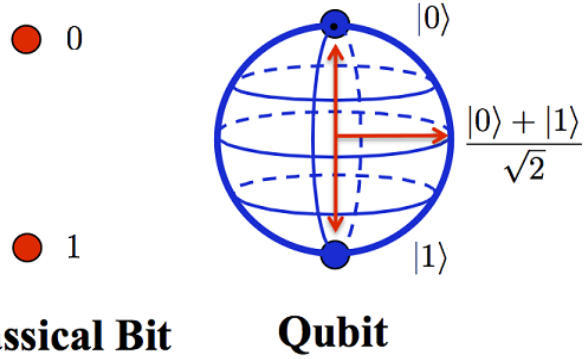
Technological Discontinuity? Quantum Computing

Rigetti's 128 qubit quantum chip





IBM's "Q" machine



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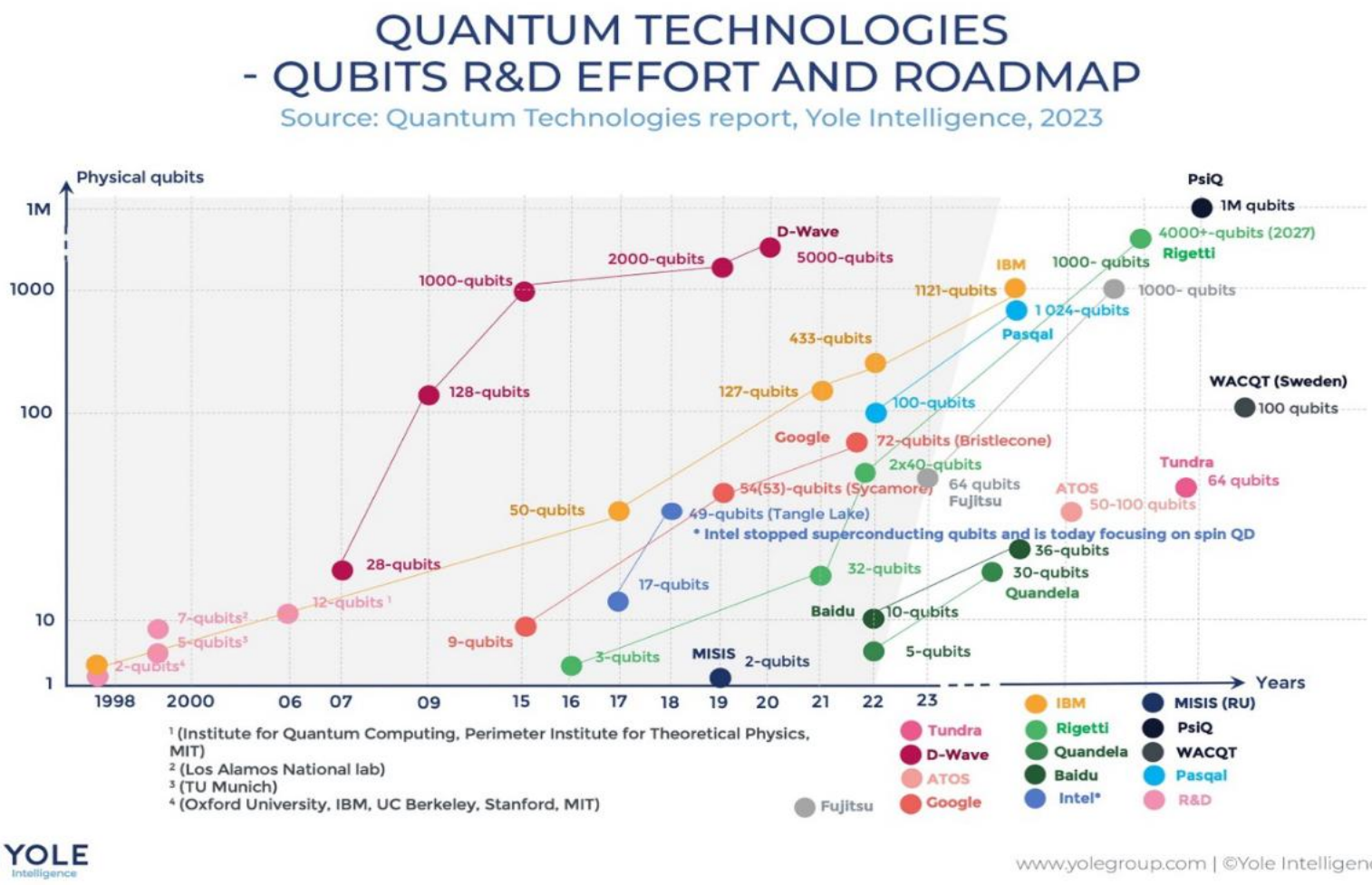
Quantum Computing – Start of a New S-Curve in Computing?



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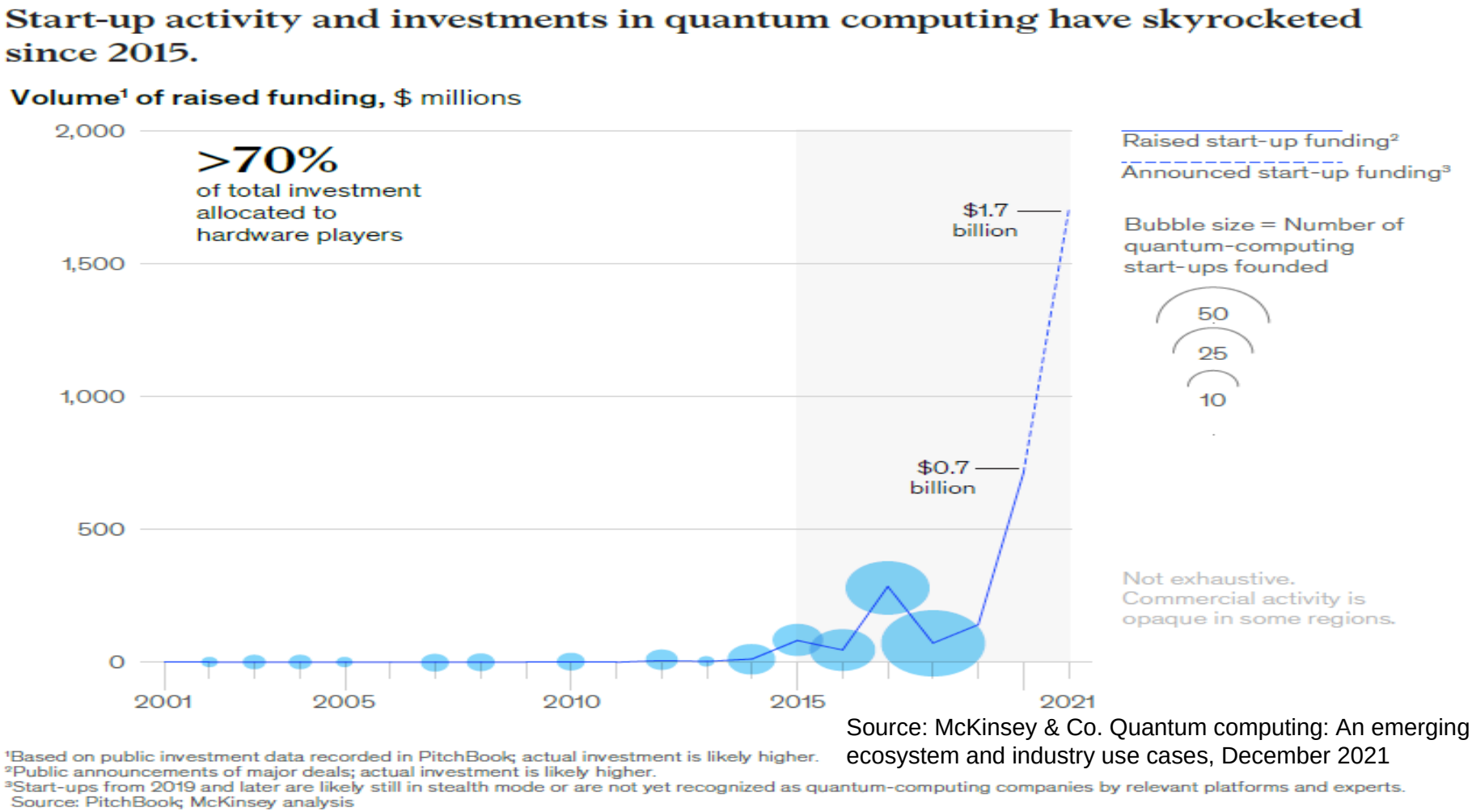
Increasing funding fuels an emerging quantum ecosystem



Source: McKinsey & Co. Quantum computing: An emerging ecosystem and industry use cases, December 2021

A Lack of Other Tech Innovations (Beyond IT & Services)?

Only These 51 Companies Have Been in the Fortune 500 Since 1955		
3M	Eli Lily	Lockheed Martin
Abbott Laboratories	Exxon Mobil	Merck
Altria Group	General Dynamics	Motorola Solutions
Archer Daniels Midland	General Electric	Northrop Grumman
Boeing	General Mills	Owens Corning
Bristol-Myers Squibb	General Motors	O-I Glass (Owens-Illinois)
Campbell Soup	Goodyear Tire & Rubber	Paccar
Caterpillar	Hershey	PepsiCo
Chevron	Honeywell International	Pfizer
Coca-Cola	Hormel Foods	PPG Industries
Colgate-Palmolive	Howmet Aerospace (Arconic)	Procter & Gamble
ConocoPhillips	IBM	Raytheon Technologies
Crown Holdings	International Paper	Rockwell Automation
Cummins	Johnson & Johnson	S&P Global
Dana	Kellogg	Textron
Deere	Kimberly-Clark	Weyerhaeuser
Dow	Kraft-Heinz	Whirlpool

Creative Destruction or Just Destruction? The Fortune 100 Changed From Old Manufacturing to Even Older Service Companies, But Not Primarily Because New Technologies Enabled New Companies

Sector	1955	2020
Manufacturing	74	20
Oil & Gas	17	9
Retail	0	11
Health Care	0	12
Finance/Insurance	0	22
Info & Comm Tech	6	17

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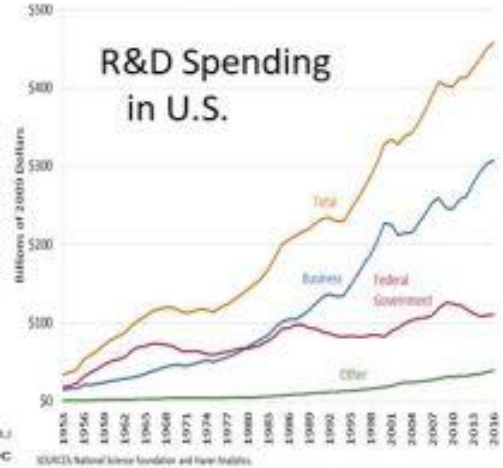
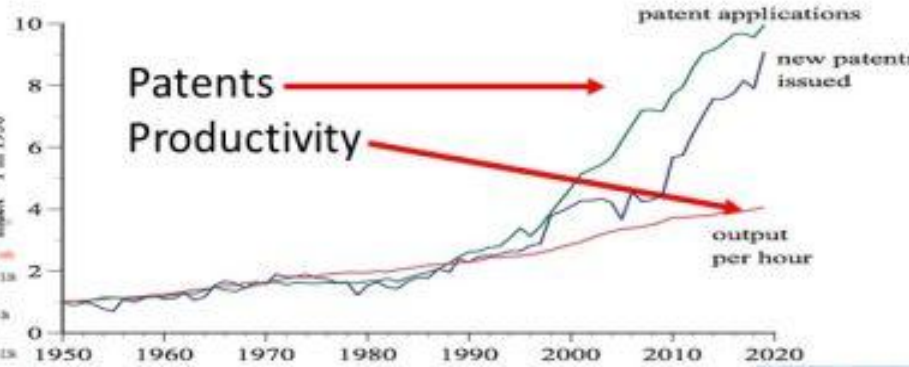
Lack of Revolutionary Technology that Potentially Increases Productivity

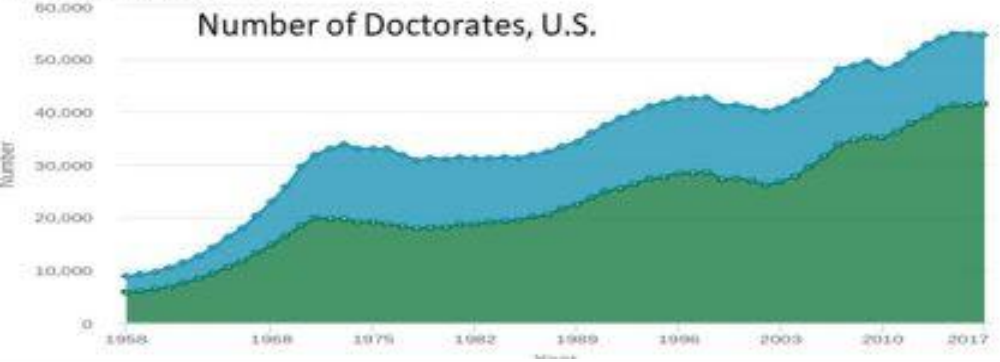
ILLUSIONS of Progress: In long run, productivity is almost everything. Other measures are less important

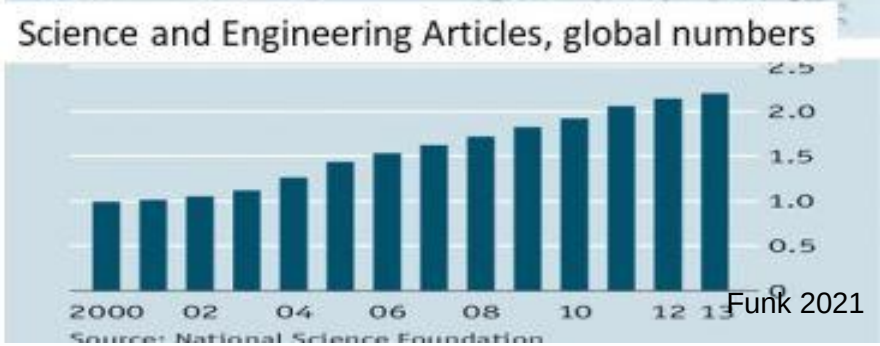












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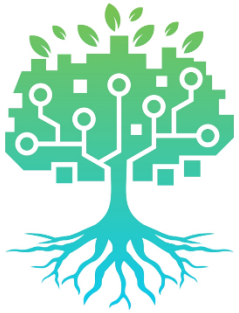
Other Innovations/Technologies would be needed to complete, some suggestions…

- New Energy systems/infrastructure, e.g. renewable, fusion, nuclear…
- New transportation system, e.g. supersonic airplanes, maglev highspeed trains, lighter-than-air transport ships, new energy cargo ships, space travel…
- New modes of production, decentralized, customized/individualized, e.g. nano-tech-based, 3d printed, automating construction, autonomous robots…
- Electrification & digitalization of money, heating/cooling, transportation…
- True medical progress on longer, healthy life, longevity,…
- Financial/banking System…DeFi..



All ELECTRIC SOCIETY
ALLIANCE

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Agenda

- Do We Live in an Age of Disruption?
- **Interrelation of Innovation and Sustainable Development**
- Interrelation of Culture, Creativity & Innovation

Why Technology is important for Sustainable Development?

Technology Improves Productivity

$$\text{Productivity} = \frac{Outputs}{Inputs}$$

Inputs: *labor, materials, capital, …*

Outputs: *goods, services*

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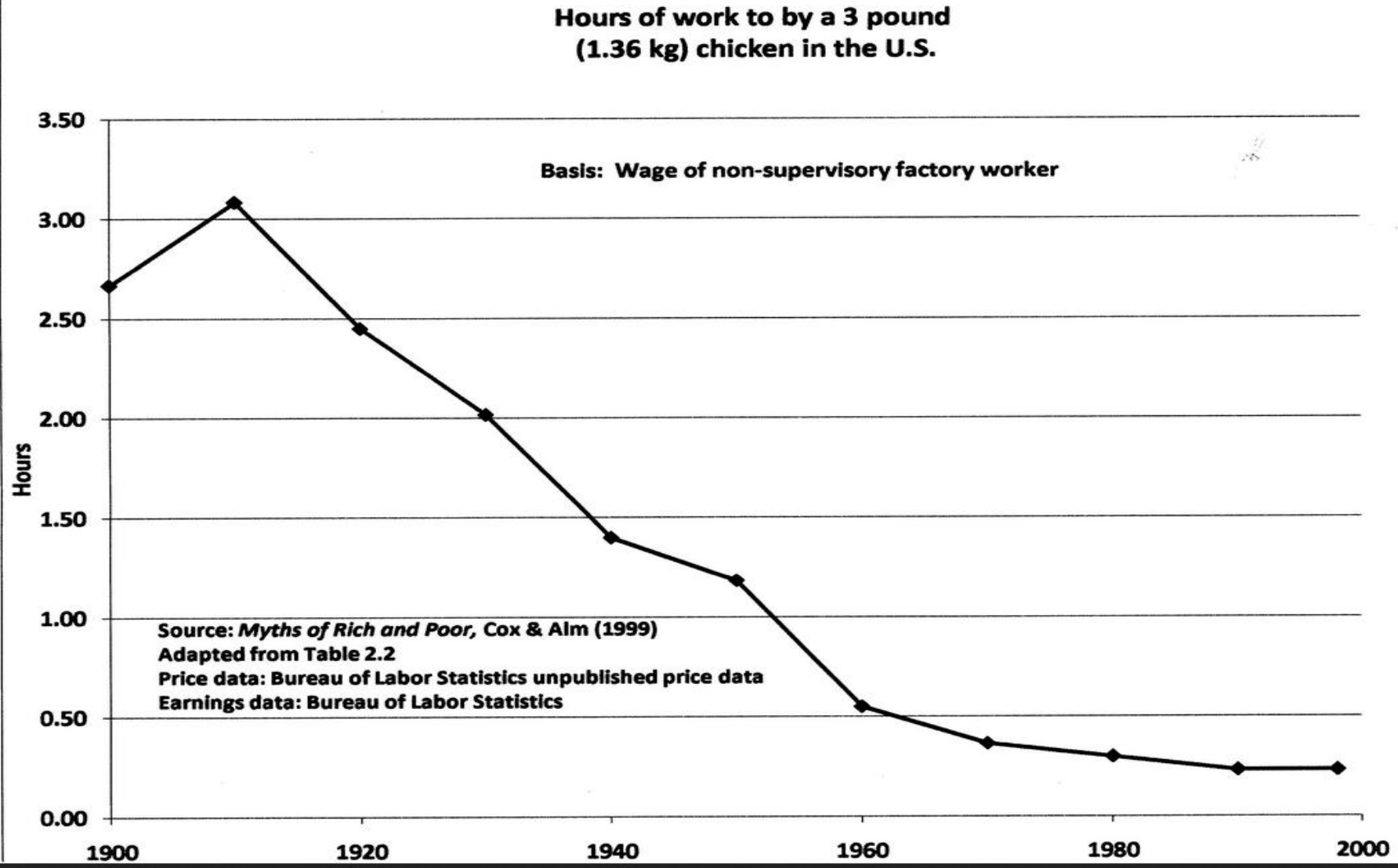
How Long Must a Factory-Worker Work For a Chicken in the US?



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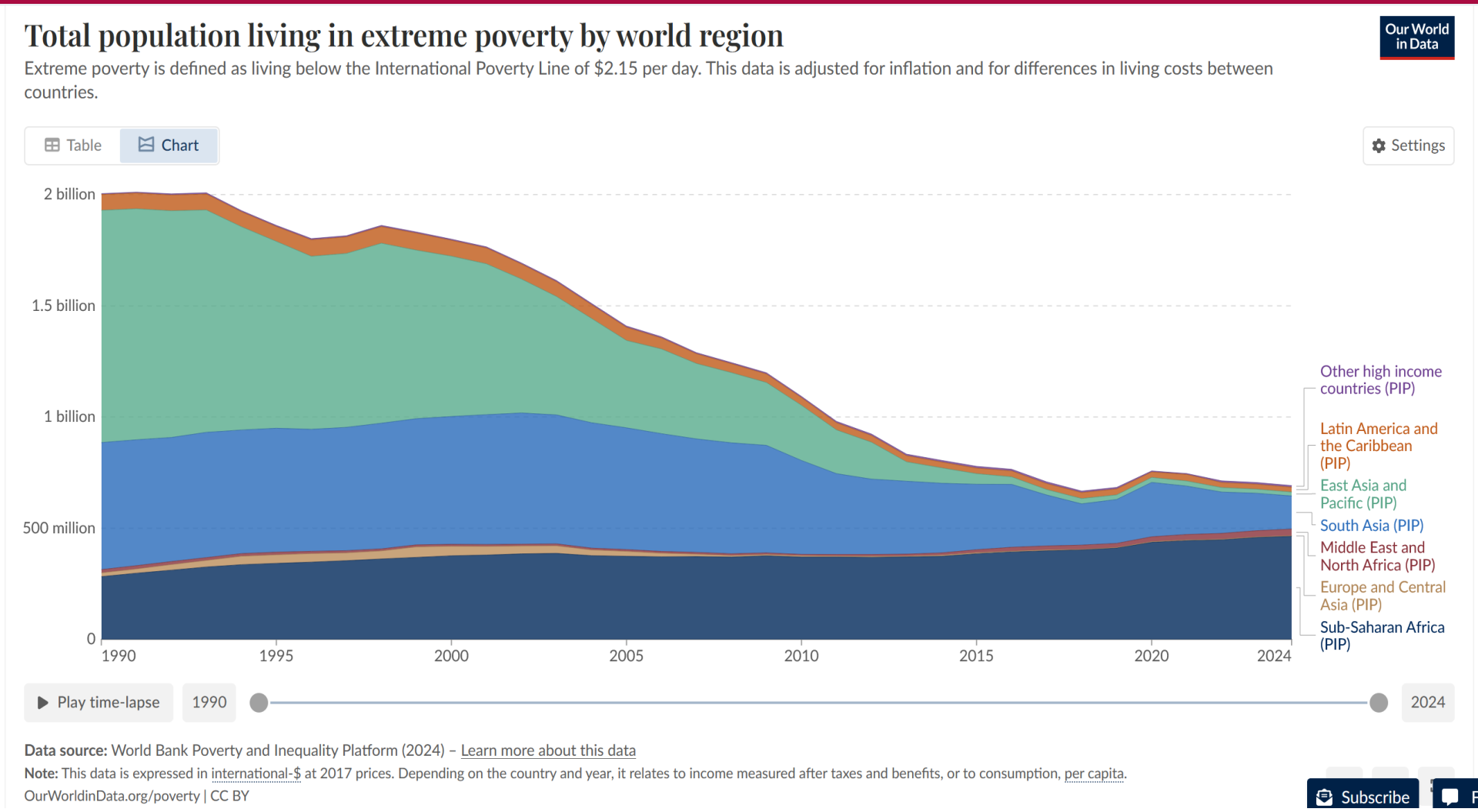
Extreme Poverty Deceased for Decades – Until Recently



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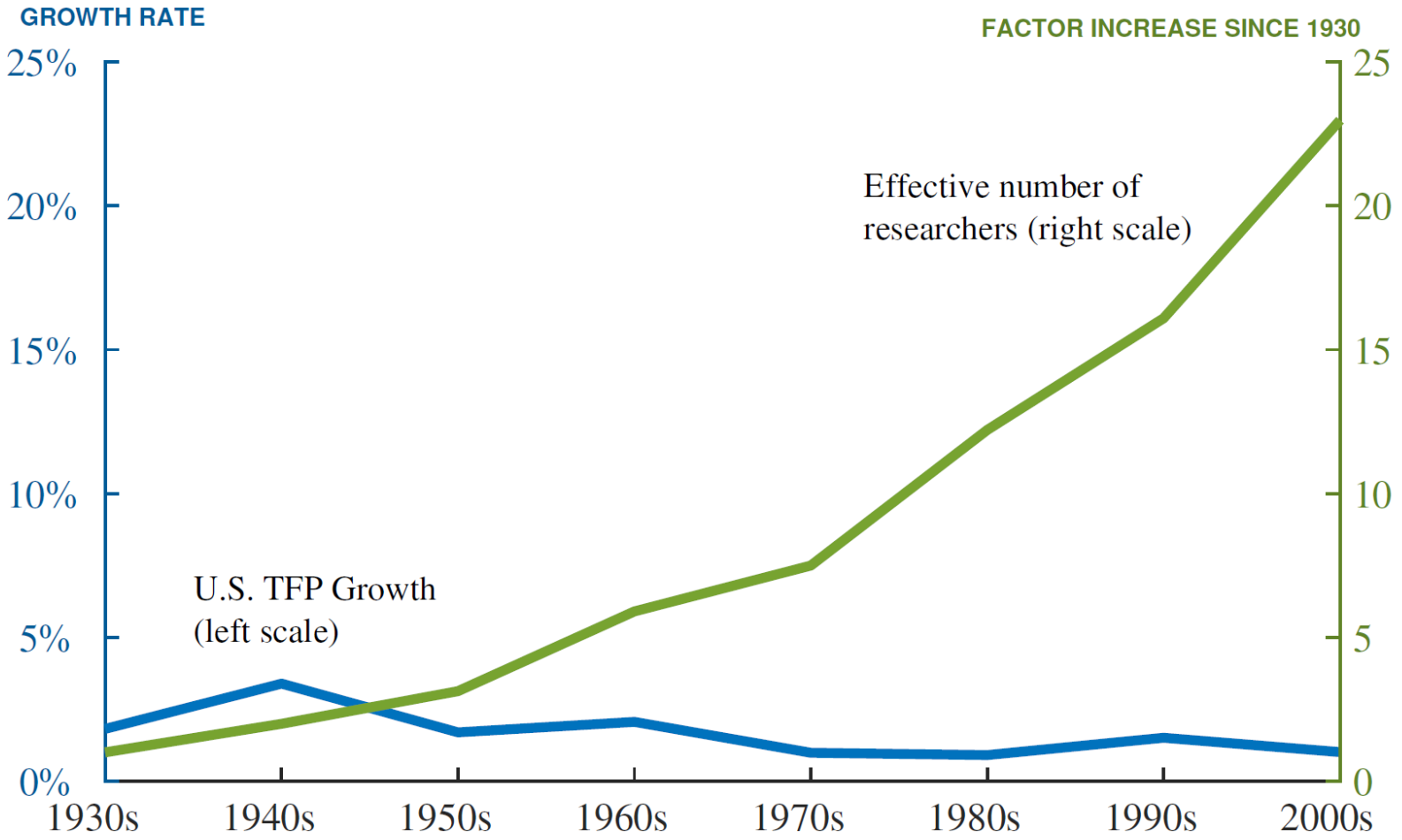
Limits of Conventional Approaches: Decreasing Effects on Productivity Growth



Bloom et al.2017

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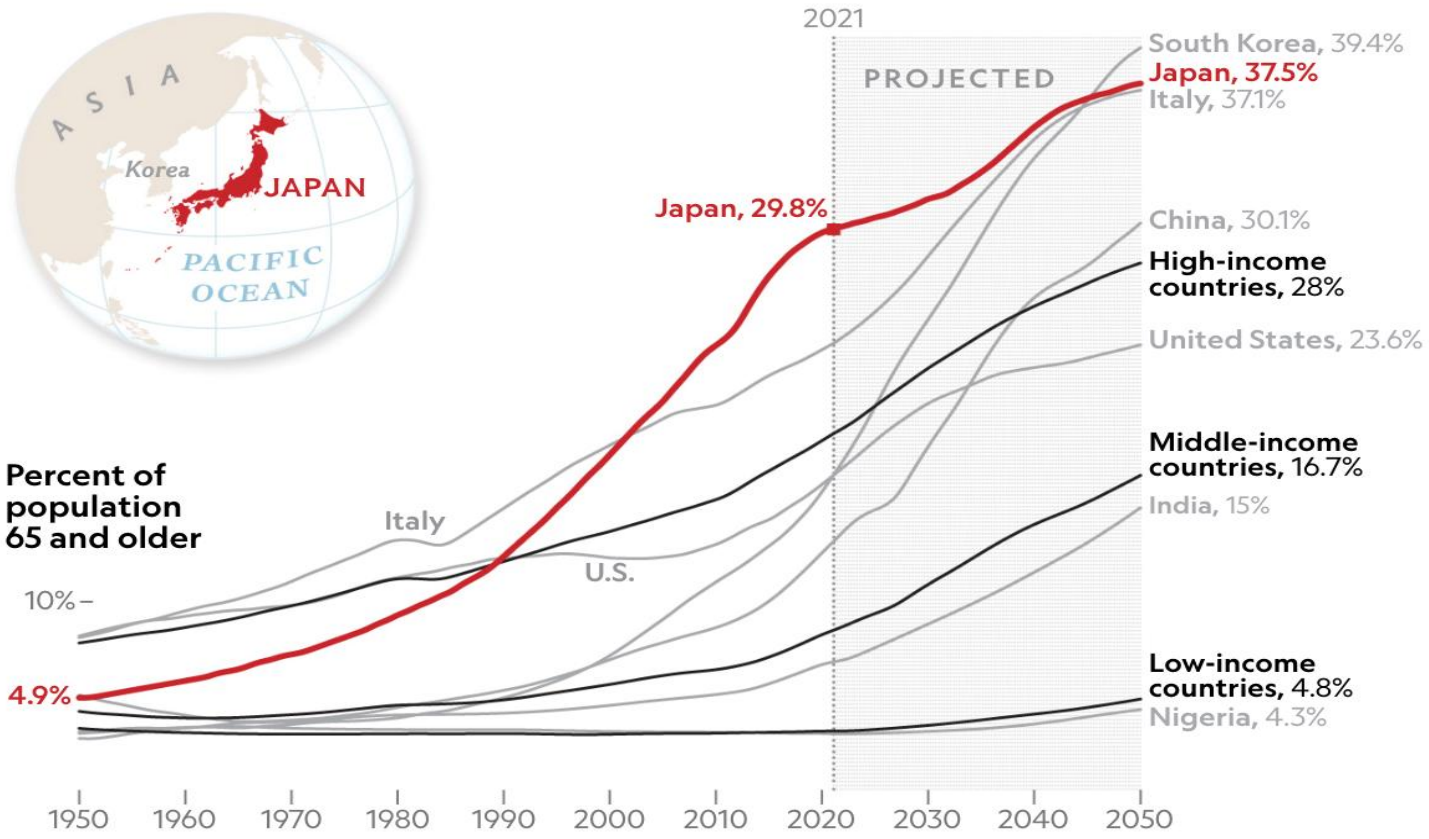
Global Demographic Trends: Low End & High Population Growth Correlate



Riley D. Champine, NGM Staff; Brandon Shypkowski
Sources: Peter Matanle, University of Sheffield; James Raymo, Princeton University; United Nations Population Division

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What is the Implication for Sustainable Development?

- „**Sustainable development** is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains two key concepts:
  - the concept of "**needs**", in particular the essential needs of the **world's poor**, to which overriding priority should be given; and
  - the idea of **limitations** imposed by **the state of technology** and **social organization** on the **environment's ability** to meet present and future needs.“

1987 World Commission on Environment and Development (Brundtland Report.) „*Our Common Future*“

→ **Disruptive innovation progresses the applied state of technology its limitations**

→ **Social entrepreneurship & catalytic innovation help to address the social organization limitations**

→ **Both address especially the “low end”**

Agenda

- Do We Live in an Age of Disruption?
- Interrelation of Innovation and Sustainable Development
- **Interrelation of Culture, Creativity & Innovation**

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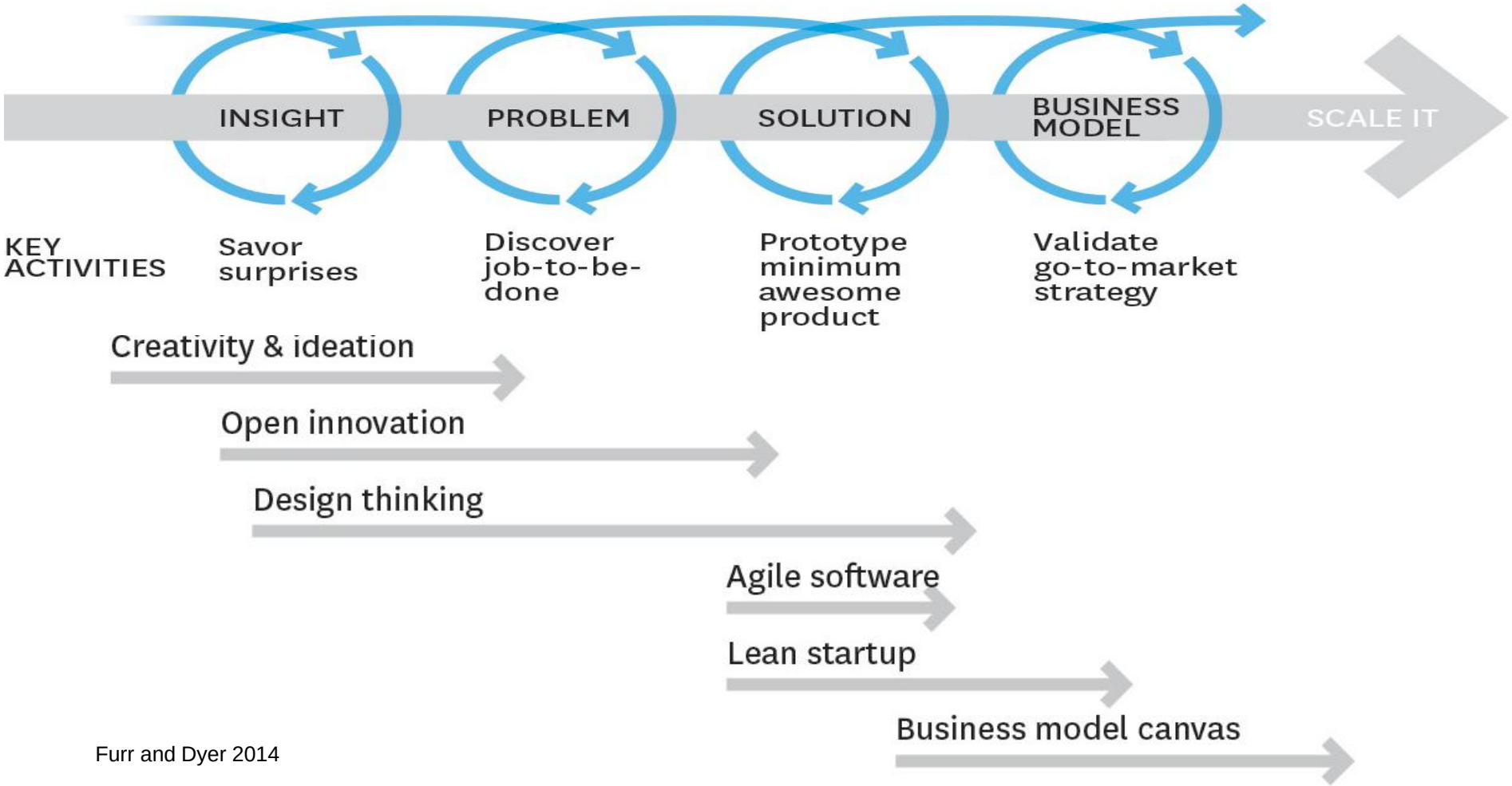
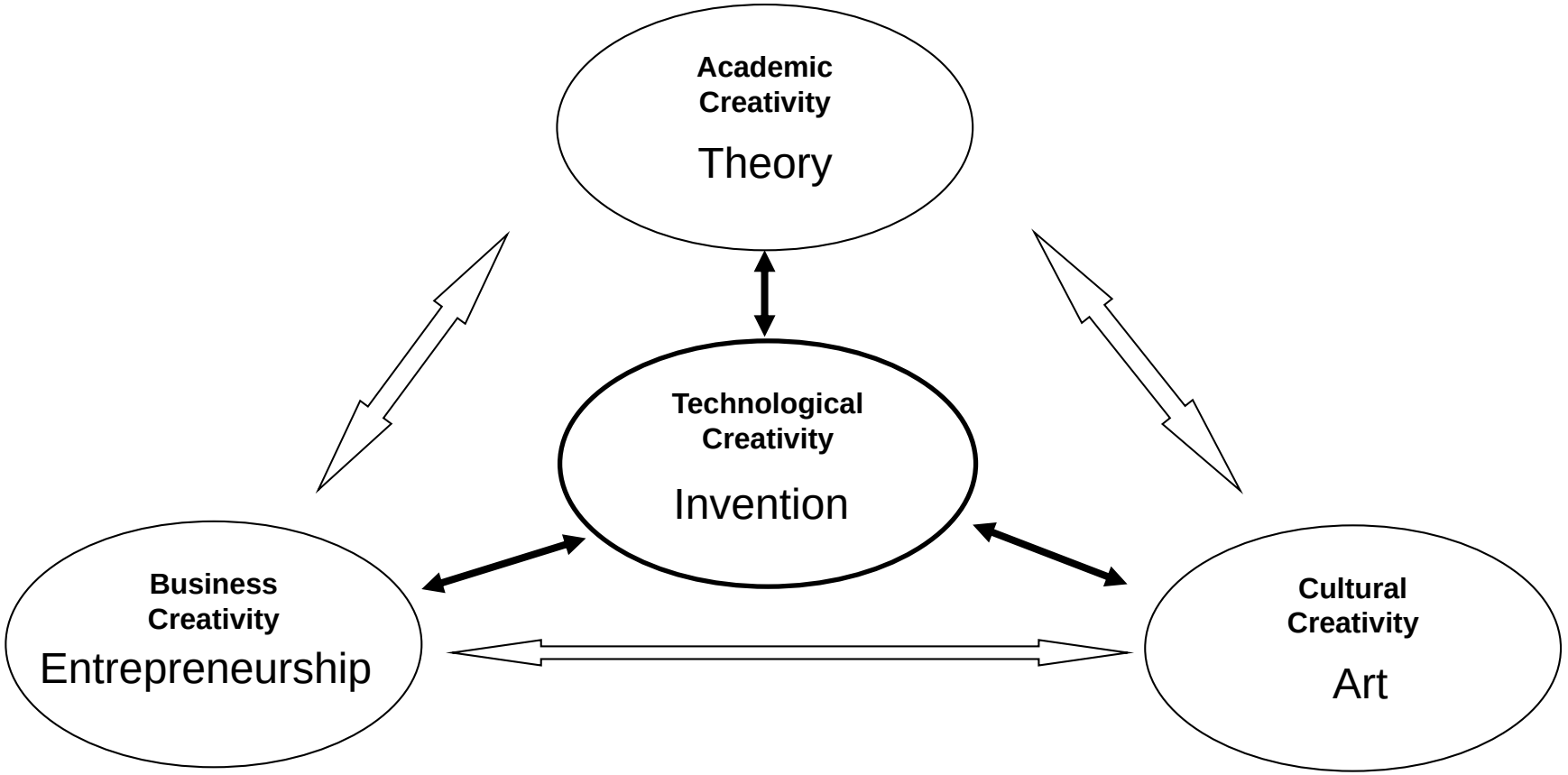
We need Creativity for Innovation



Furr and Dyer 2014

Connection of Art, Creativity, Science & Innovation?

Domains of Creative Activity



Franke 2004

Connection of Cultural Creativity & Science?

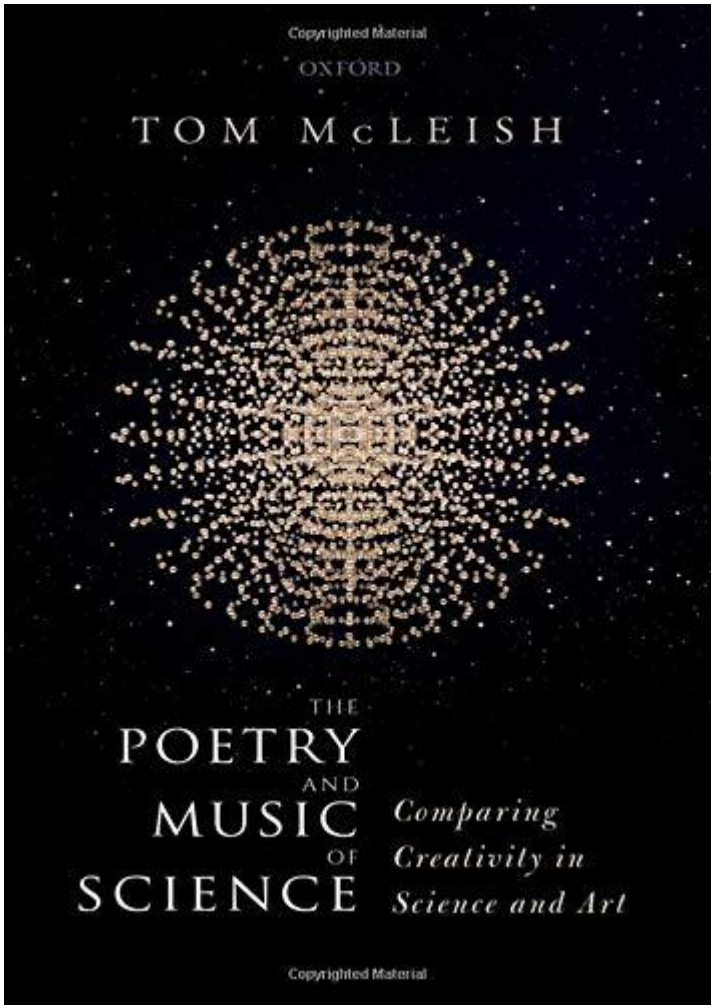
I am enough of an artist to draw freely upon my imagination. Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world.

Albert Einstein 1929

Science is deeply imaginative: why is this treated as a secret?

Tom McLeish 2019

Imagination and **Creativity** in **Science**



- What human qualities are needed to make **scientific discoveries**, and which to make **great art**?
- Many would point to '**imagination**' and '**creativity**' in the second case but not the first.
- **The assumption that doing science is in any sense less creative than art, music or fictional writing and poetry is challenged**.

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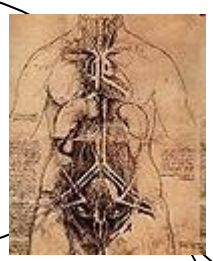
Domains of Creative Activity - Transdomain Creative Persons



Leonardo da Vinci





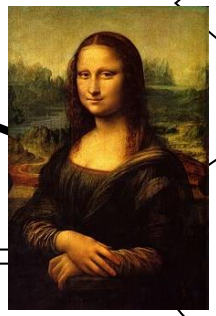
Academic Creativity

Theory



Technological Creativity

Invention





Creativity

Art

Business Creativity

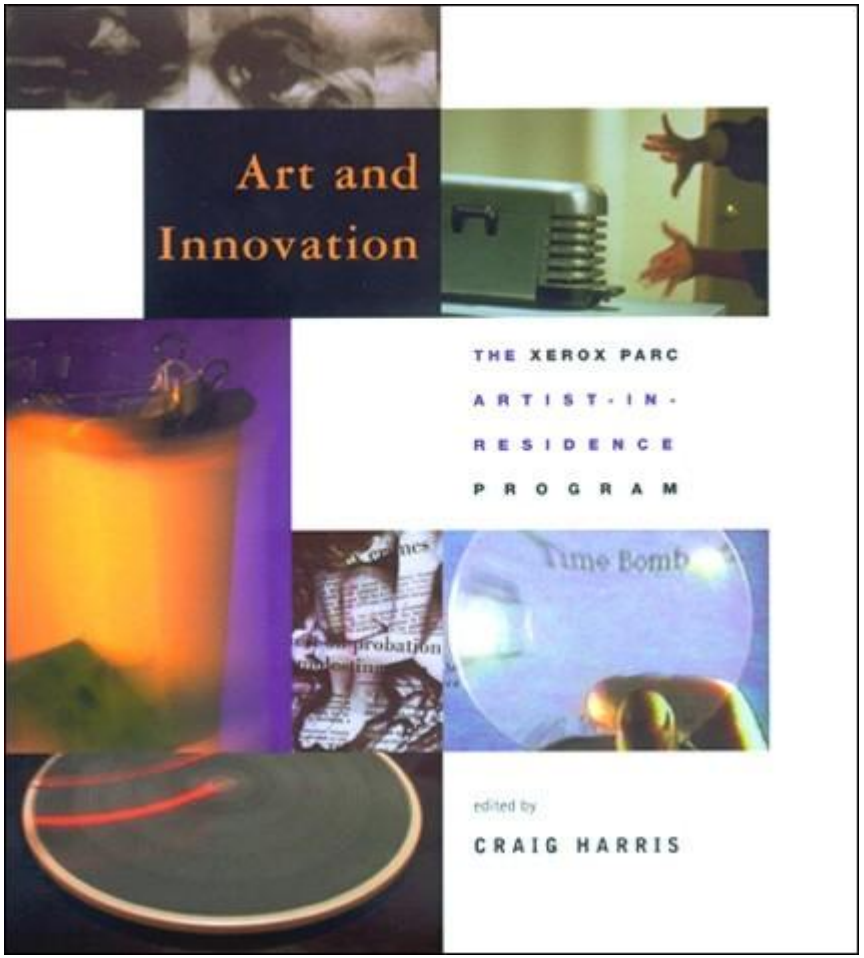
Entrepreneurship





Franke 2004

Art as Stimulus for Corporate Innovation Culture: Artist-in-Residence Programs



The Xerox PARC **Artist-in-Residence Program** (pubished 1999)

Exploring a radical combination of research, art and new media.

The idea behind Xerox's interdisciplinary Palo Alto Research Center (PARC) is simple: if you put creative people in a hothouse setting, innovation will naturally emerge. PARC's Artist-in-Residence Program (PAIR) brings artists who use new media to PARC and pairs them with researchers who often use the same media, though in different contexts.

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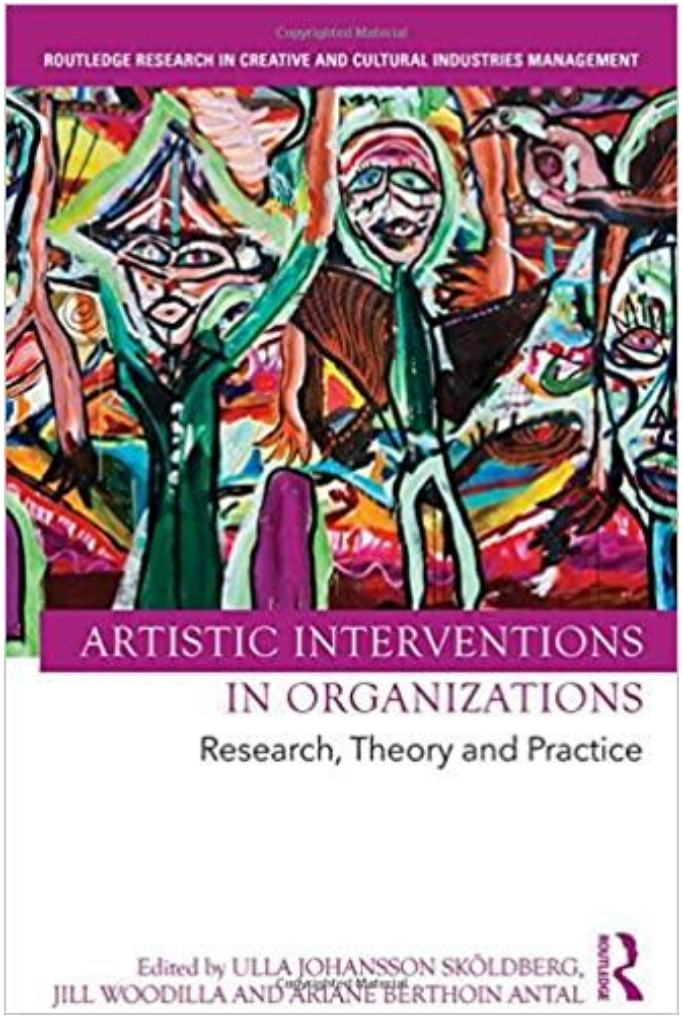
Art as Stimulus for Corporate Innovation Culture: Artistic Interventions



- Bertoin Antal insists that since the late 1990s the interaction between arts and organizations has changed
- More recently that collaboration has changed into a closer form of interaction where the artists are brought into the organization to truly interact what Berthoin Antal (2012) describes as “artistic interventions” and emphasizes that this term clearly goes beyond collaborations or simply learning. “Intervention” reflects the fact that the entrance of the arts into the work environment “intervenes in the organization’s culturally engrained routines and perspectives.” (Berthoin Antal, 2012:45).
- This definition also goes beyond classical “artist-in-residence” programs where the focus traditionally was on the creation of art in different settings and mutual inspiration (Harris, 1999).
- The **focus of artistic intervention is on “mutual learning” and the “process of creating” rather than the artwork as an outcome** (Shrivastava et al. 2012). It involves a **reflection** of the respective worlds, clearly beneficial to both corporation and artists.



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Wimmelforschung on Bosch R&D Campus Renningen: “Platform 12“

- The Platform 12 is located on the 12th floor
- Equipped with furniture from the 1920s-50s years and filled with unusual art objects
- Workspace for 1500+ researchers to meet and exchange with other researchers
- Key element to make ideas visible and even to be able to track and trace other researcher's work
- Creating friction through art objects and provoke unusual conversations



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Culture as Factor for Economic, Social and Technological Development & Innovation

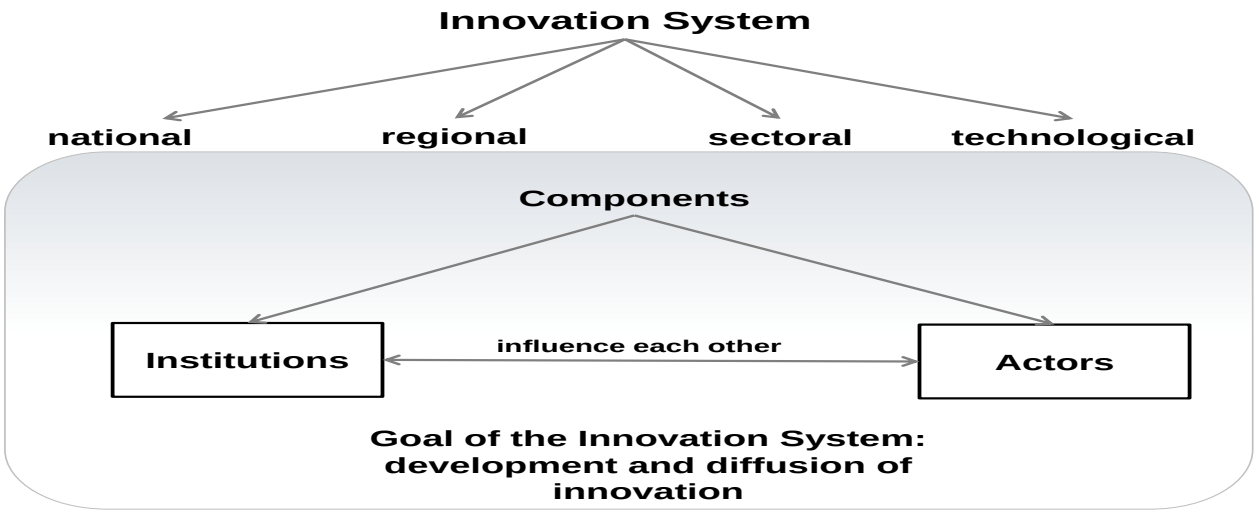
- Historically, **economic and technological development** have been related to forces such as **religion** (Weber 1904/protestant ethic & capitalism, Merton 1938/religion and the **rise of modern science**)
- Later **social and economic welfare** is a driving force of **innovation** (e.g. Rudolf Diesel's "Solidarismus" 1903)
- Hard and soft **institutions are shaped by country culture/ religion**
- E.g. more **individualist culture** leads to **more innovation** and to higher growth (Gorodnichenko & Roland 2017)
- While research has pointed to the role of **institutions** as well as the role of internal dynamics in shaping (organizational) behaviors, the **role of ideology has been relatively neglected** (Foss and Klein 2024)

  → Ideology as Worldview aka *Weltanschauung*?

Institutions & the Innovation System Approach

Innovation System Approach

"Institutions are the humanly devised constraints that **structure human interaction**. They are made up of **formal** constraints (e.g., rules, laws, constitutions), **informal** constraints (e.g., norms of behavior, conventions, self-imposed codes of conduct), and their enforcement characteristics. Together they define the **incentive structure of societies** and specifically economies.
Institutions and the technology employed **determine the transaction and transformation costs** that add up to the **costs of production**…..if **institutions are the rules of the game**, organizations and their **entrepreneurs are the players**" North (1994)



Institutions & the Innovation System Approach

National Innovation System

Freemann (1987, 1995)



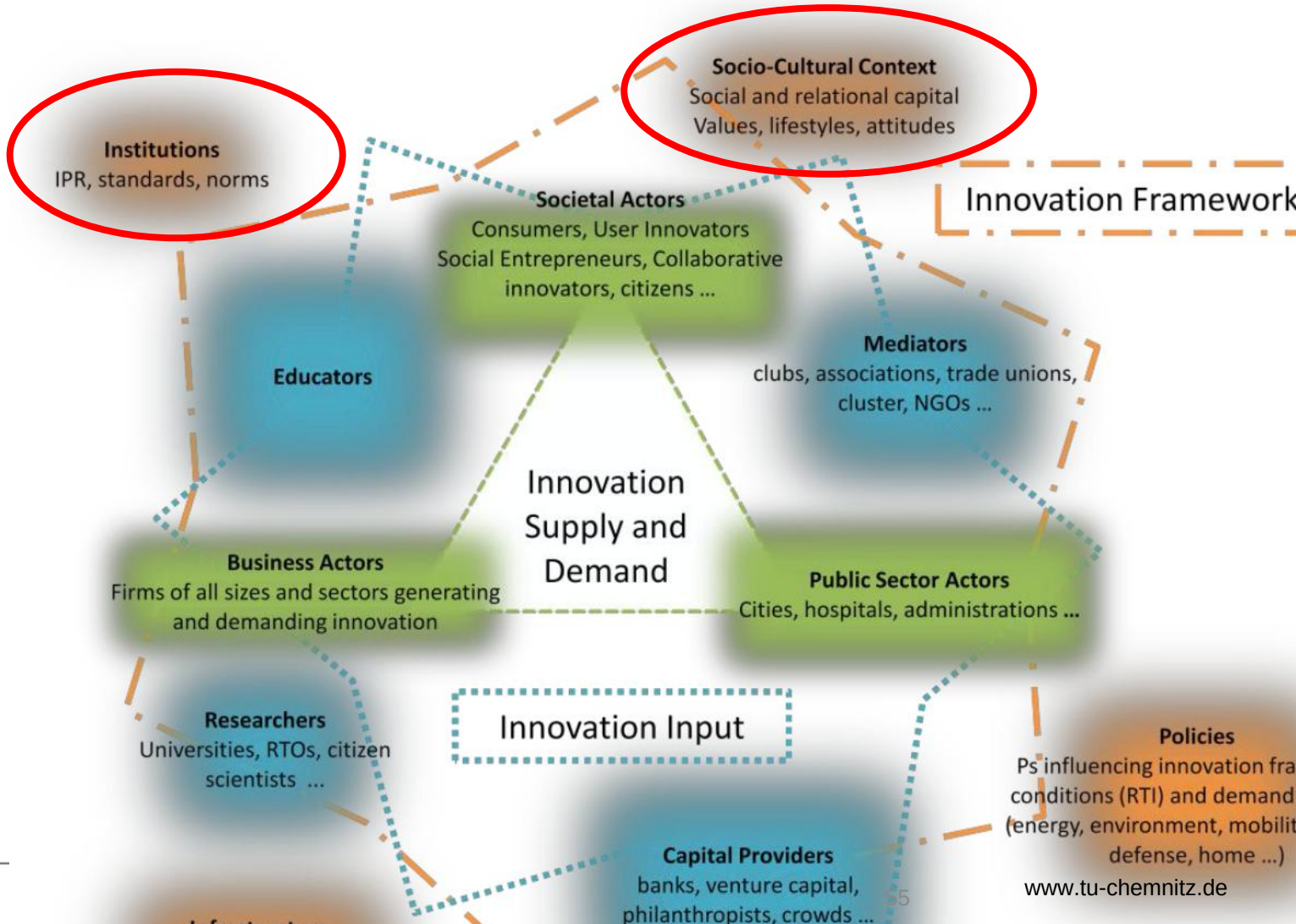
Definition: „**The network of institutions in the public and private sectors whose activities and interactions initiate, import, and diffuse new technologies**“

“Contrary to some recent work on so-called 'globalisation', this paper argues that **national and regional systems of innovation remain an essential domain of economic analysis**. Their importance derives from the **networks of relationships** which are necessary for any firm to innovate. Whilst external international connections are certainly of growing importance, the influence of the national education system, industrial relations, technical and scientific institutions, government policies, cultural traditions and many other national institutions is fundamental.”

Institutions & the Innovation System Approach

Innovation System & Actors

Warnke et al. (2016)



Conclusions

- Do We Live in an Age of Disruption?
  - No golden age so far for Europe or USA but maybe for China? Location & perspective matters?? Still many hybrid solutions…
- Interrelation of Innovation and Sustainable Development
  - Are there limits of growth or is demographics destiny?
- Interrelation of Culture, Creativity & Innovation
  - Culture is sometimes underestimated and comes with many faces in this context, e.g. creative industries
- **To be continued in the coming days!**

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Thank you!

Reflection
Q&A