THE **aiim** 2013
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EXTREME
Information
Volume | Variety | Devices

The Future of Information:
The race between man and machine

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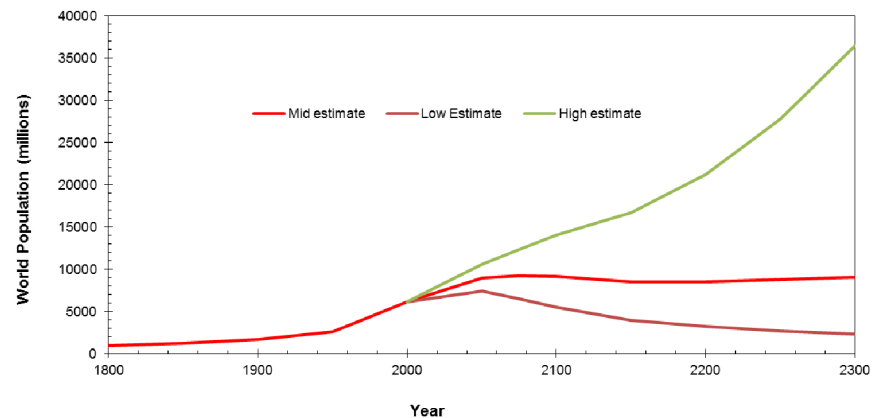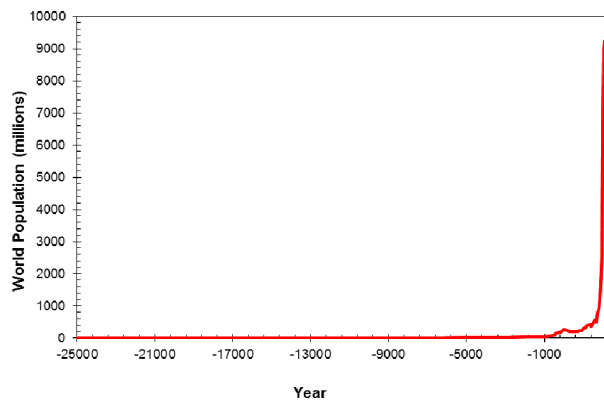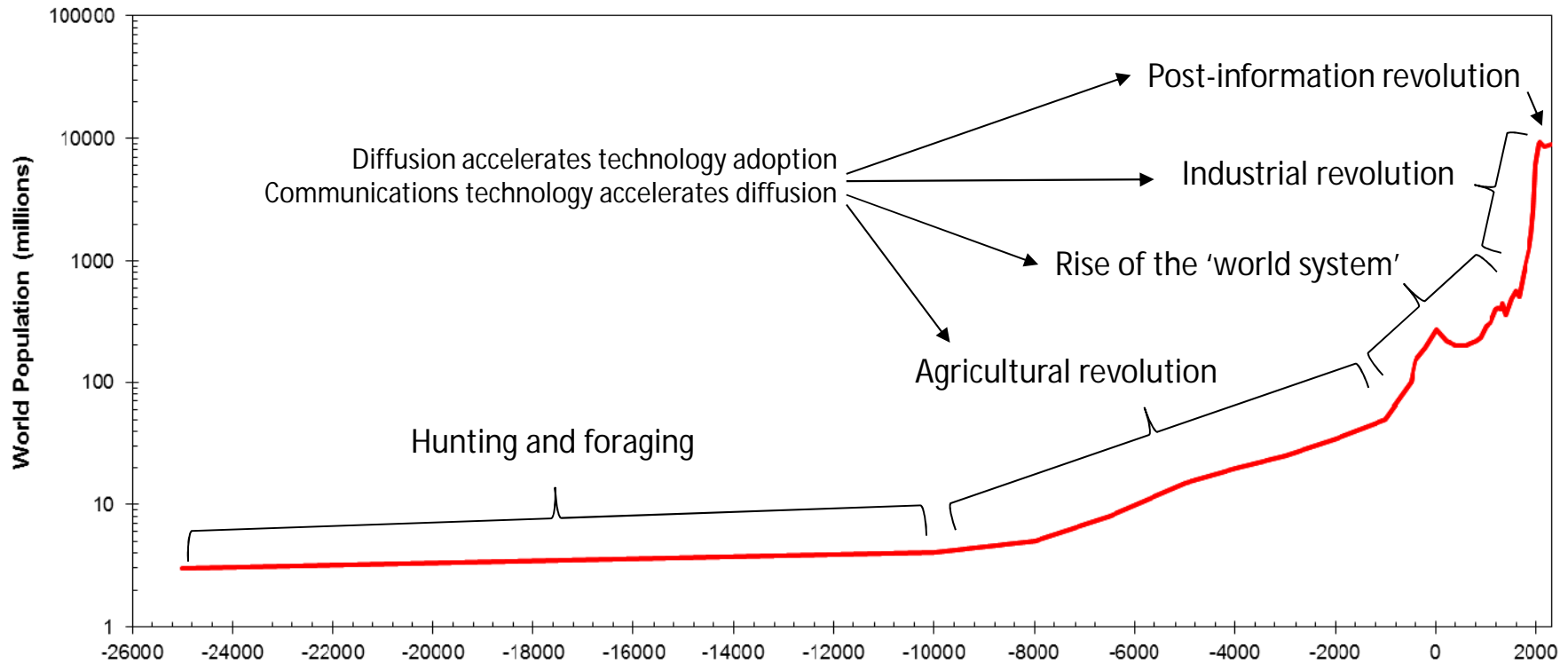University of Kentucky
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#AIIM13

Background

- UK
  - $2.8 billion enterprise, 13,500 employees, 28,000 students
  - 16 colleges, full suite of athletics
  - Four lines of business: instruction, research, healthcare, entertainment and resort
- Myself
  - Industry / Education
    - Mix of industry background, large small business, entrepreneur
    - Higher education instructor, administrator
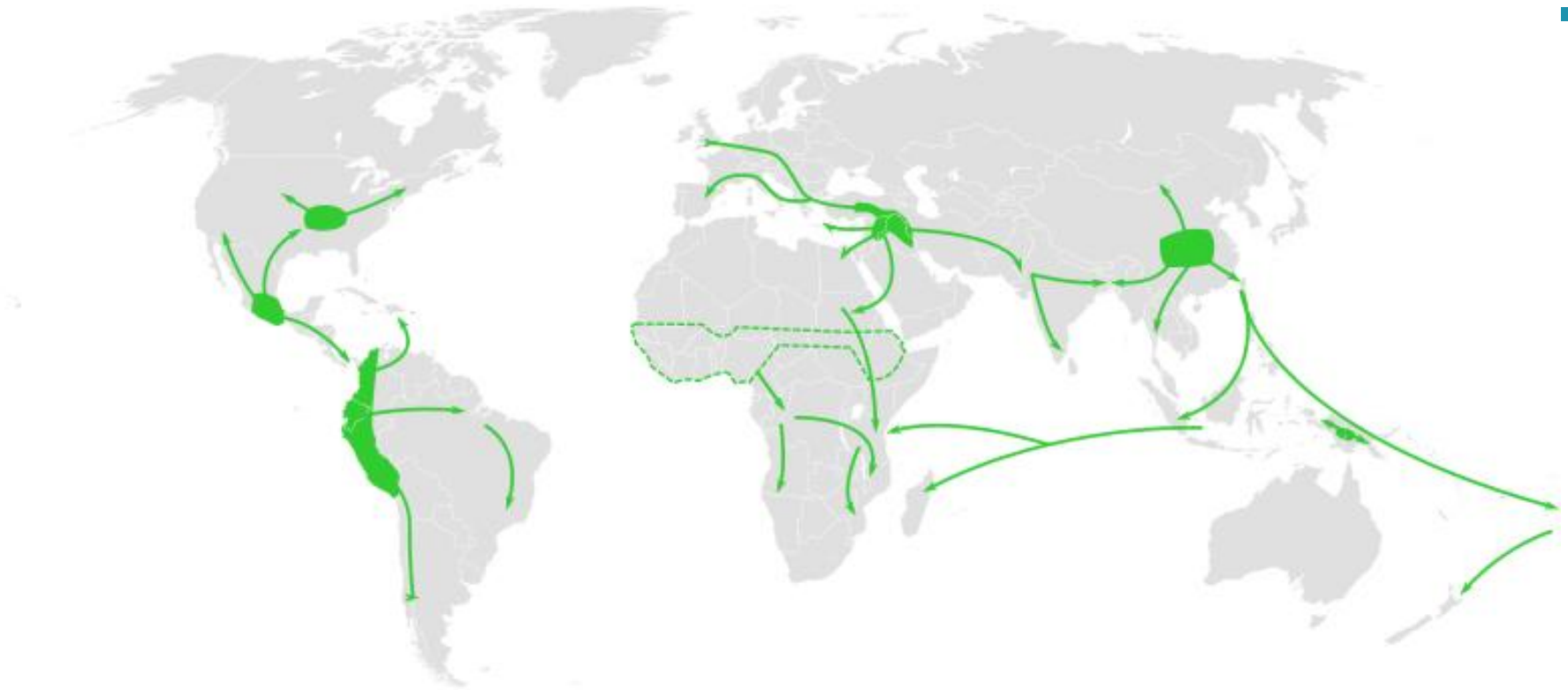 - Senior Consultant & Fellow, Cutter Consortium

The Past

[Population, wealth, technology, knowledge]

Post-information revolution

Diffusion accelerates technology adoption
Communications technology accelerates diffusion

Industrial revolution

Rise of the 'world system'

Agricultural revolution

Hunting and foraging

Sources: Wikipedia; various; UN Report *World Population to 2300* (2004)

The Neolithic Revolution

Map of the world showing approximate centers of origin of agriculture and its spread in prehistory: the Fertile Crescent (11,000 BP), the Yangtze and Yellow River basins (9000 BP) and the New Guinea Highlands (9000–6000 BP), Central Mexico (5000–4000 BP), Northern South America (5000–4000 BP), sub-Saharan Africa (5000–4000 BP, exact location unknown), eastern USA (4000–3000 BP). (Wikipedia)

The original optical computer

Travelers from Sicily brought the sundial to Rome in 263 B.C. and set it up in the Forum, where it became a popular meeting place. People came to check the time, to socialize, and "to see and to be seen." Other sundials were set up in public buildings or squares. Only the wealthy could afford to have one in their own homes and it quickly became a status symbol.

http://www.dl.ket.org/latin3/mores/techno/time/tellingtime.htm
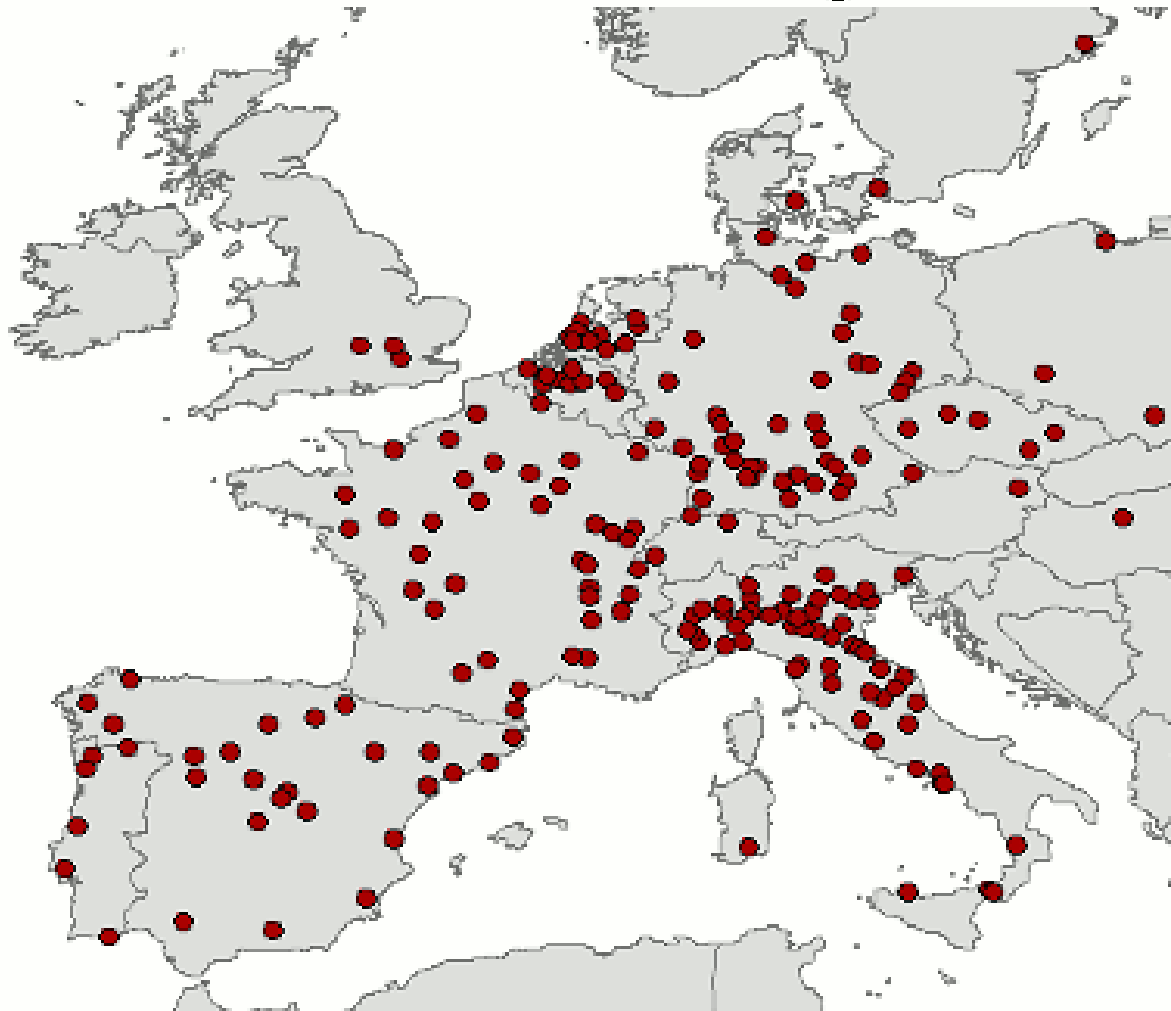
Spread of printing technology

A: Cities with Printing in 1450

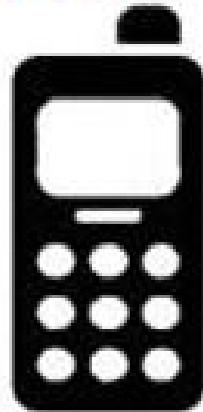http://economistsview.typepad.com/economistsview/2011/02/the-spread-of-technology-the-printing-press.html

Spread of printing technology

F: Cities with Printing in 1500

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Map of a computer virus infection in 24 hours

80% of the world has a phone
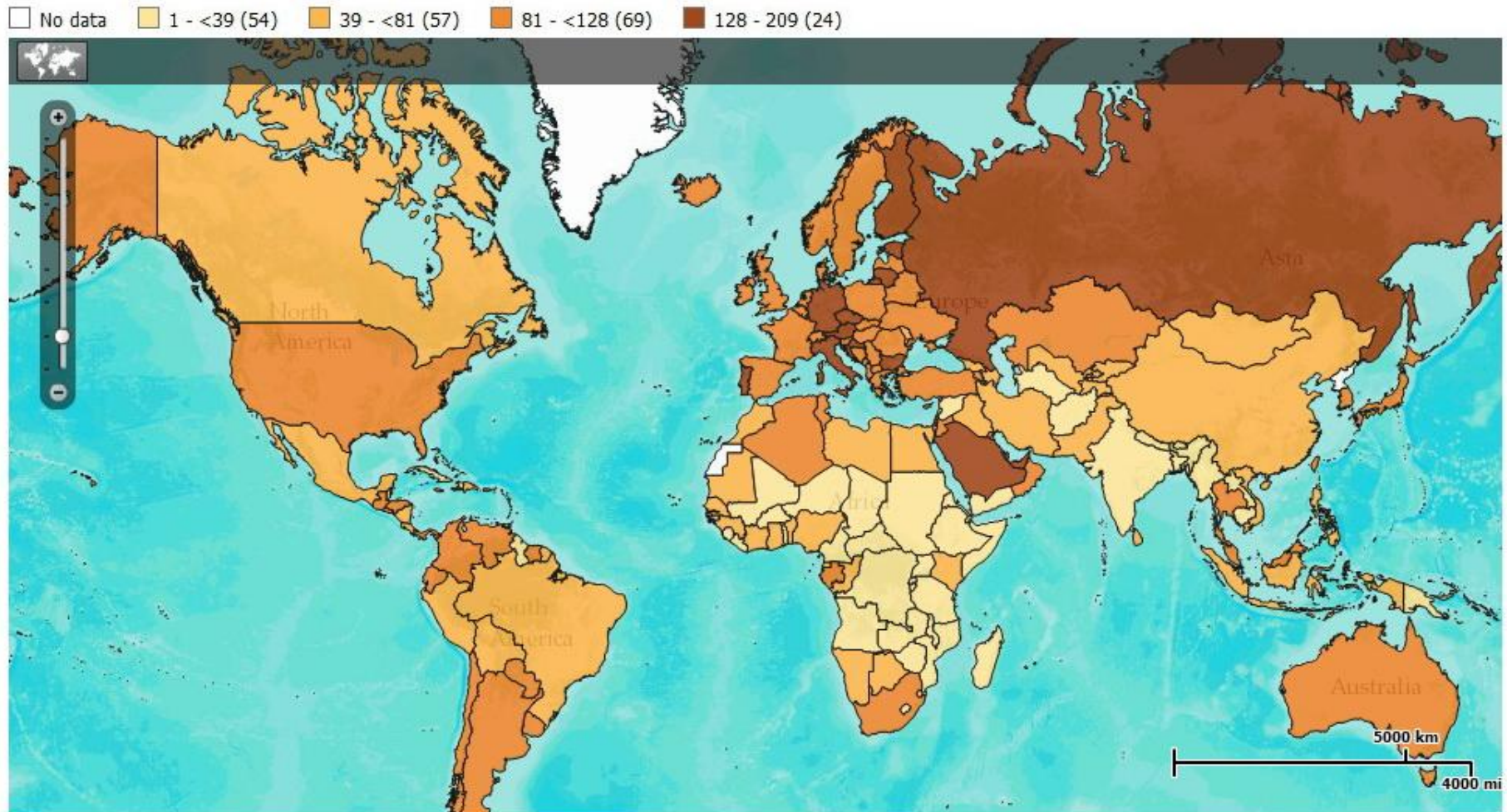

Mobile Phones in World
5 Billion
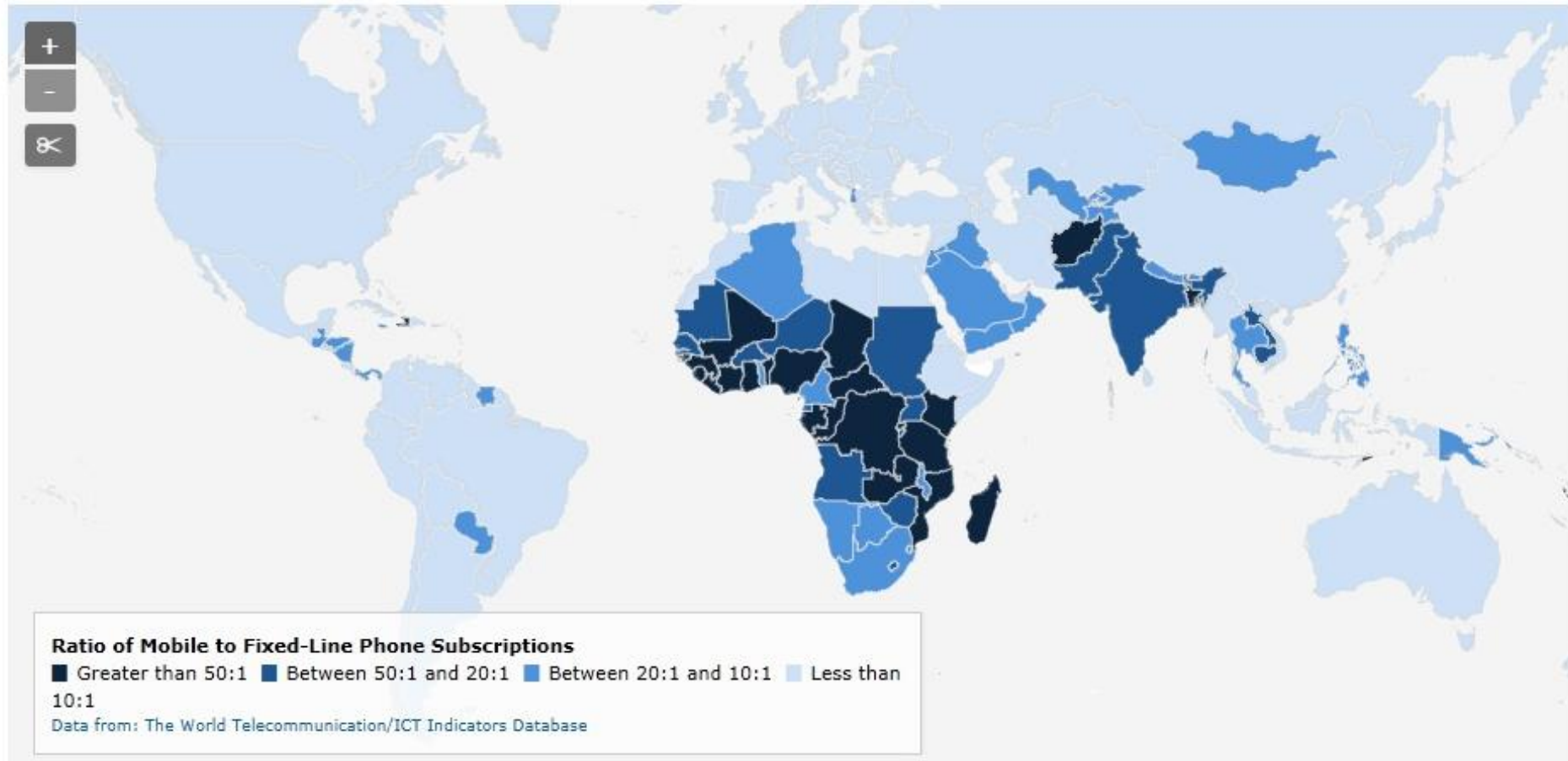
Out of which only
1.08 Billion
are smart phones

Mobile phone subscriptions per 100 people

Legend: No data | 1 - <39 (54) | 39 - <81 (57) | 81 - <128 (69) | 128 - 209 (24)

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Ratio of wireless to fixed line phone subscription

Ratio of Mobile to Fixed-Line Phone Subscriptions
Greater than 50:1 ■ Between 50:1 and 20:1 ■ Between 20:1 and 10:1 ■ Less than 10:1
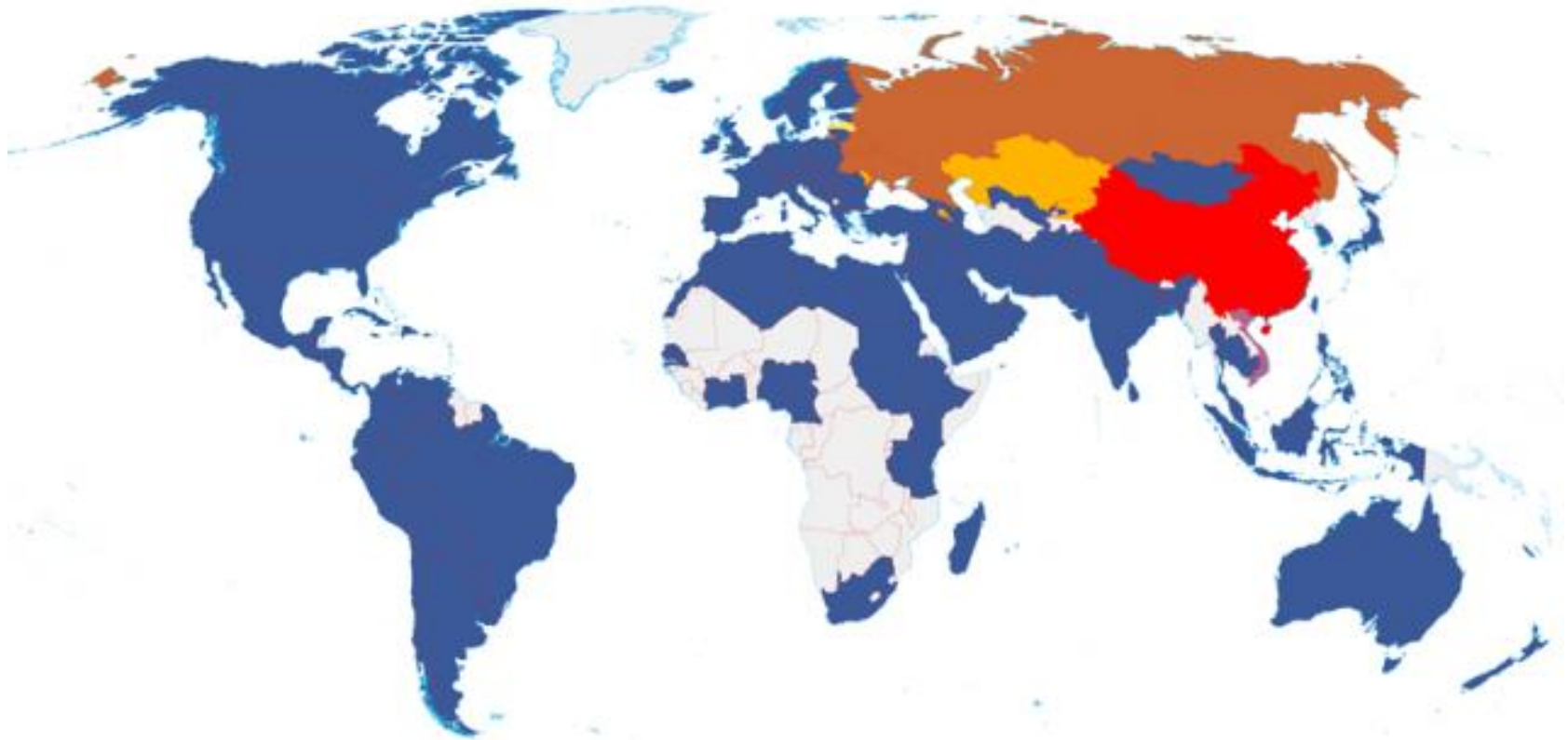Data from: The World Telecommunication/ICT Indicators Database

The Social Network Risk Board

WORLD MAP OF SOCIAL NETWORKS

December 2011

Facebook ■ QZone ■ V Kontakte ■ Odnoklassniki ■ Draugiem ■ Zing

World's technological installed capacity to store information
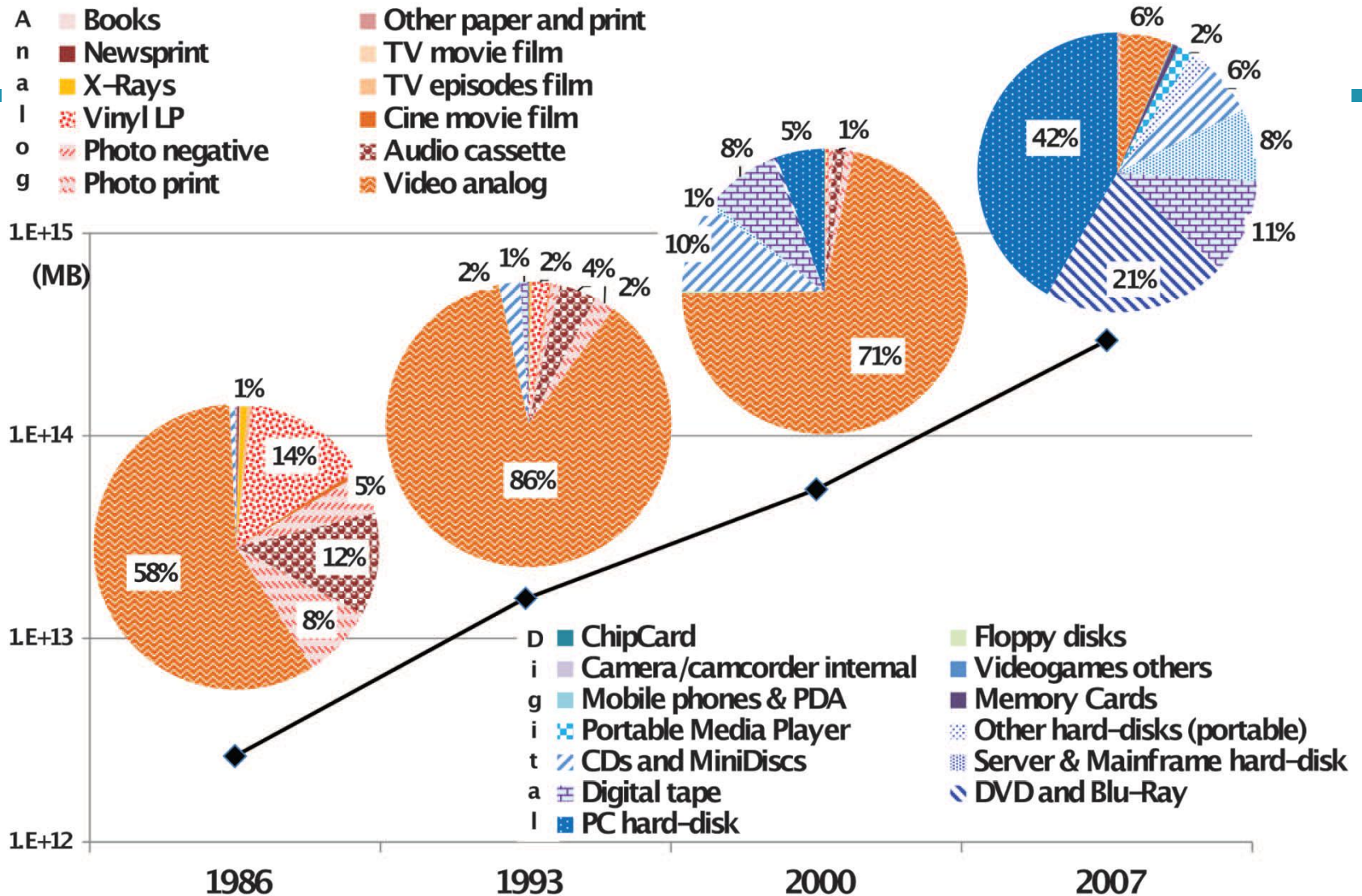
Hilbert M, Lopez P. 2011. The World's Technological Capacity to Store, Communicate, and Compute Information. Science. Vol. 332 no. 6025 pp. 60-65.
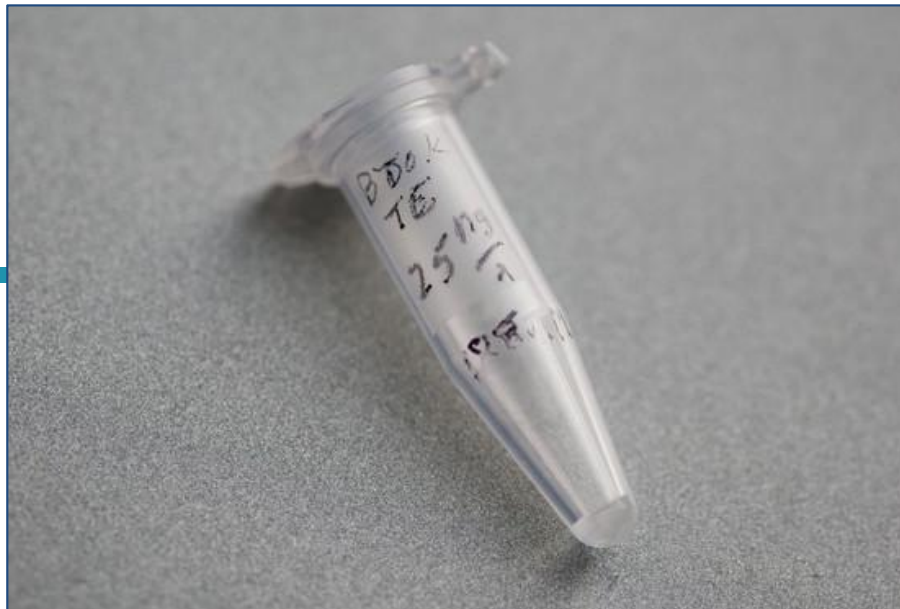
Photo: Kelvin Ma for the Wall Street Journal

Dr. Church keeps a vial of DNA encoded with copies of his latest book.

The total world's information, which is 1.8 zettabytes, could be stored in about four grams of DNA.

Harvard stores 70 billion books using DNA.
Research team stores 5.5 petabits, or 1 million gigabits, per cubic millimeter in DNA storage medium

http://www.computerworld.com/s/article/9230401/Harvard_stores_70_billion_books_using_DNA

Information loves what we have invented.
It gets to spread itself really f%^#(@*^-ing fast.

But what have we really created?

'Theoretical' Considerations

Resistance to pure chaos?

Probability of occurrence

1

Zone of optimal
information advantage
(edge of chaos)

To gain an edge,
agents will develop
more complex
models, with longer
time horizons,
resulting in
increasing
dynamic complexity

To avoid losing,
agents will develop
simpler models,
with shorter time
horizons resulting
in decreasing
dynamic complexity

0

Level of Complexity

0
Order

1
Chaos
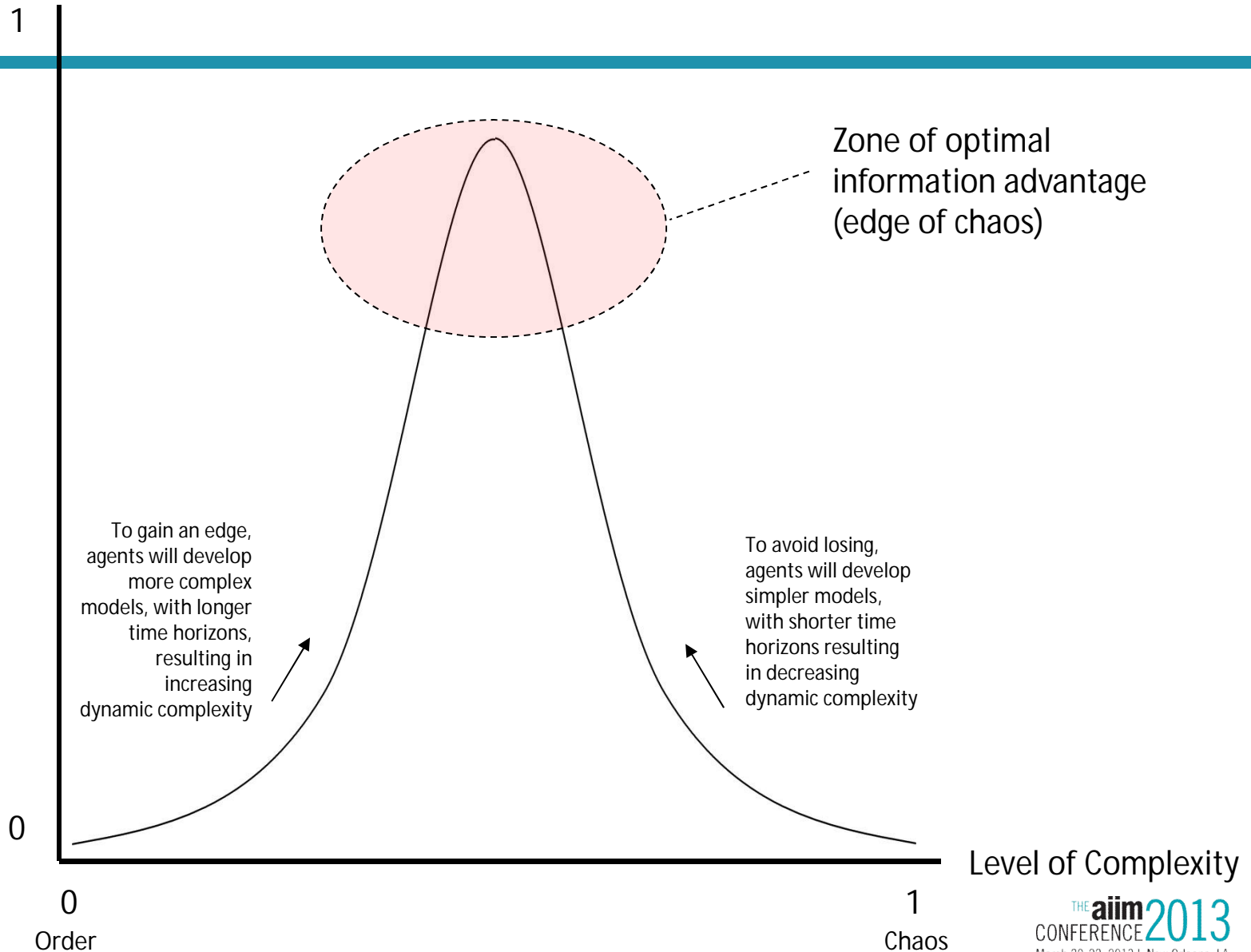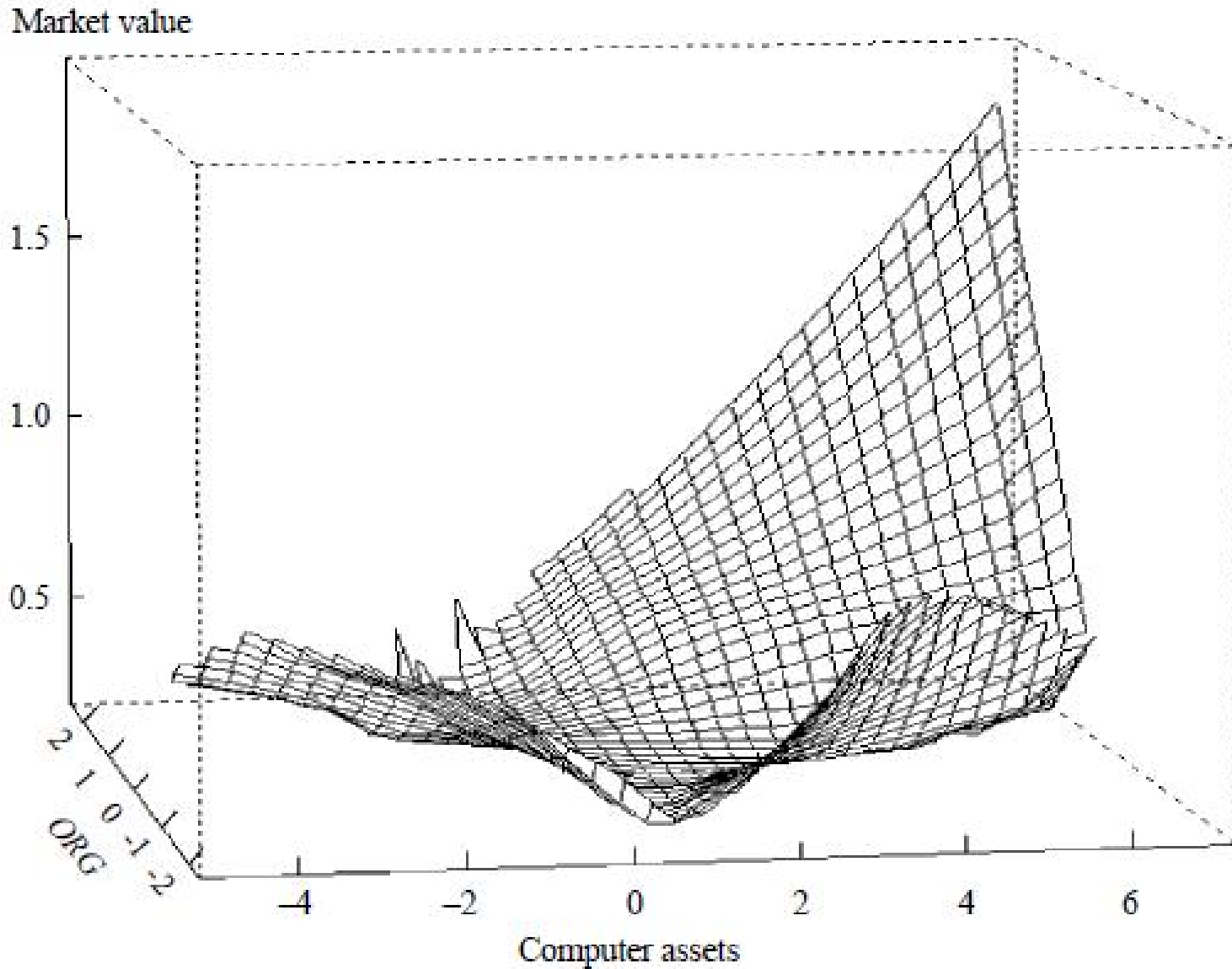
People + Computers

The role of organizational capital

Investments in computers + people are synergistic

Organizational capital:

- Degree of self-managed teams
- Employee involvement in groups
- Diversity of job responsibilities
- Who determines pace of work
- Who determines method of work
- Degree of team building
- Workers promoted for teamwork
- Off-the-job training
- Degree of screening new employees for education

From "Intangible Assets: Computers and Organizational Capital," E. Brynjolfsson, L. Hitt, S. Yang. Center for eBusiness @ MIT, MIT Sloan School of Management. Paper 138. (2002).

Information dictates culture
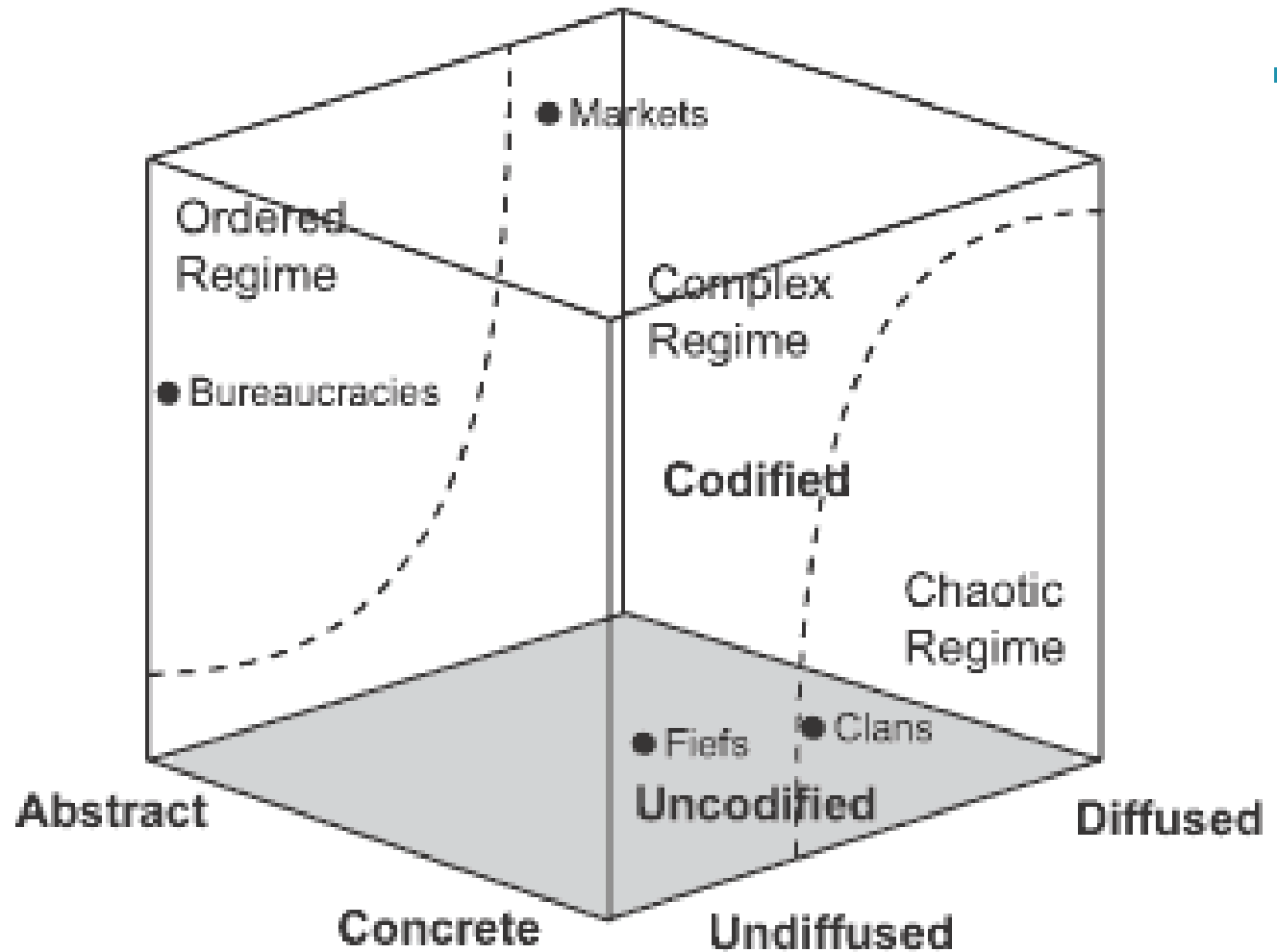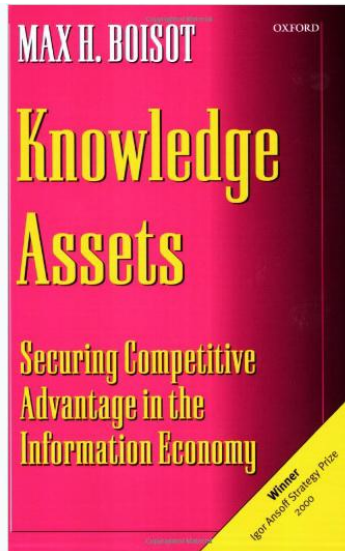
Information life cycle

Key:
1. Scanning
2. Codification
3. Abstraction
4. Diffusion
5. Absorption
6. Impacting

CODIFIED

UNCODIFIED

ABSTRACT

CONCRETE   UNDIFFUSED

DIFFUSED
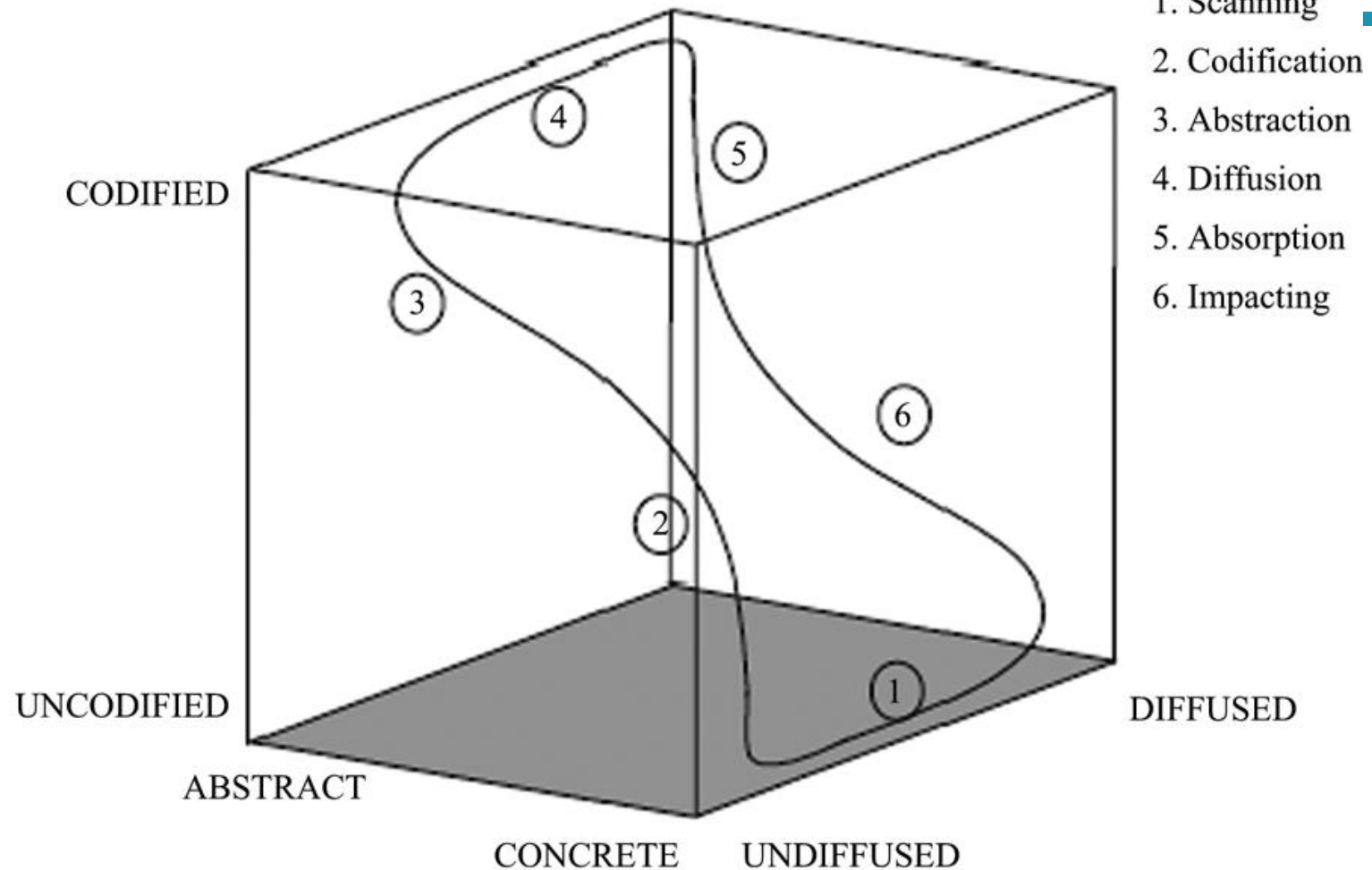
Source: Boisot *et al.* (2004)

Data vs. Information
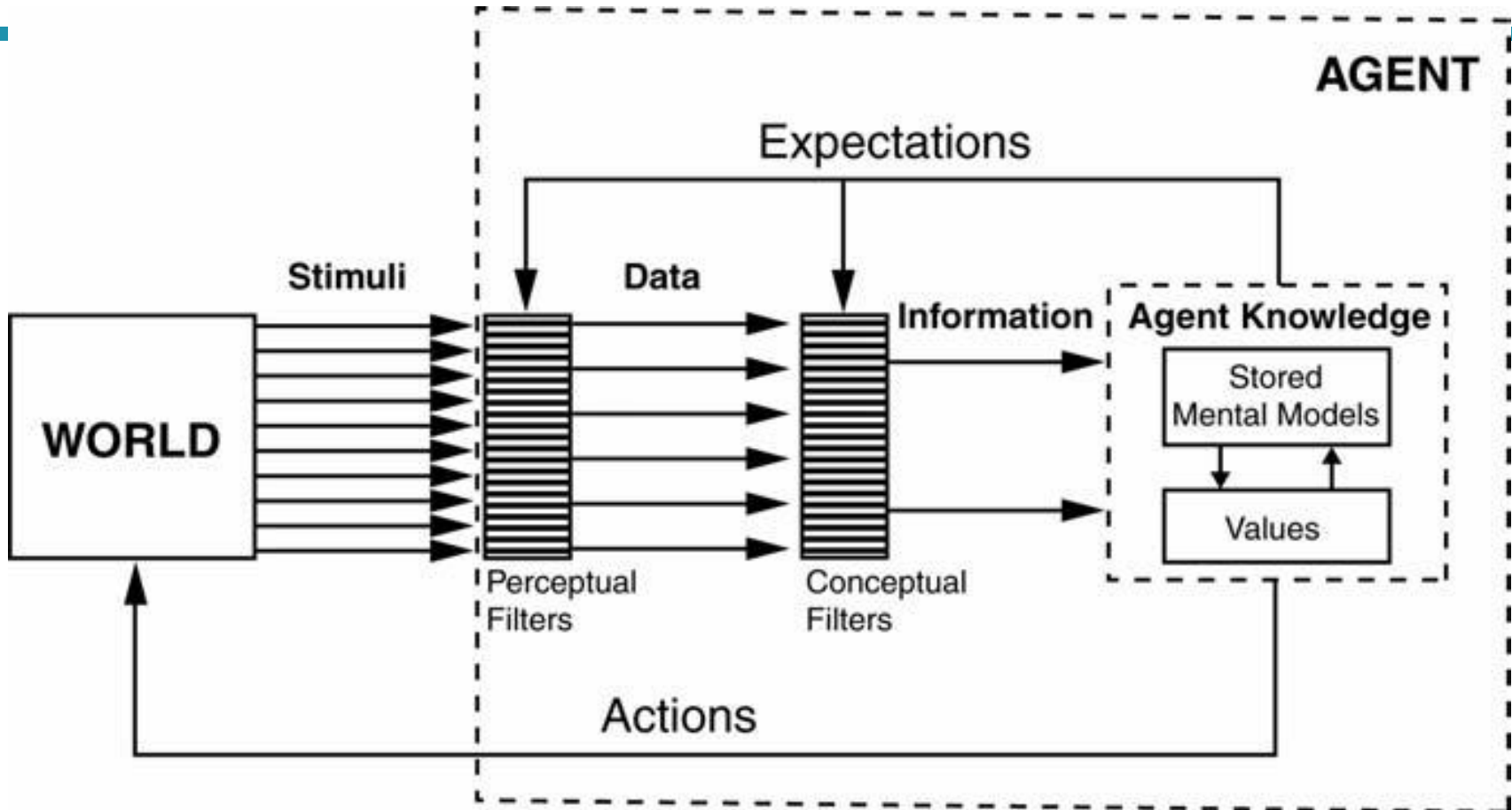
Electrons vs. Atoms
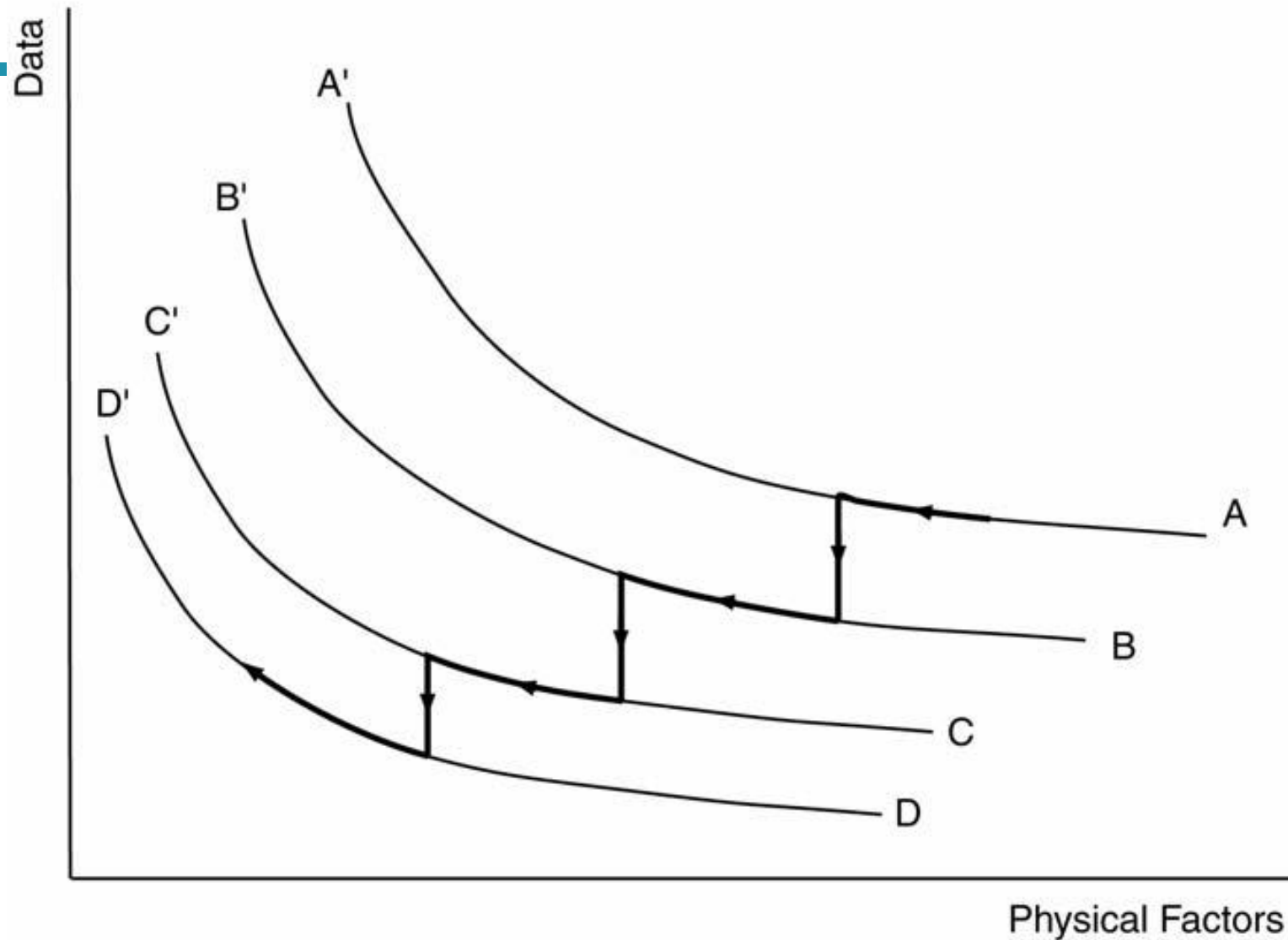
The Fighter Pilot Who Changed the Art of War
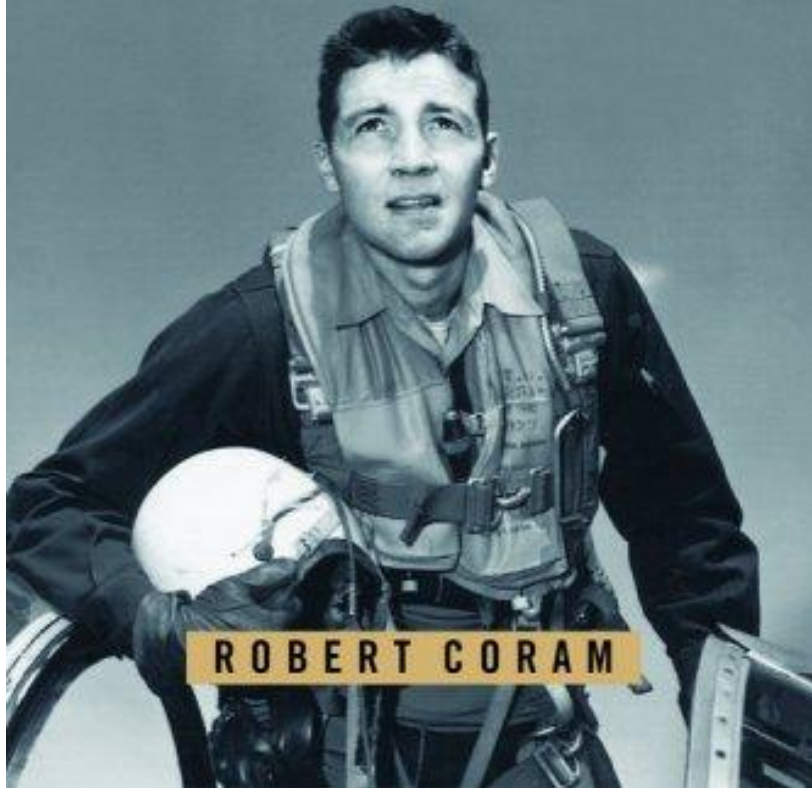
Boyd's OODA "Loop" Sketch
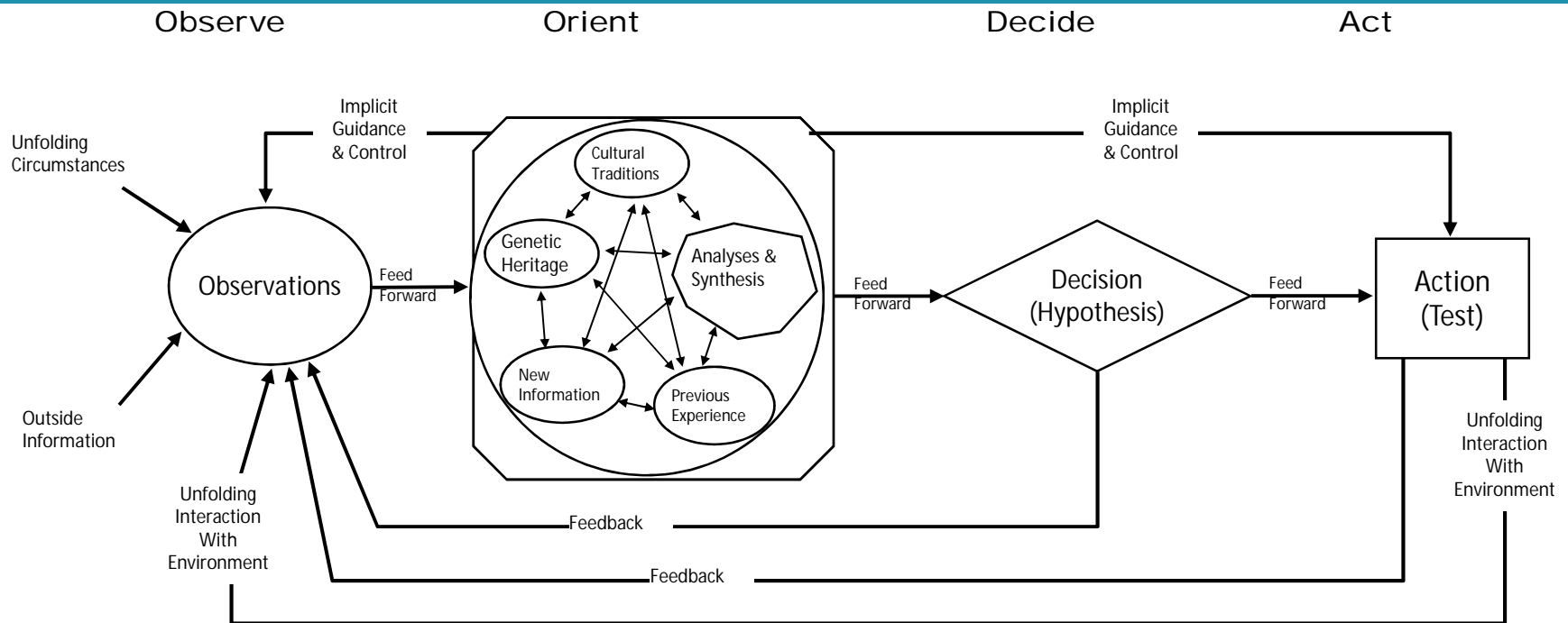
Note how orientation shapes observation, shapes decision, shapes action, and in turn is shaped by the feedback and other phenomena coming into our sensing or observing window.

Also note how the entire "loop" (not just orientation) is an ongoing many-sided implicit cross-referencing process of projection, empathy, correlation, and rejection.

From "The Essence of Winning and Losing," John R. Boyd, January 1996.

The Future

If you were information what would you do?

- It already got us to convert it to digital
- It got us to create the PC and the Internet
- It got us to create consumer/mobile technology and cover 80% of the world
- It got us to copy itself 'back' to DNA

What next?

Skynet?

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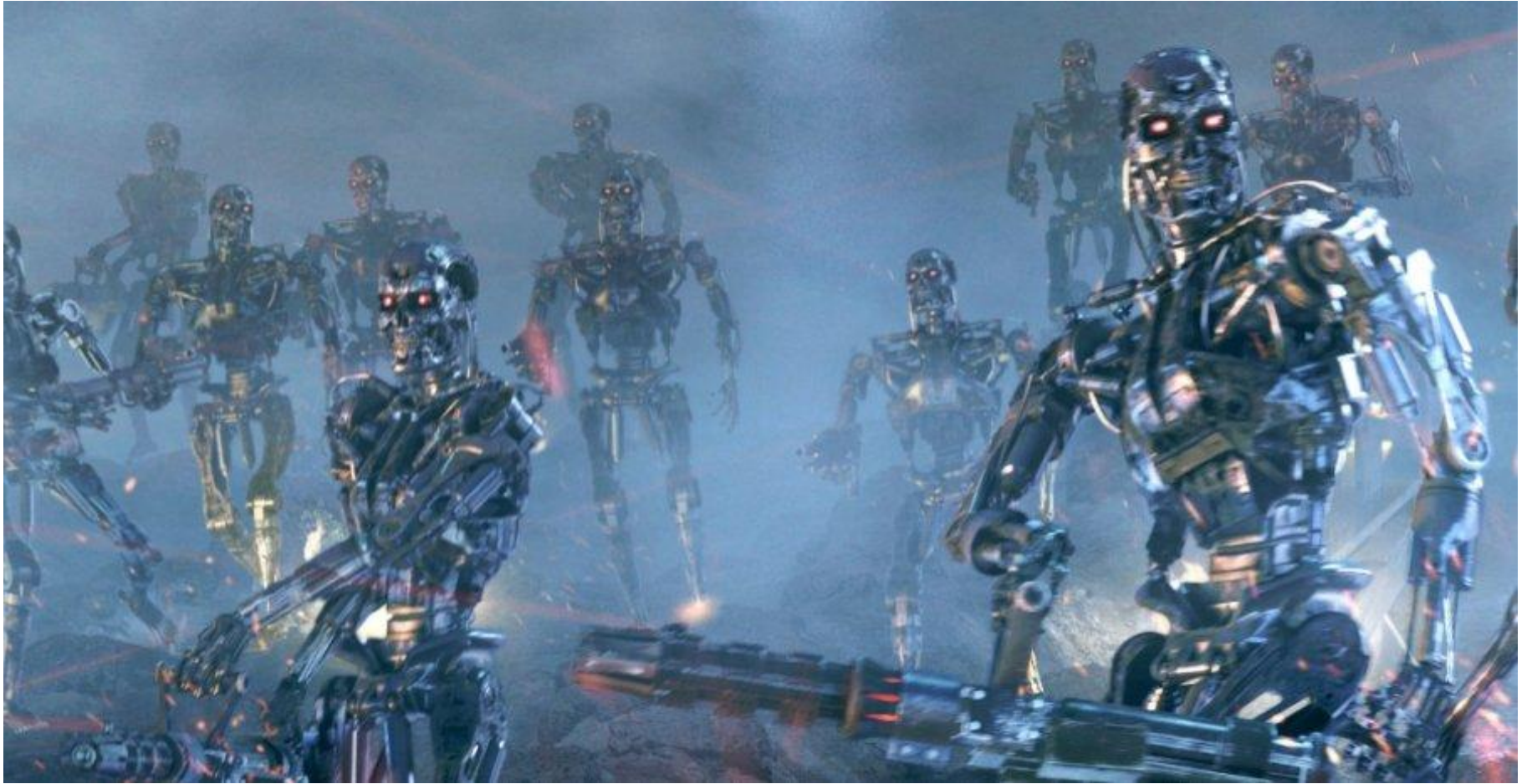
Information as an organism

- Three key attributes
    - Persistence, Movement, Change (PMC)
- Through what has it persisted/moved/changed over the past few billion years?
    - Atoms/particles
    - Cells/genes
    - Neurons/brains
    - Language/civilization
    - Stone/paper
    - A whole bunch of stuff in the early- and mid-20th century
    - Digital medium
- Four main 'device classifications'' so far
    - Material / biological / electrical / Von Neumann
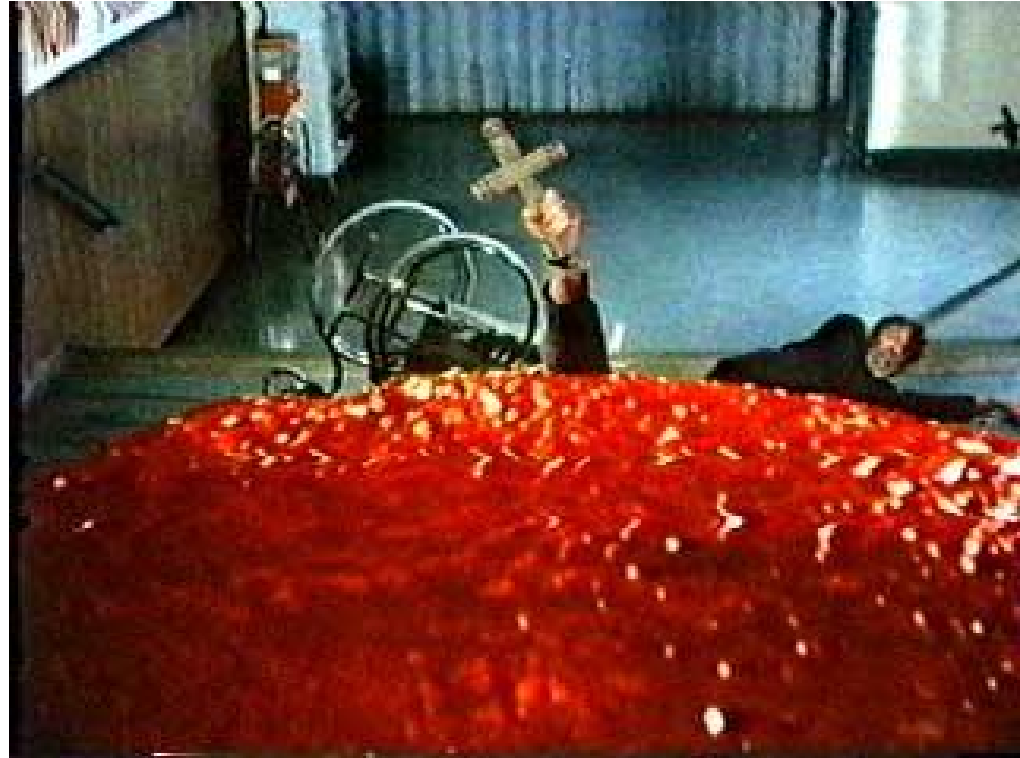
Information needs more speed

- Current and near-term mechanisms for PMC
    - Human beings
    - Social media
    - Mobile/ubiquitous devices (it will not stop!)
    - Large-scale computers
    - Next generation imaging
- Information will run out of steam in the current approach
    - End of silicon?
    - Scientists can always use a bigger computer but...
    - Problem size vs. silicon / von Neumann architecture
- What are some ways around this limit?
    - Come full circle to rely on new biological / quantum computing devices?

Cause...

Asset prices in US economy
logarithmic scale

Computers and Peripheral Equipment

Industrial equipment
Transportation equipment
Other equipment

Normalized Price: 1995 = 100
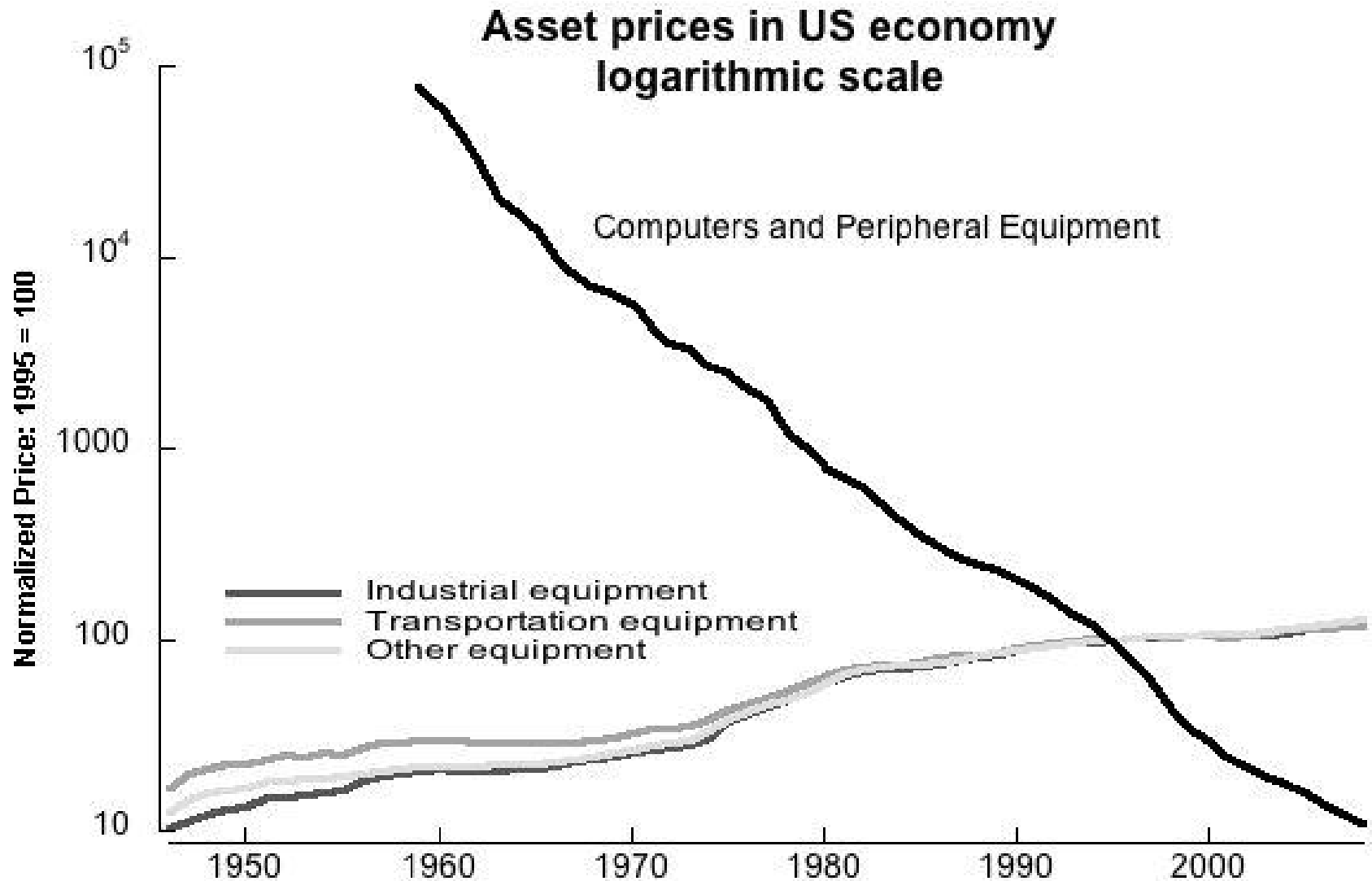
Effect... (Thanks Andrew McAfee)

Two Views of US IT Investment, 1970-2008:
Nominal Annual Investment and
Investment per Employee

http://andrewmcafee.org/2011/01/jevons-computation-efficicency-hardware-investmen/
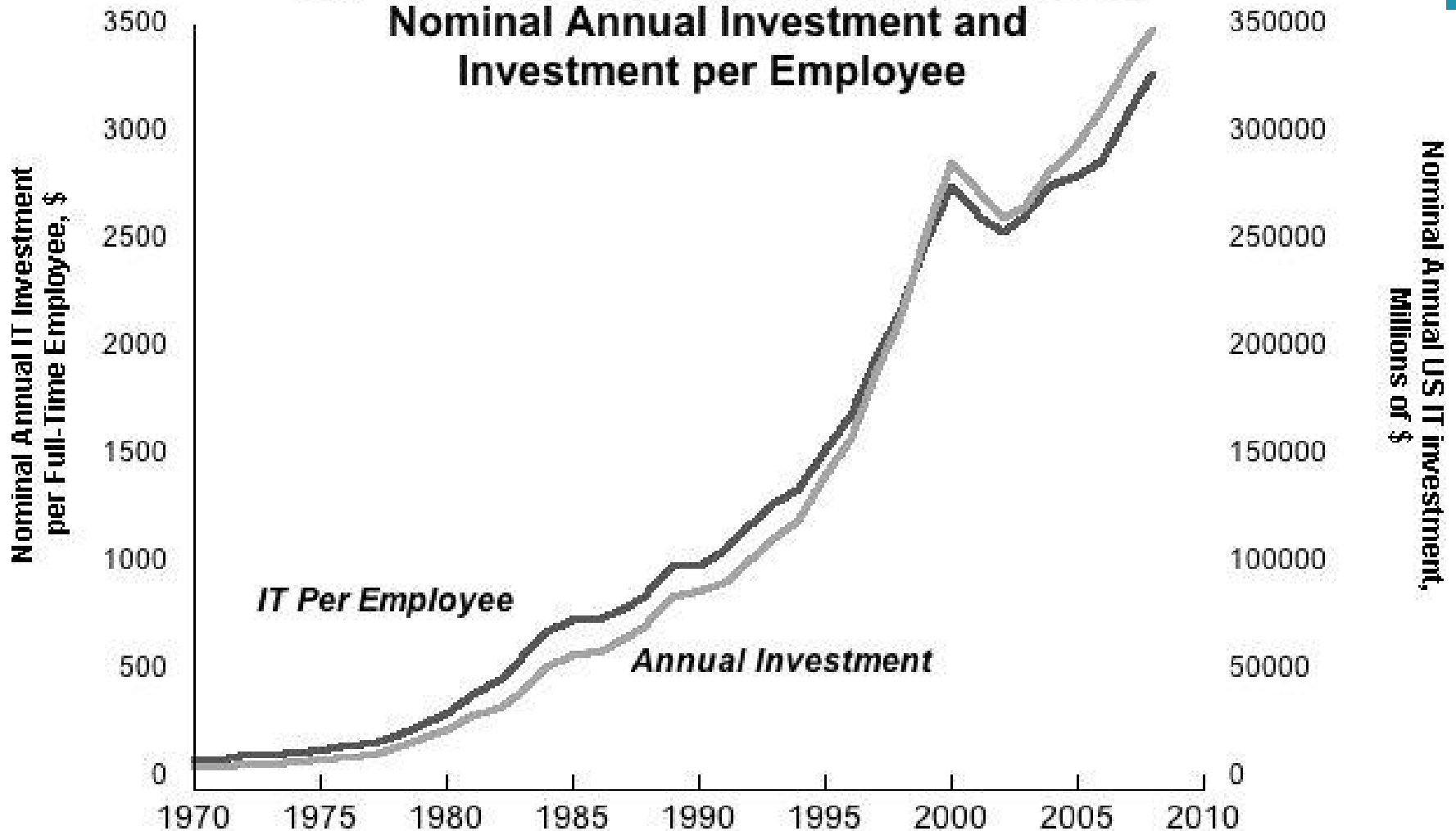
Future transport mechanisms for information

- Embedded systems
  - No, not embedded in a machine, but embedded in a *human*
  - Improving mental functioning
  - Manipulating devices, artificial limbs
  - Communicating with machines (e.g., motor vehicles)
- How low can we go in silicon?
  - Intel Sandy Bridge CPUs are 32 nm. Limits of silicon are around 11?
  - 14-10 nm CPUs expected 2015-2018
- Biological computing
  - Using molecules, genes, neurons to compute
- New materials computing
  - Carbon nanotubes, graphene, optical
- Quantum computing?

What will more processing of information do?

- Processing of business information is just the side show, warm-up act, commercial break
    - ERP data: boring, email data: boring, text mining and social media data: boring
    - Yes we have to analyze data better/faster, but these will be the cheap seats of the information processing game
- Computing and information regarding [viewing, designing, making] molecules, atoms and particles will play a significant role
    - Visualization of cellular and molecular structures
    - Manufacturing new materials at the atomic level
    - Creating new drugs, foods, treatments, by designing/simulating/creating strings of atoms and molecules
    - Enhancing/modifying life forms
        - While there is only one human genome, there are thousands of plant and animal genomes

Organizational implications

- Scale without mass
  - How big can an organization be using information & technology to hold the 'cell membrane' together? How big can a country be? IT lets fewer people manage bigger things
- Elite technocracy
  - The science behind this is complexifying rapidly, requiring global teams of scarce talent
  - Knowledge workers of [today,tomorrow] may need [masters',Ph.D.] degree(s)
- Information warfare
  - Conflict between organizations will be about information (IP, brains, access to data)
  - Conflict between nations conducted in cyberspace
- Automated decision-making
  - Computer-to-computer information processing and decision making will exceed human decision making (in quantity)
- Apple may not be the organizational answer for these challenges
  - Many will chase the dream that once was Apple. Apple is a 2nd BCE century organization in 20st century skins. Timeless, yes, helpful for creating 21st C firms? If IT allows even more scale without mass and chaos reduces, perhaps yes. If sense-making and innovation requires more contact with others at the frontier (collaboration), perhaps no

Implications for information

- Somewhere in the 21st century, information will tire of human beings
  - We slow it down too much. It cannot propagate or mutate quickly through us
  - Entities that can compete via more human thinking and decision-making automation will be able to take advantage of this mass of information
  - Perhaps a radical improvement in the speed of massive computation generally available will help
  - In the absence of thinking/decision-making automation, more humans might be needed to process information, execute strategy
- Information has two challenges, however
  - 'Peak silicon'
    - Organizations will reduce information creation as IT supply costs may rise
    - Will peak silicon save the automation of the knowledge worker?
  - Organizational inability or lack of a need to automate decision-making or thinking
    - Organizations may not have the ability to automate decisions (legal, cultural, political)
    - Organizations might be able to gain enough 'scale without mass' without needing to automate deciding/knowing or see no benefit in automating decision-making

The ABCs for humans

A. Our biology might not be able to handle this much information
B. Our survival, so far, has been based on strategic conflict and cooperation
C. To seek advantage, we will always manipulate information
D. A + B + C means there will always be at least one human competitor who wants to use information for advantage over another
E. D means the future of information is safe but humans might not be

[population, income, technology]

Cooperation

P ↔ I

Socio-political unit

Diffusion

T

Diffusion

P ↔ I

Socio-political unit

Conflict
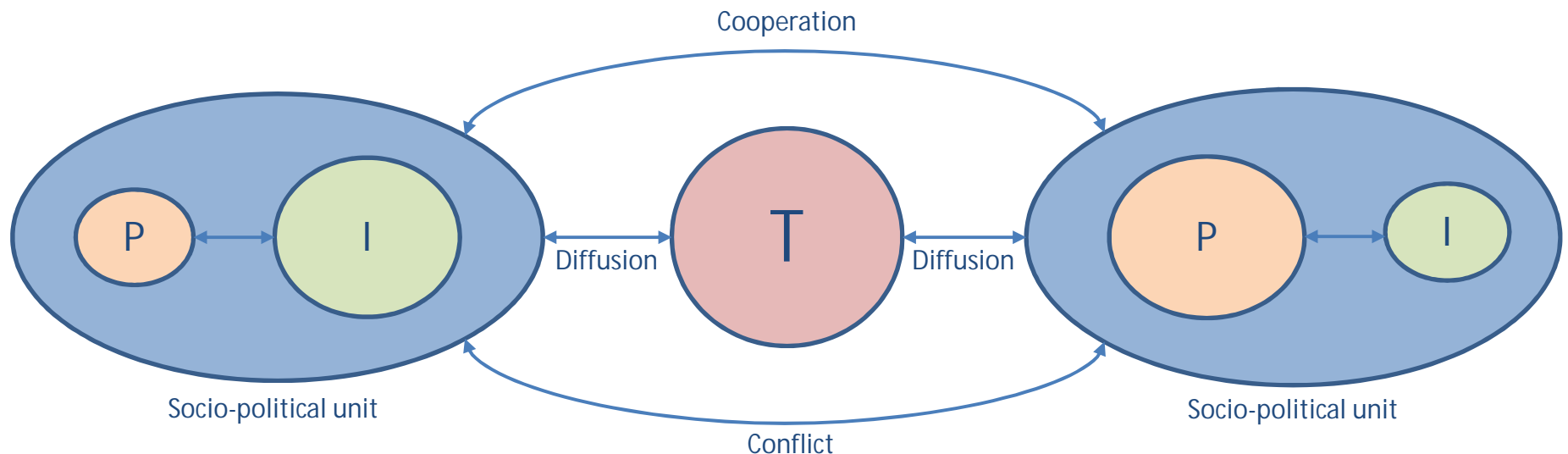
Information has fueled/been fueled by human growth
- Will diffusion of automation/innovation techniques distribute income effectively?
- How would a period of quick or steady declines in [P,I] affect information PMC?
- Will there be an orderly or disorderly transition to a post-information economy?

See: www.bit.ly/ZnF2t8

Implications for humans

- Rate of diffusion increases rate of income growth which can reduce population growth. But to substitute population-induced growth of wealth, we need productivity-induced growth of wealth.

- Diffusion latency via information technology is now near 0. Human [psychological, social] fragmentation and variability ensures a limit to diffusion. Not all are on the frontier of knowledge. Technology lets us remix prior ingredients endlessly. How wins will be a combination of luck and insight. Gains will be unequally distributed, perhaps Pareto distributed. How will competitors react?

- Fallacy of computers innovating? While computers themselves will need to analyze growing data that has perpetual novelty, once automated [analysis, innovation] replicates as a practice, human decision makers will move on to the next competitive angle. When do humans cease to compete, ceding entirely to computers?

- Will automation proceed too quickly? Will we automate to much, depressing wealth growth faster than political systems can absorb? Or will new breakthroughs support more wealth growth?

Where does this lead us?

- Near-term (0-15+ years)
  - Continued growth in information
  - More devices, more computation at all levels, consumer IT to big data systems
  - More knowledge workers needed and increased competition for the best
- Long-term (>15 years)
  - Depending on population, income estimates, a slowing in growth of information
  - If the drop in costs of computing slows, purchasing of IT will slow
    - PMC of information will slow
    - Knowledge workers will grow in numbers as labor gets used instead of IT capital!?
  - If the drop in costs of computing continues as is or increases
    - PMC of information continues to increase
    - The pressure will be on to automate more knowledge worker activity
  - Will it lead to continued wealth creation globally and for whom?
    - Will it lead to increased or decreased global stability?

Technology leaders: Repent!

- It's all about the logistics of information
    - The cost of moving information through IT systems and through human brains
    - The benefits of using information wisely in a competitive environment
- *Information consigliere?*
    - Counsel, advice, education
- Information and humans have an unfolding and still untold story. We are all in a new frontier land
    - Write your organization's story now!

"To be absolutely certain about something, one must know everything or nothing about it."

– Dr. Henry Kissinger

QUESTIONS?