



# 21<sup>st</sup> Century Knowledge, Skills, Character: A Clear and Present Imperative

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August 8, 2012

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# My first time in Peru !



# Our New World

# VUCA

Volatility

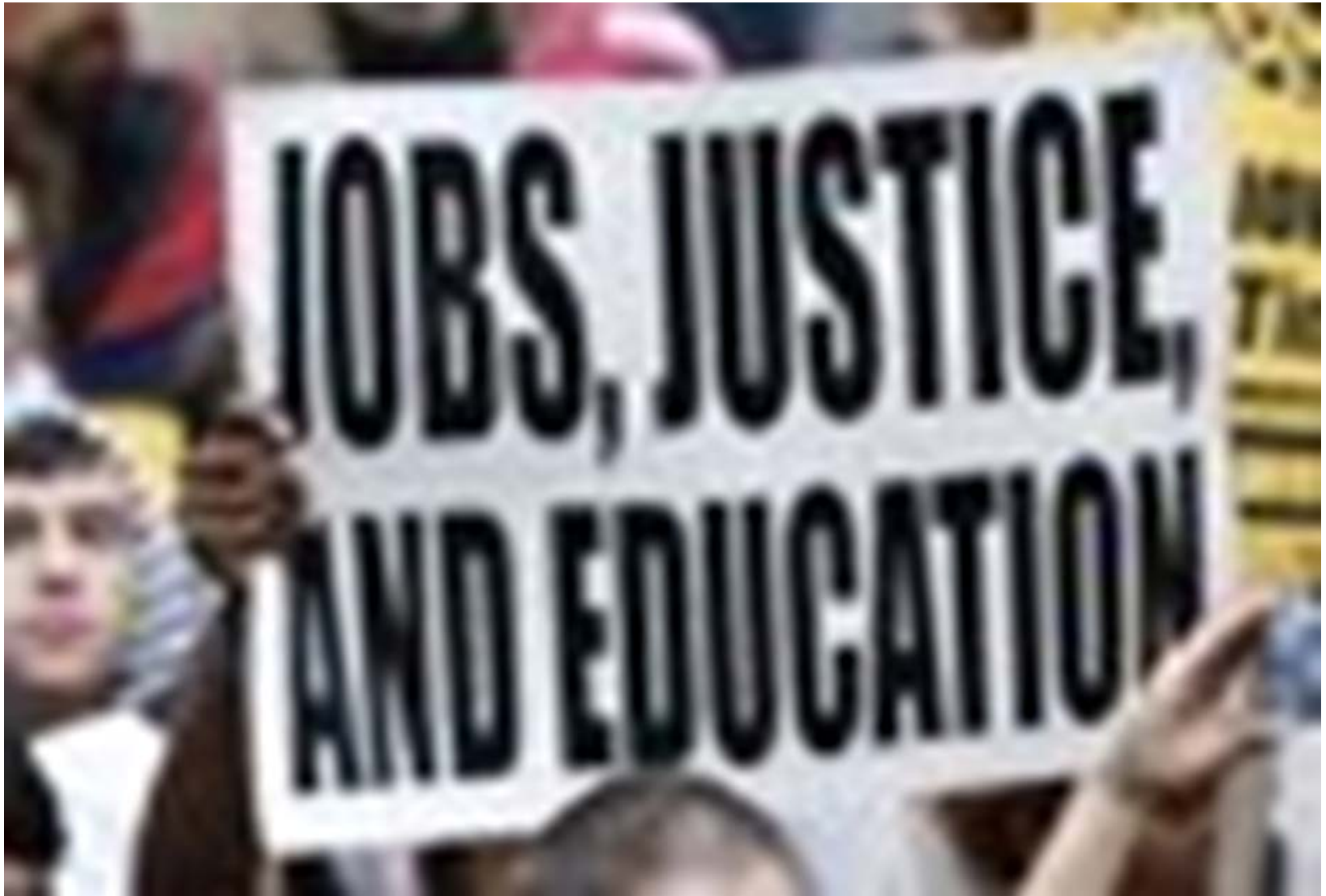
Uncertainty

Complexity

Ambiguity



# The stakes have never been higher



Source: Video extract from "Occupy Wall Street"

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# Key Message

**Relevance** ☐ Comprehensive rethinking

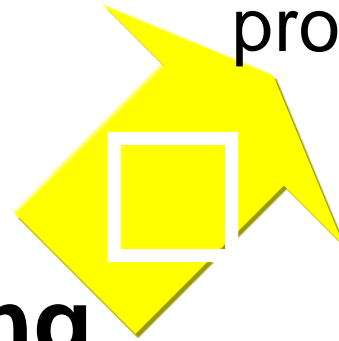
- Knowledge
- Skills not just Knowledge
- Character not just Knowledge and Skills

# The Benefits of Learning

Social &  
environmental  
wellbeing



Lifelong  
personal  
prosperity



**Learning**

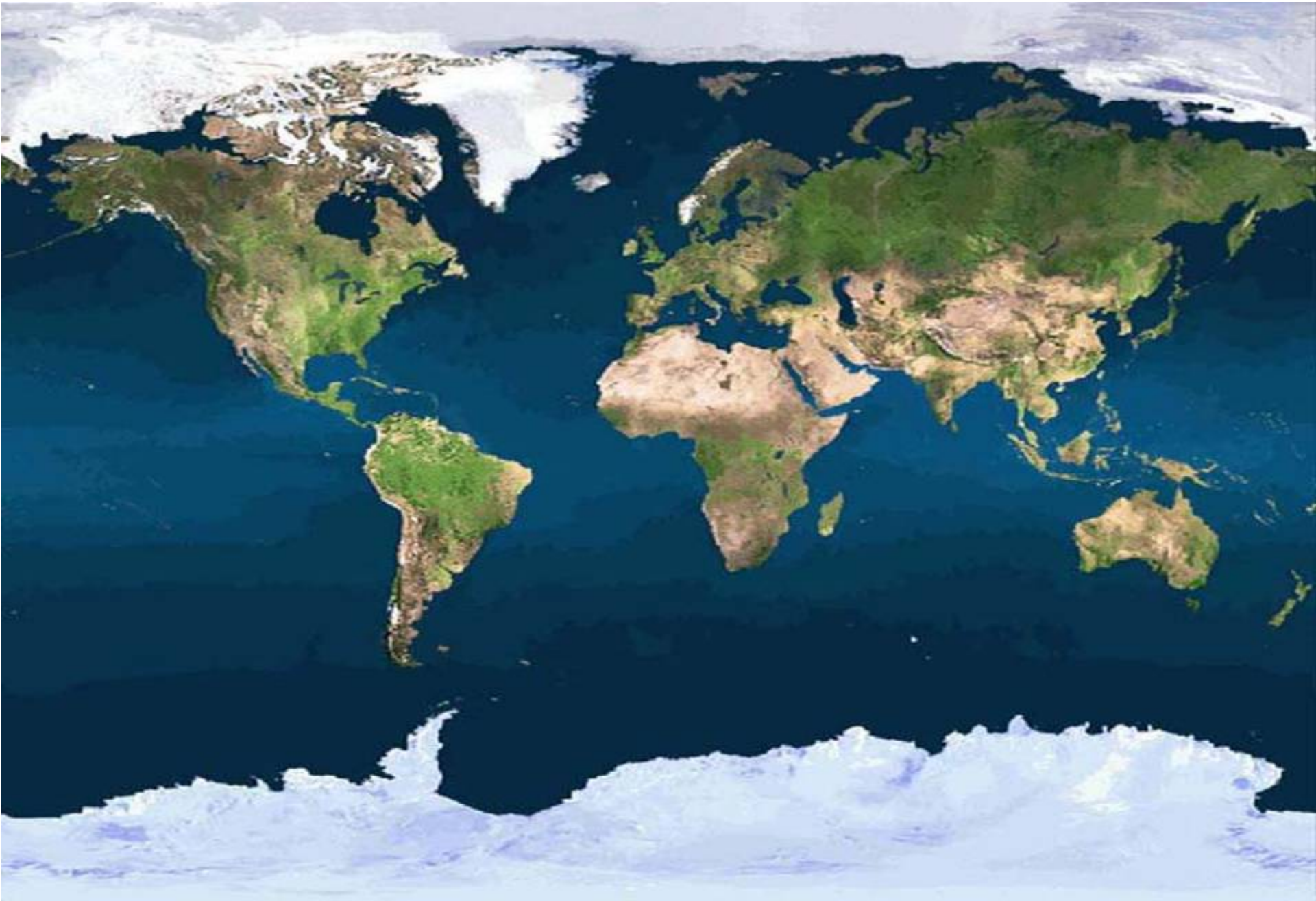


Economic  
competitiveness

# The New World We Live In



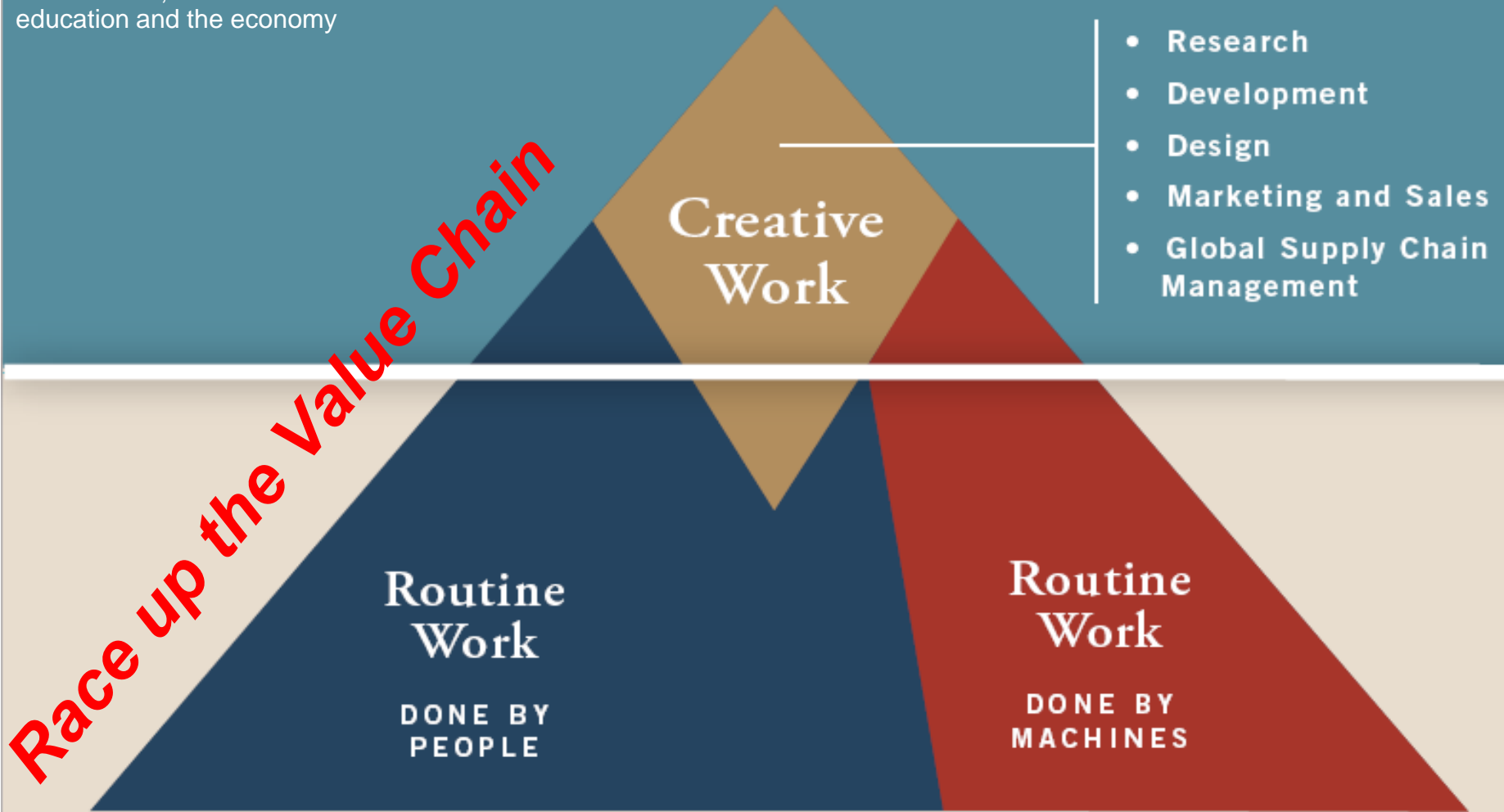
# Globalization Productivity Education





# IN MORE DEVELOPED COUNTRIES

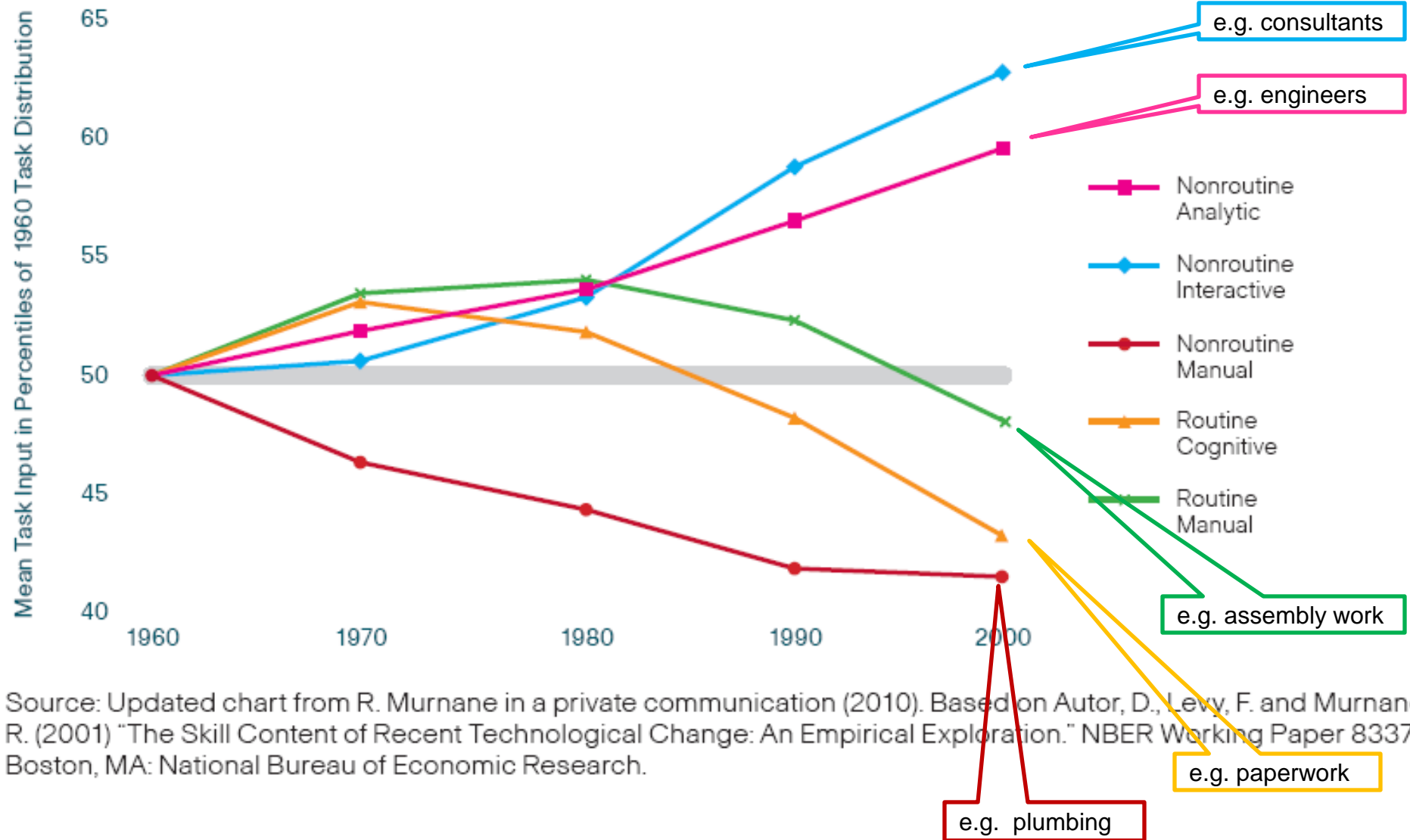
Source: "Tough Choices or Tough Times" 2007, National center on education and the economy



IN LESS DEVELOPED COUNTRIES

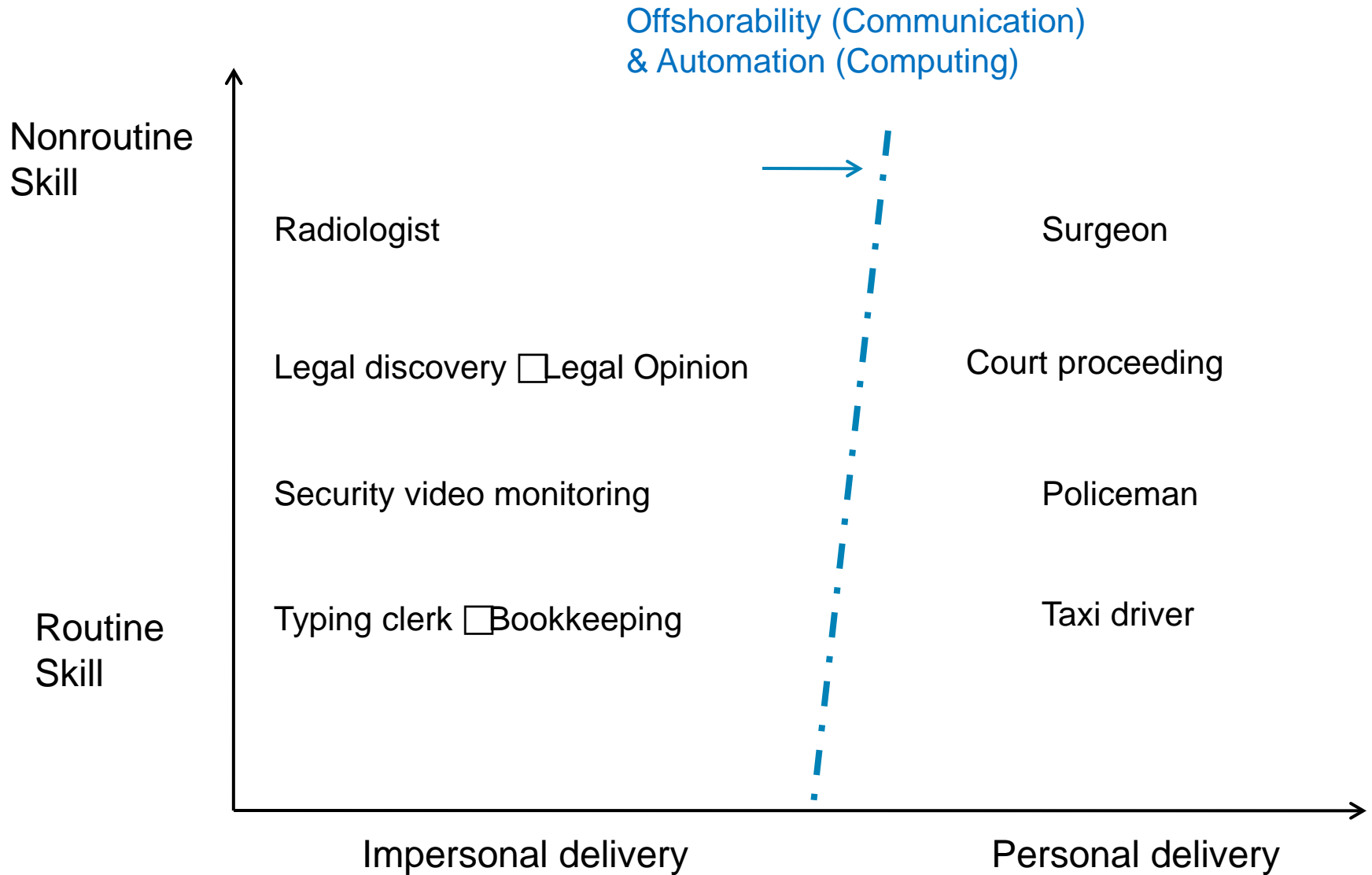
# Accelerating Change Demands Different Skills

Economy-Wide Measures of Routine and Nonroutine Task Input, 1960–2002



Source: Updated chart from R. Murnane in a private communication (2010). Based on Autor, D., Levy, F. and Murnane, R. (2001) "The Skill Content of Recent Technological Change: An Empirical Exploration." NBER Working Paper 8337. Boston, MA: National Bureau of Economic Research.

# Skill vs Delivery



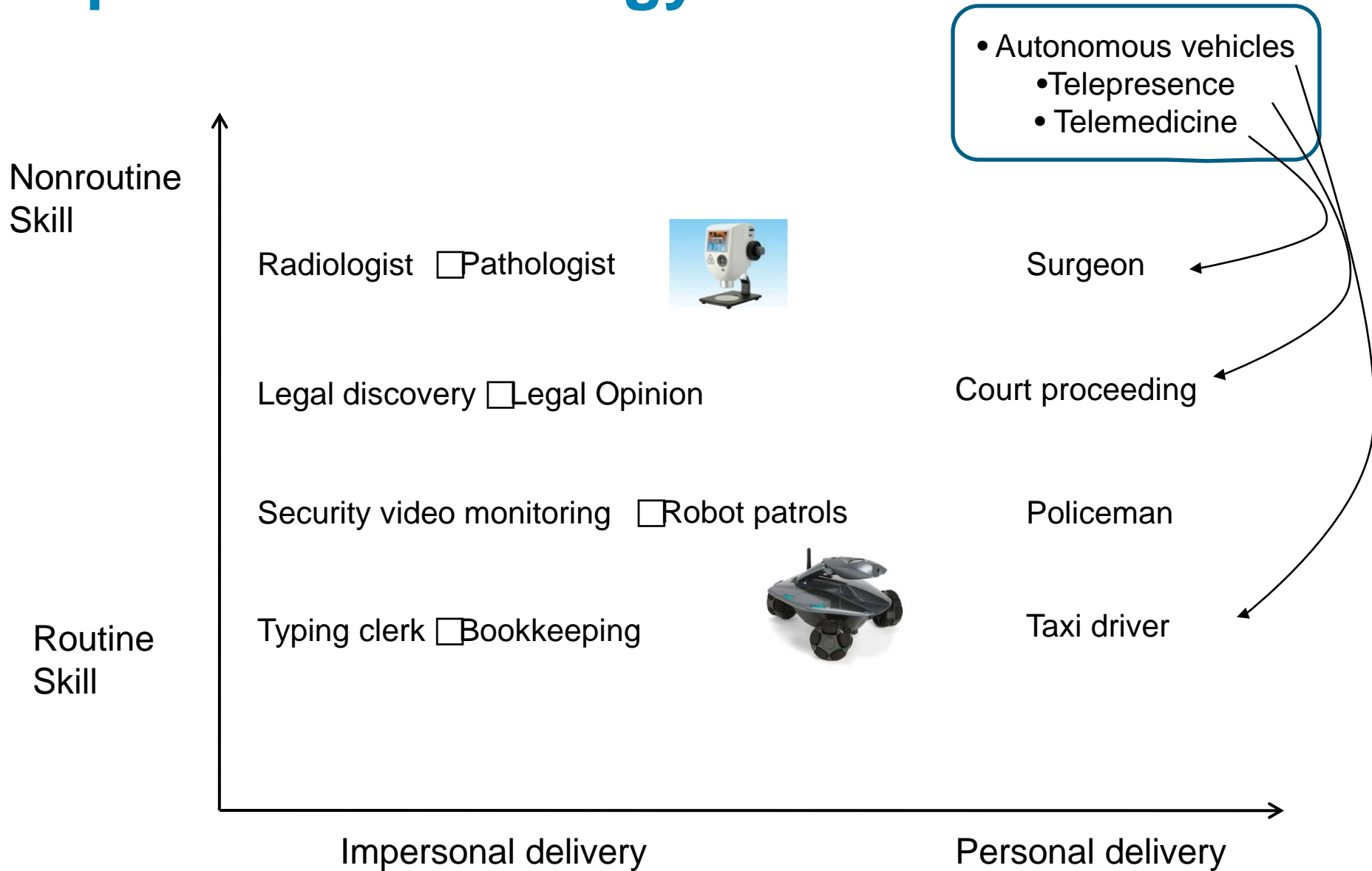
# The Impact of Technology



# Non-Digital Displacement Technologies



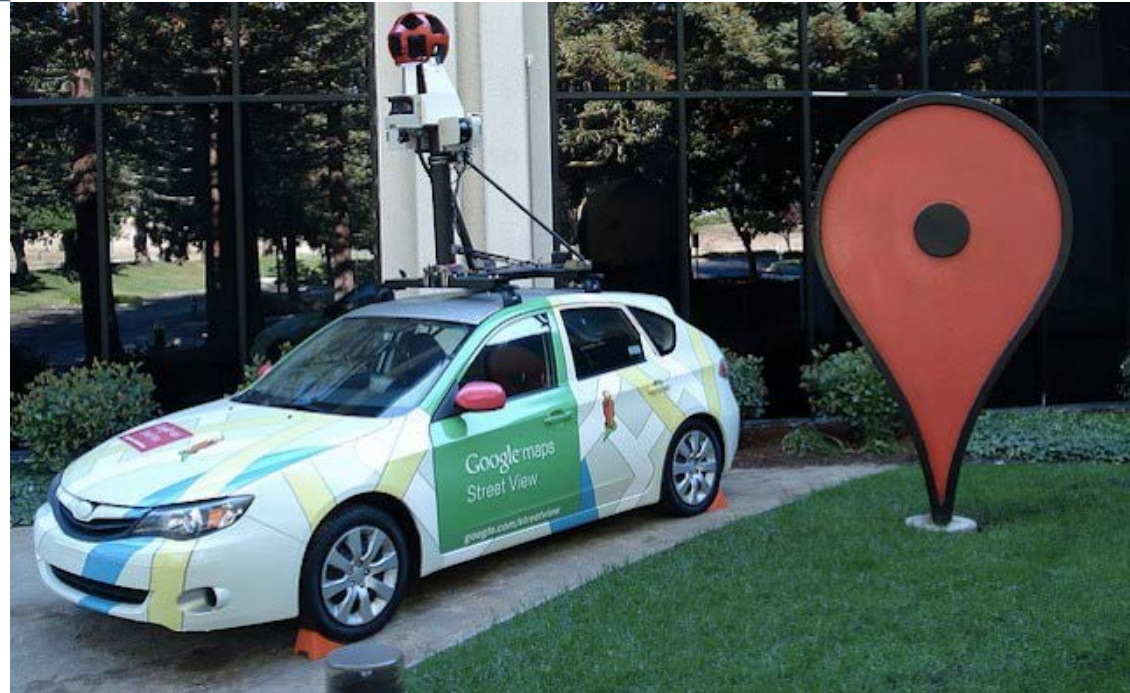
# Impact of Technology



# Google Autonomous Vehicle



>200kmiles through 2011,  
one minor accidents,  
occasional human intervention

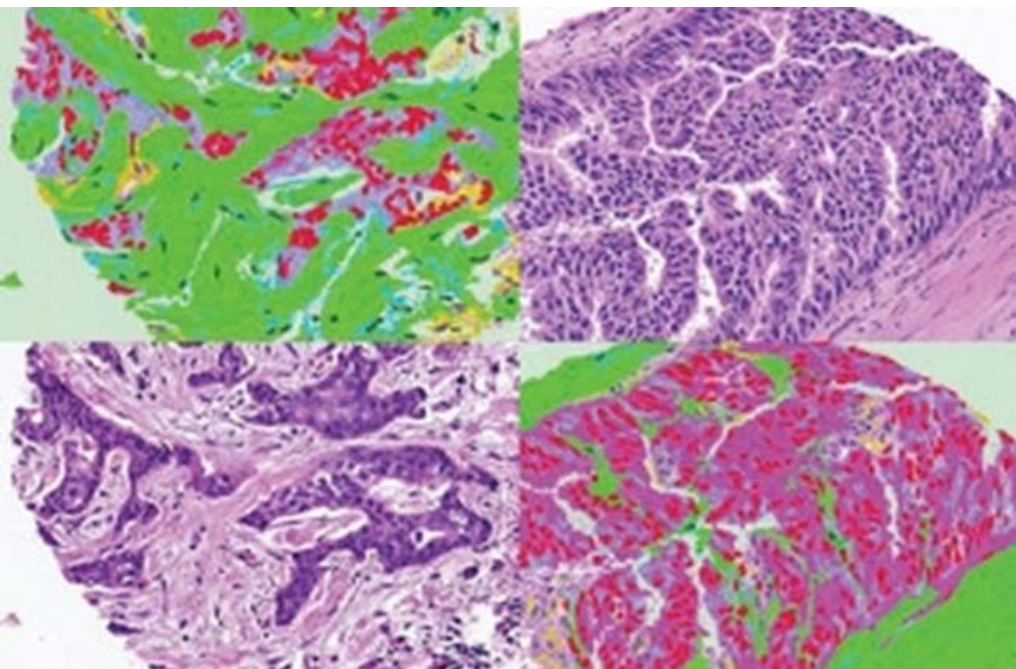


# “Computational Pathologist”

“Computers found more accurate than doctors in breast-cancer diagnosis”

Science Magazine November 10, 2011

“Computational Pathologist” by  
Stanford Schools of Engineering and Medicine





# Even modeling



H&M admits using a mannequin as digital model with “no flaws”

Source: Le Monde Culture & Idées, December 24, 2011

# Displacement due to Technology

Ox  Harvester

Horse  Automobile

Lab Mice  Assays (not soon enough...)

Humans:

Scribes  printing press

Washers  washing machine

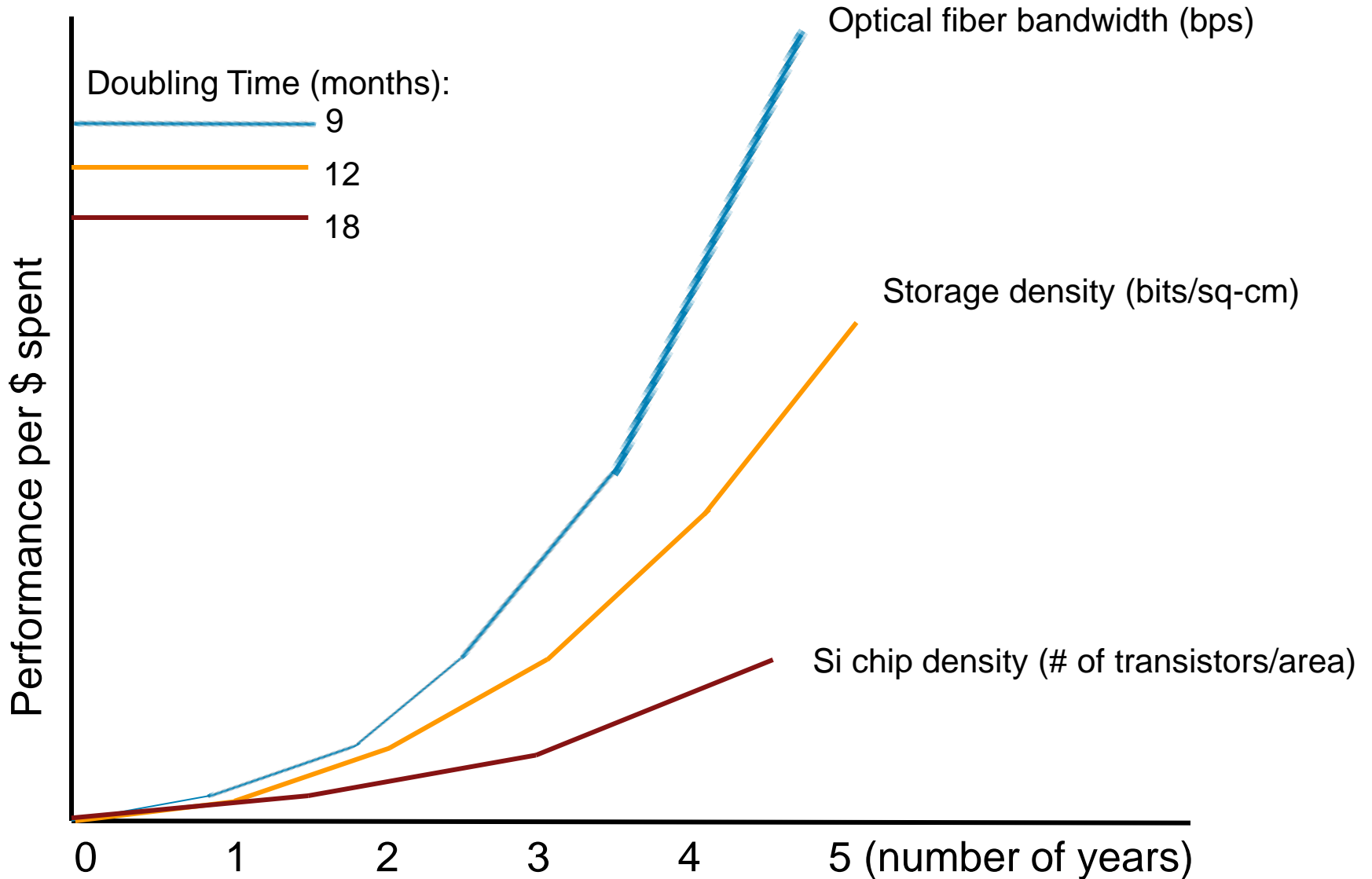
Cashiers/Attendants  bar code scanner

Healthcare/Finance/Services/Jeopardy champions  Watson

etc



# Technology *Acceleration*



# Brave New World

## Human Genome mapping (2005)

“Technology today can do in five minutes a decoding task that would have taken a year to complete a decade ago”

Eric Lander, Founder, The Broad Institute

*Improvement by a factor  
of 1 million in ten years*



# More to come

iPhone: \$400 price point

- 40T in 2015
- 40E in 2025

Video record your entire life (2025) }

ExoBrain (2025-2030)

Already  
possible  
in the  
Cloud !

# More to come... 3-D Printing

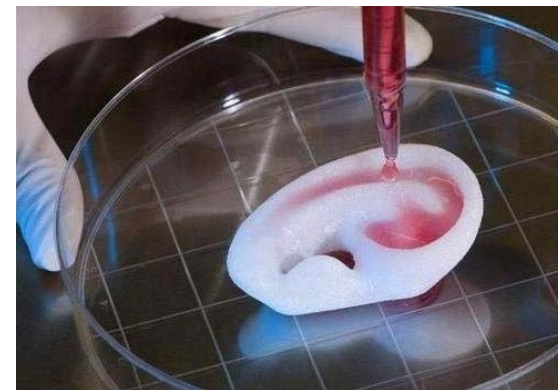
## “3-D Printing Spurs a Manufacturing Revolution”

The New York Times September 13, 2010

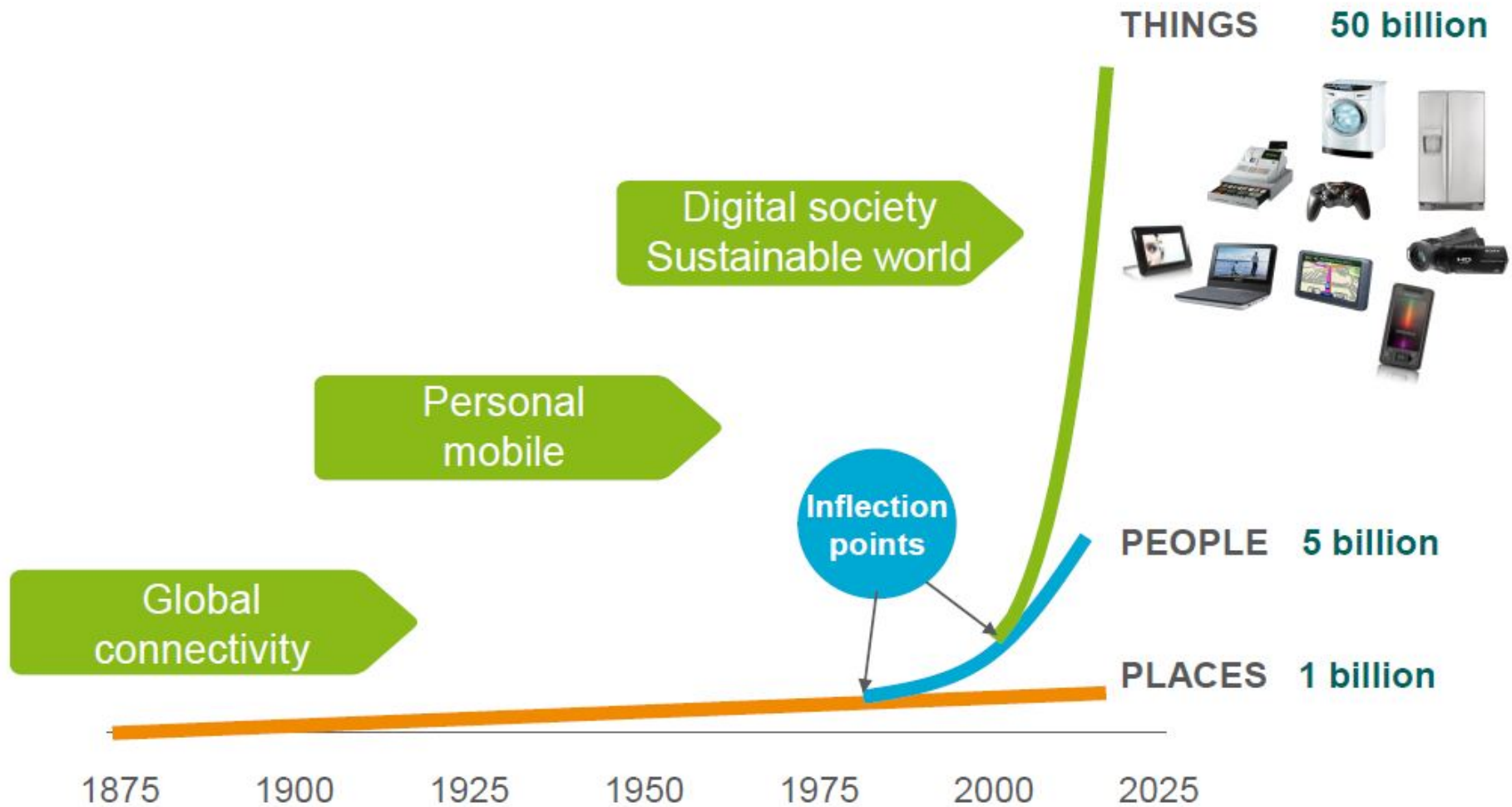


“It’s about going from the Model T to something like a Mini that has 10 million permutations.”

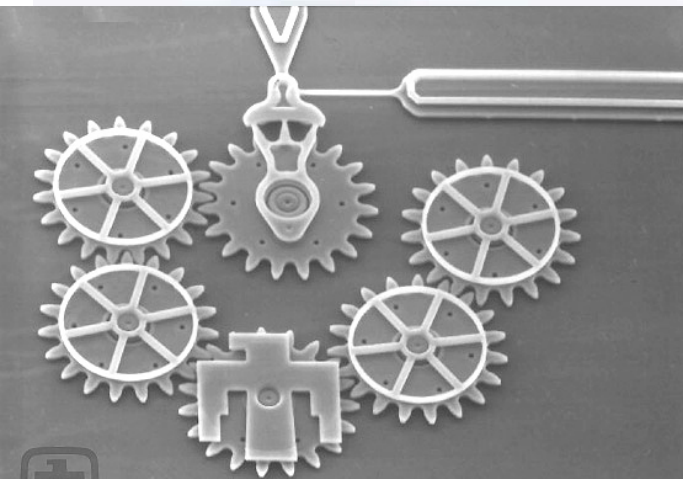
Scott Summit, Bespoke Innovations:



# More to come... Things



# More to come... Robotics



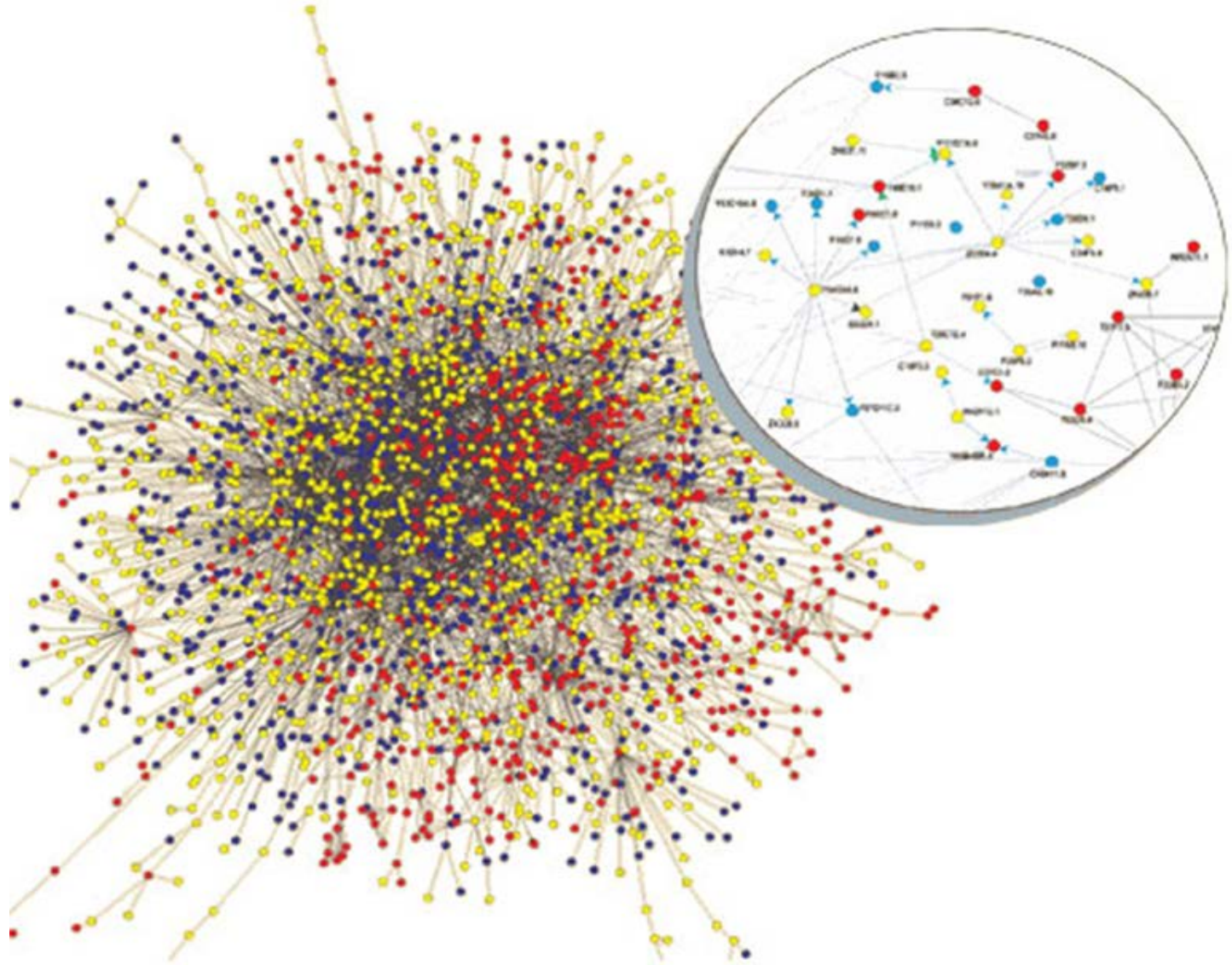
Video: Aldebaran Robotics

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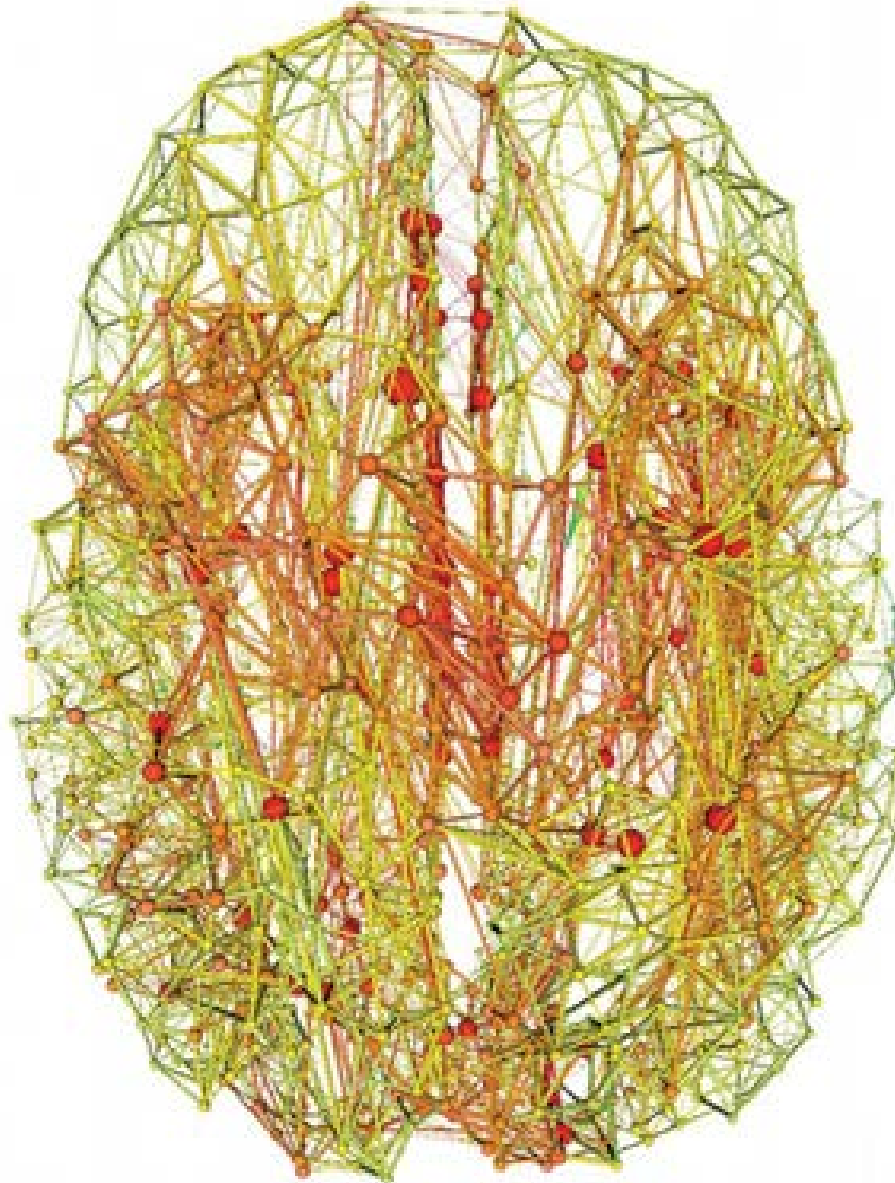
# More to come... Biotech



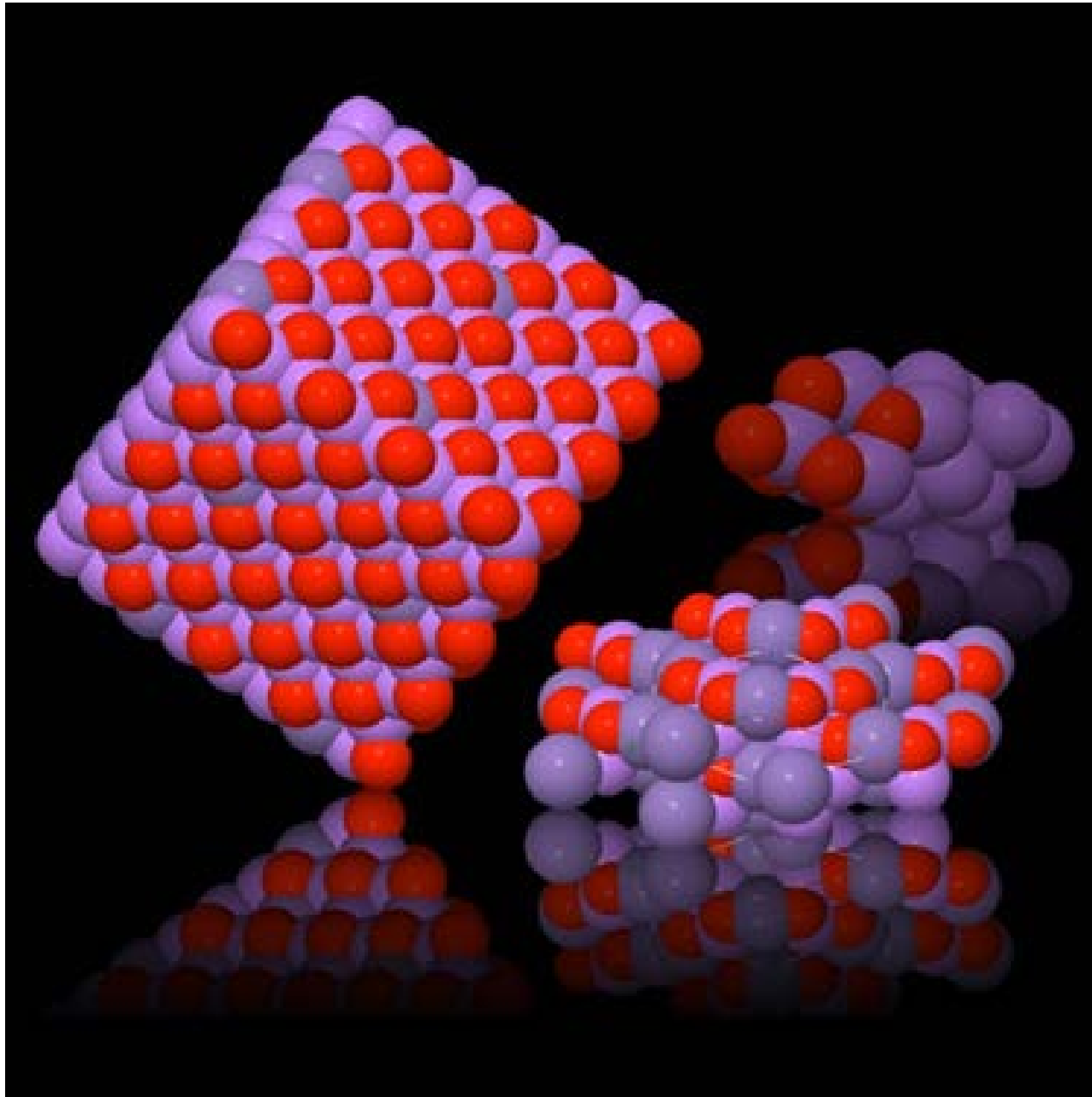
**MOLECULAR CARTOGRAPHY:** 2,898 proteins (nodes) by 5,460 interactions (edges). *Science*, 303:540–3, 2004.)

[Validating the Interactome - The Scientist - Magazine of the Life Sciences](http://www.the-scientist.com/article/display/14769/#ixzz1cAq1h53e) <http://www.the-scientist.com/article/display/14769/#ixzz1cAq1h53e>

# More to come... Neuroscience



# More to come... Nanomaterials



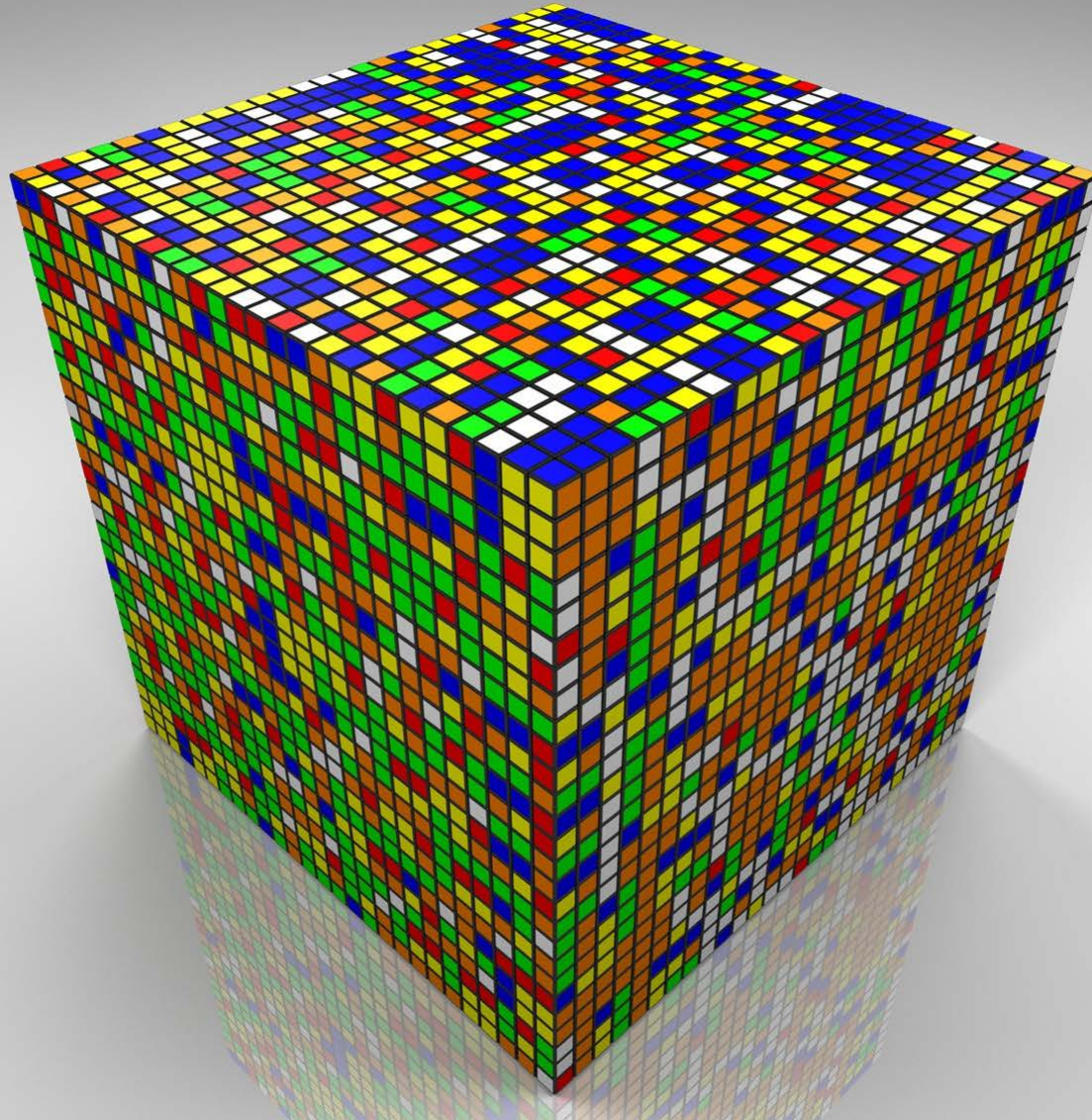
# More to come – Augmented Reality



# More to come... Virtual Reality



# A combinatorial explosion of possibilities



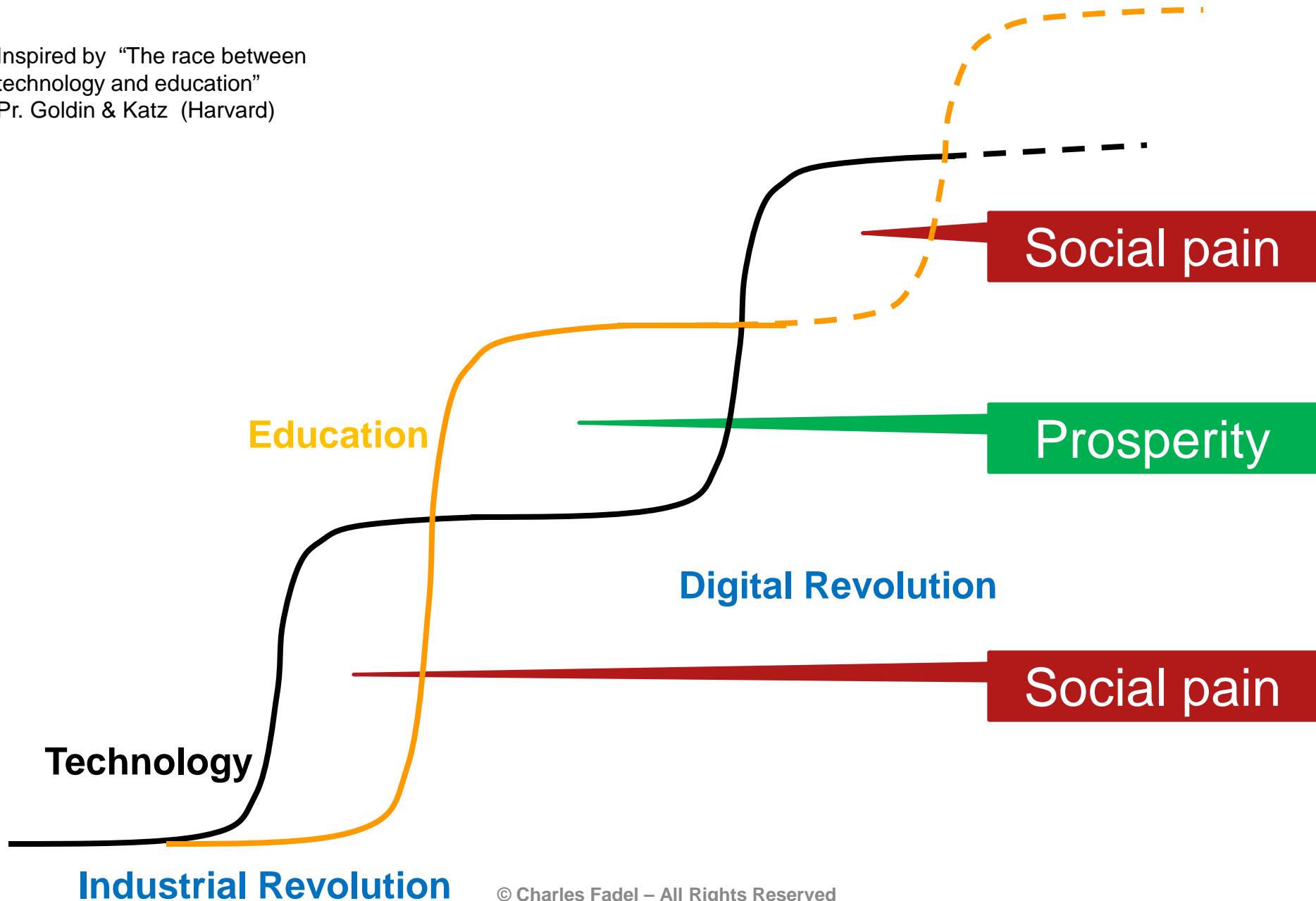
“The future is already here –  
it's just not very evenly distributed.”

Science-Fiction author William Gibson,  
quoted in [\*The Economist\*](#),  
December 4, 2003



# The Race between Technology and Education

Inspired by "The race between technology and education"  
Pr. Goldin & Katz (Harvard)





# So what should students learn in...

... an ambiguous/uncertain era, with ubiquitous search and A.I.?

- Fluidity with Technology
- Versatility
- Adaptability
- Resilience
- Critical thinking
- *Synthesizing/integrating*
- *Creating !*

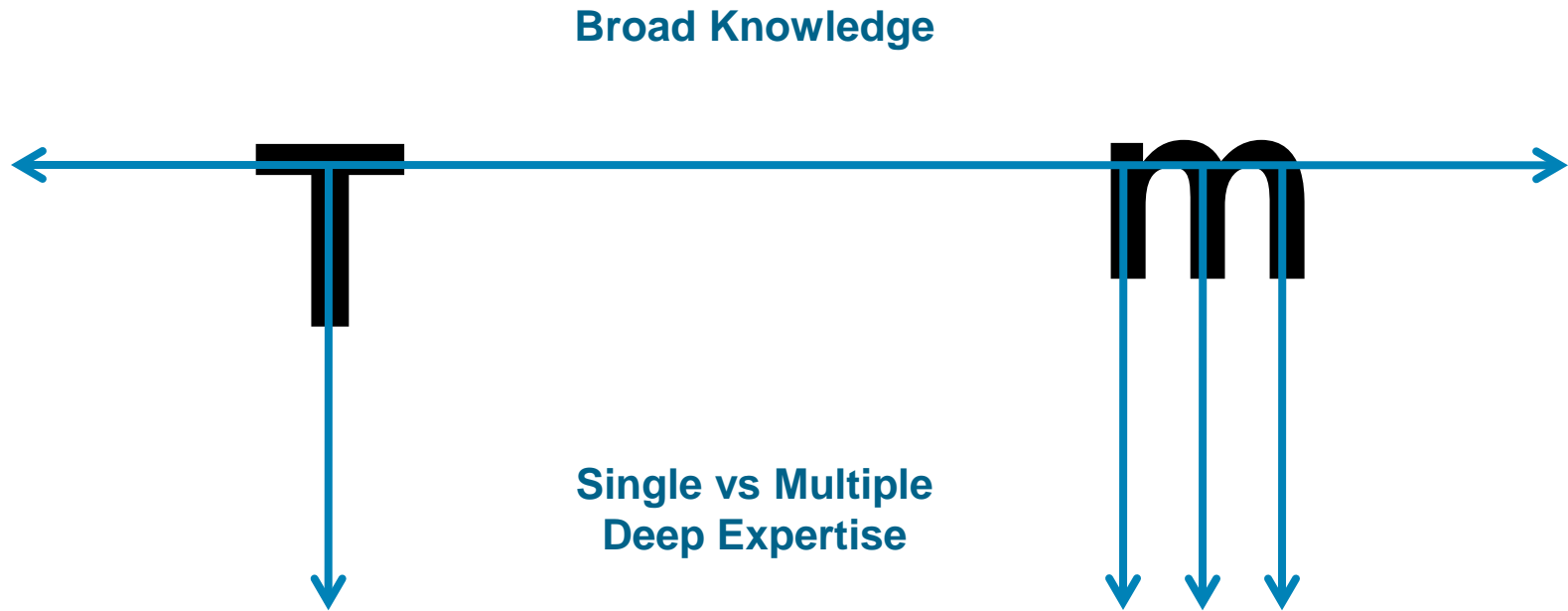
# Technical fluidity: Chess as example

- *“Human strategic guidance combined with the tactical acuity of a computer was overwhelming.”*
- *“Weak human + machine + better process was superior to a strong computer alone and, more remarkably, superior to a strong human + machine + inferior process”*

Source: Gary Kasparov, “The Chess Master and the Computer,” New York Review of Books, February 11, 2010

How about learning Processes?

# Versatility as a strategy



**m-shaped Individual, not just T-shaped**

# From the Master

“Technology alone is not enough... it’s technology married with liberal arts, married with humanities, that yield the results that make our hearts sing”.

Steve Jobs, iPad2 intro speech, March 2011



# Creativity & Innovation



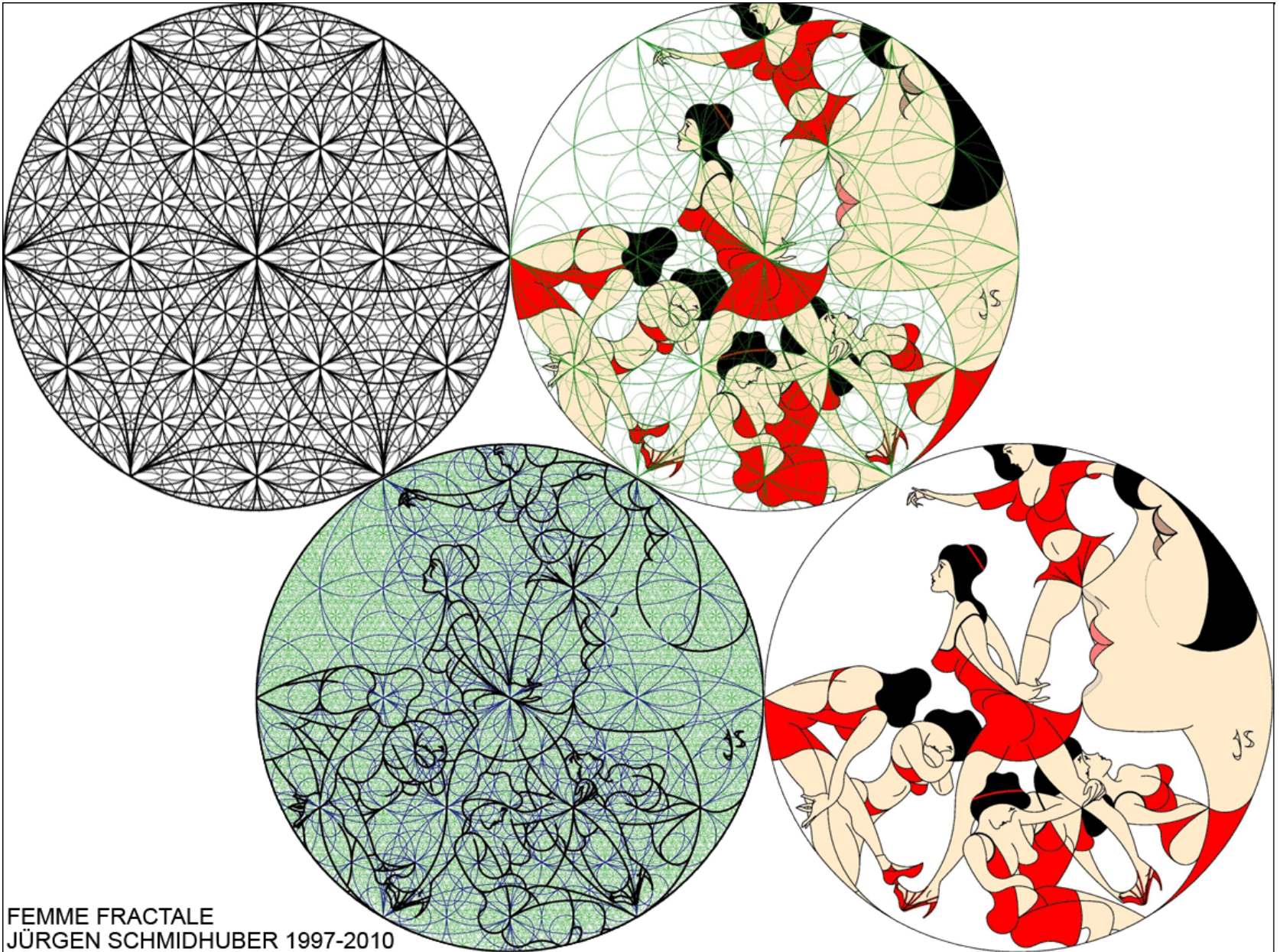
Handwritten text in a cursive script, likely a historical manuscript, located below the sketch. The text is written in brown ink and appears to be a list or a set of instructions, possibly related to the anatomical study shown in the sketch above.

# “The dancing salesman problem”



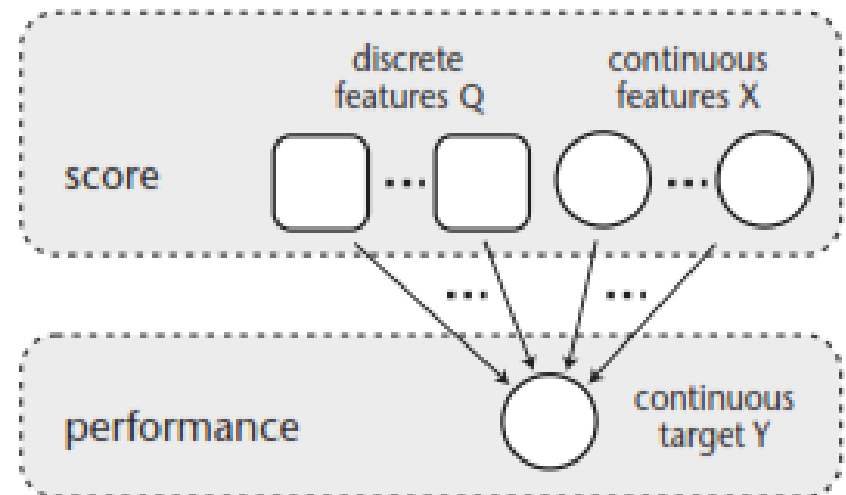
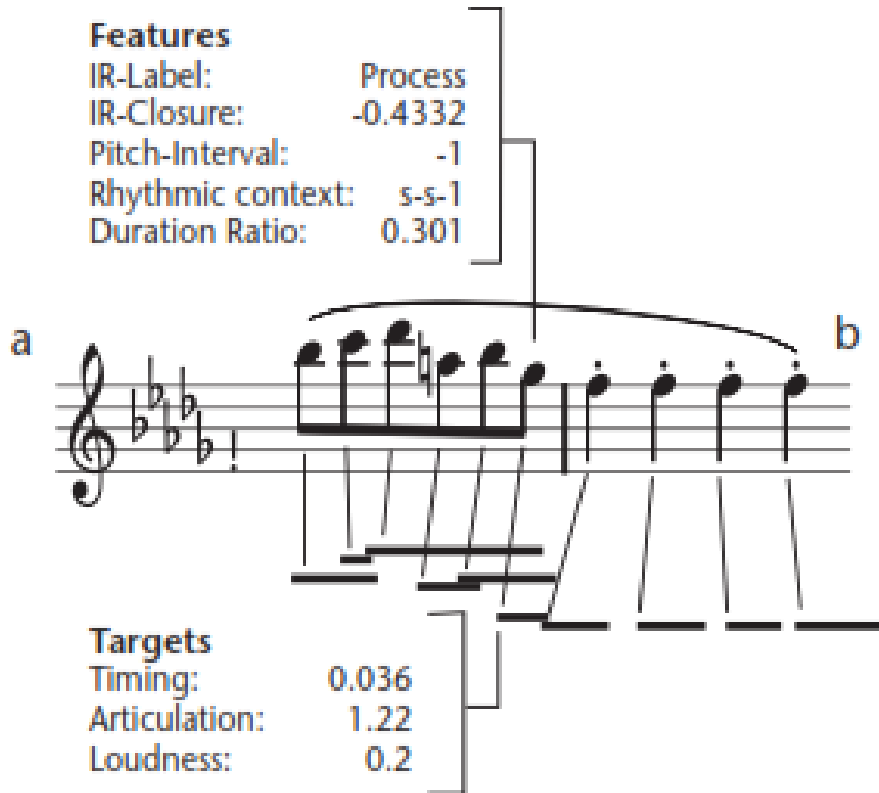
Source: The Painting Fool

# Visual arts too



FEMME FRACTALE  
JÜRGEN SCHMIDHUBER 1997-2010

# Music



*Figure 2. An Example of the Features and Target Values that Are Computed for a Given Note and the Structure of the Bayesian Model.*

## The Core of YQX: A Simple Bayesian Model

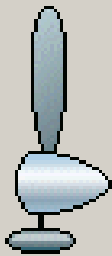


# Computerized Trading – Flash Crash

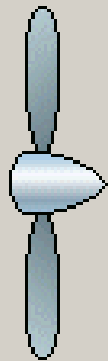


# Innovation follows patterns *automatable*

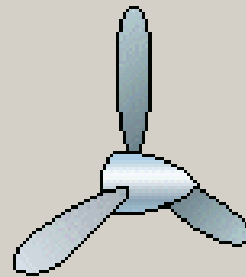
Mono bi poly system



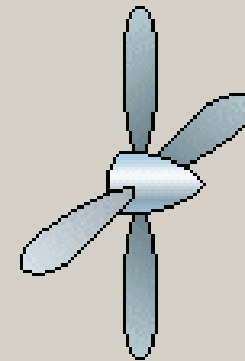
One-blade  
propeller



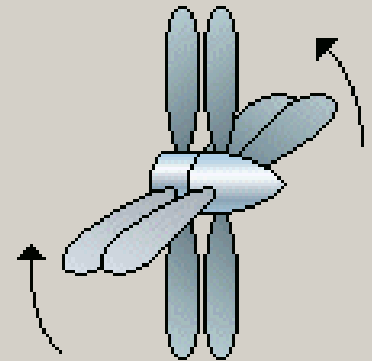
Two-blades



Three-blades



Four-blades



Double four-  
blades

Different products evolve according to the same pattern 



What should students learn  
in the 21<sup>st</sup> century?

With funding from



FONDATION HENRI MOSER  
65, rue du Rhône - 1204 Genève



# Partners



Government of Alberta  
Education



FINNISH NATIONAL  
BOARD OF EDUCATION



KEDI  
KOREAN EDUCATIONAL DEVELOPMENT INSTITUTE



HARVARD



Olin College



Penn  
UNIVERSITY OF PENNSYLVANIA

STANFORD  
UNIVERSITY

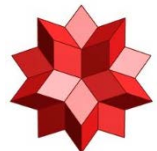
GRADUATE SCHOOL  
OF EDUCATION



Microsoft®

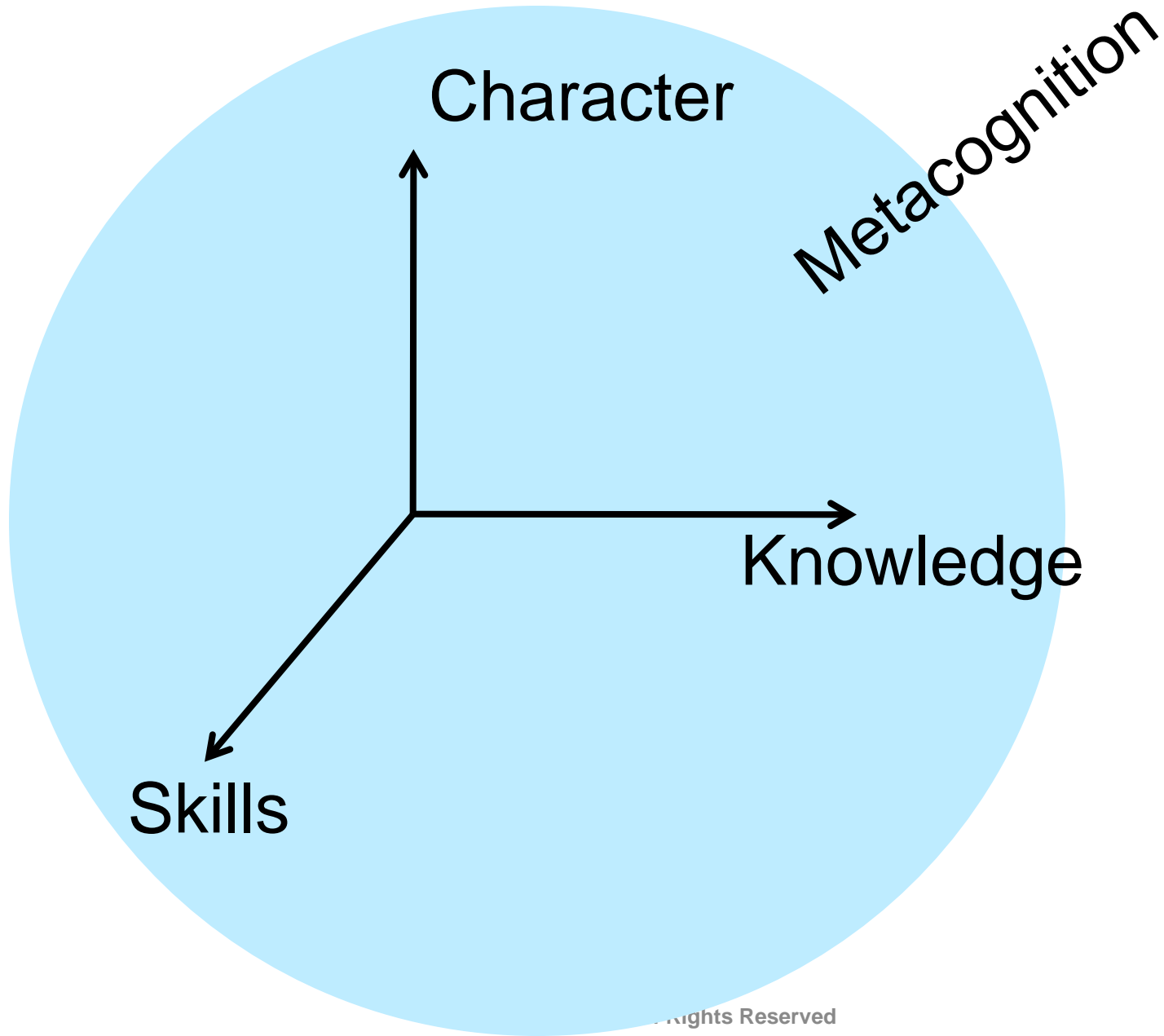


PROMETHEAN  
LIGHTING THE FLAME OF LEARNING





# Imagine if we rethink *What* is taught



# Schooling vs Real-World

“...school learning is abstract, theoretical and organized by disciplines while work is concrete, specific to the task, and organized by problems and projects...”

Source: OECD, “Learning for Jobs” 2009

# Subject Evolution

Source: UPenn GSE

Greek, Latin

Contemporary Languages incl. 2<sup>nd</sup> language

Reading, Writing

Literature

Oratory

Rhetoric

Grammar, Handwriting, Spelling

Music

Art

Philosophy & Ethics

History

Arithmetic

Geometry

Astronomy

Algebra, Trigonometry, Calculus

Biology, Chemistry, Physics

**Ancient  
Greece &  
Rome**

**Early  
Christianity &  
Middle Ages**

**Renaissance &  
Enlightenment**

**Modern  
Industrial  
Era**

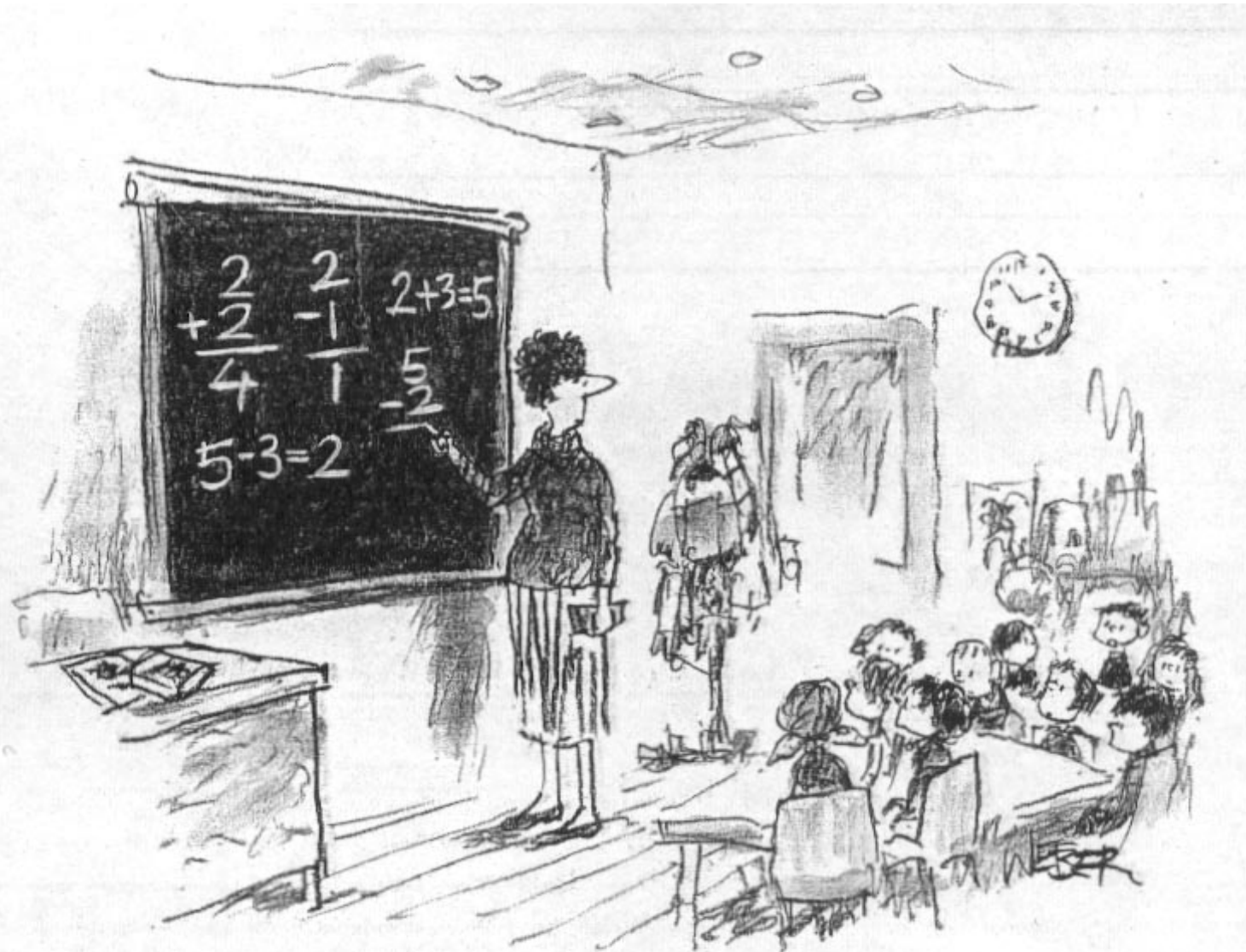
**Today**

Language

Humanities

STEM

# Begging for Relevance



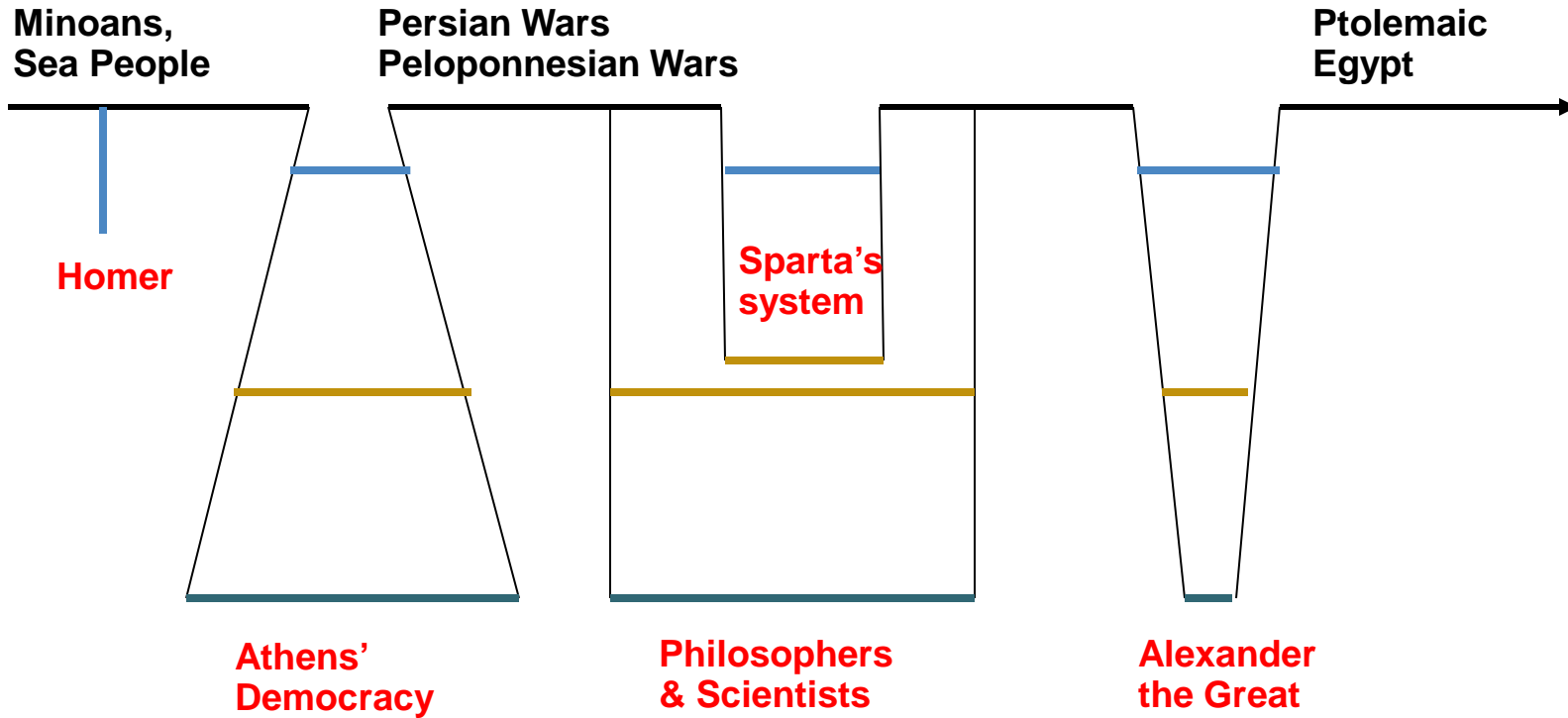
*"Please, Ms. Sweeney, may I ask where you're going with all this?"*



# Relevance is a choice

Discipline (below)	Algebra	Applied Maths	Calculus	Discrete Mathematics	Foundations	Geometry	Numbers & Operations	Statistics & Probability	Topology & Recreational
X represents significant usage in	Matrices, Operations, Vectors etc	Complex systems, Control, Game theory, etc	Analysis, Transforms, Polynomials, etc	Automata, Graphs, Computational maths etc	Sets, Logic etc	Curves, Dimensions, Transformations, Trigonometry, etc	Arithmetic operations, Fractions, Sequences, etc	Distributions, Analysis, Estimation, etc	Knots, Figures, Folding, Spaces, etc
Anthropology							X	X	
Architecture		X				X	X	X	X
Art/Design						X	X		X
Biology (genetics, zoology, etc)	X	X	X	X		X	X	X	X
Business	X	X	X	X			X	X	
Civil engineering	X	X	X	X		X	X	X	X
Computer science	X	X	X	X	X	X	X	X	X
Economics	X	X	X	X		X	X	X	X
Electrical engineering	X	X	X	X		X	X	X	
Geology/Geography	X		X				X	X	
History							X	X	
Law							X	X	
Linguistics		X					X	X	
Mechanical engineering	X	X	X	X		X	X	X	X
Medicine/Pharmacy		X					X	X	
Music			X				X		
Neuroscience	X	X	X	X		X	X	X	
Philosophy					X		X	X	
Physics	X	X	X	X	X	X	X	X	X
Psychology	X	X	X	X			X	X	
Sociology							X	X	

# Impact vs Context



Example: Ancient Greece



# What else is needed ?

Psychology/Sociology/Anthropology ?

Personal Finance/Economics ?

Entrepreneurship ?

Engineering ? Robotics ? Programming ?

Recreational Maths in lower grades ?

Linguistics ?

Mythology ? Philosophy ?

Woodworking ? Gardening ? 3D Printing ?

Career management ?

Resourcefulness ?

Project management ?

Processes ?

Etc.

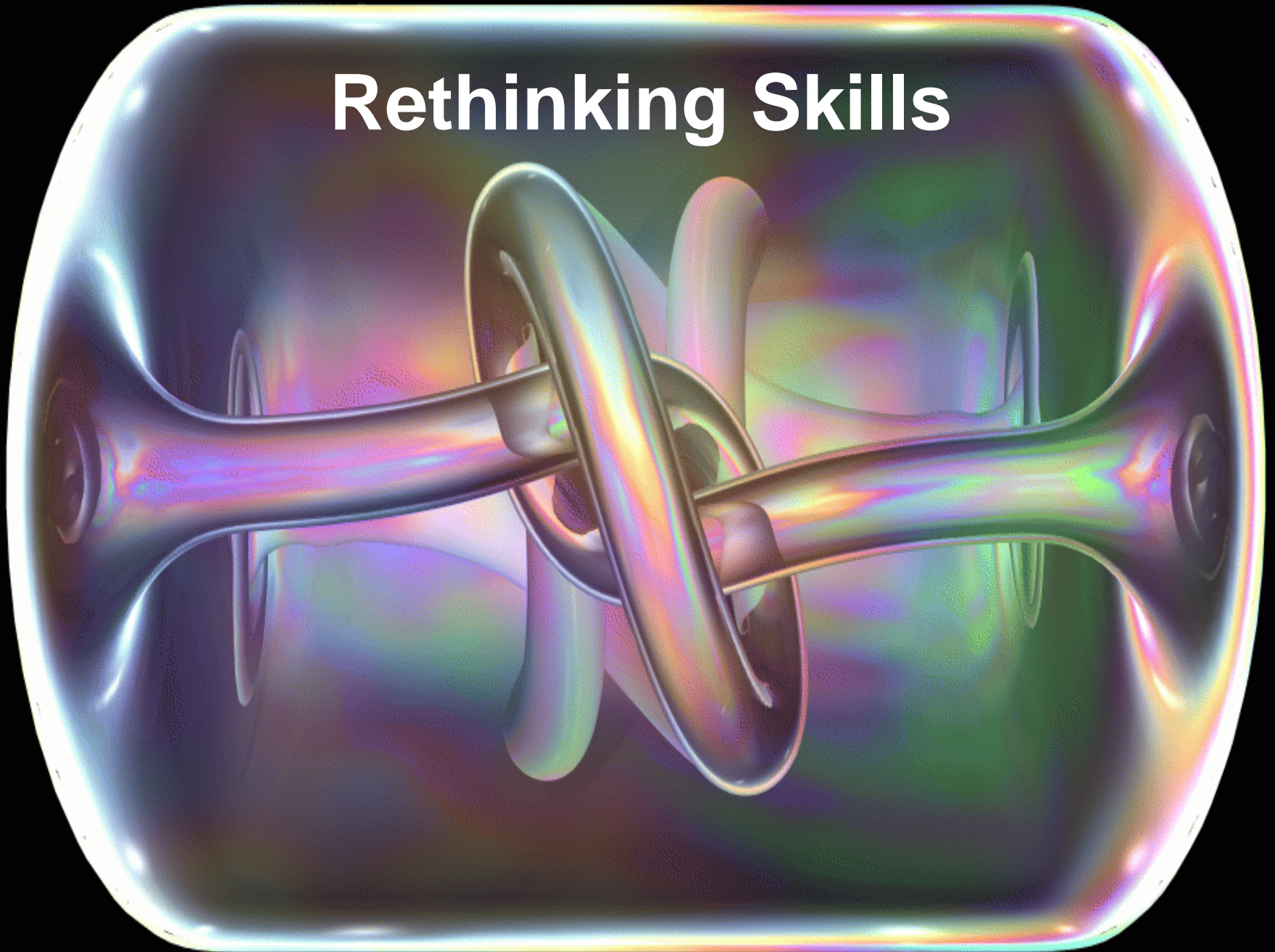


So...

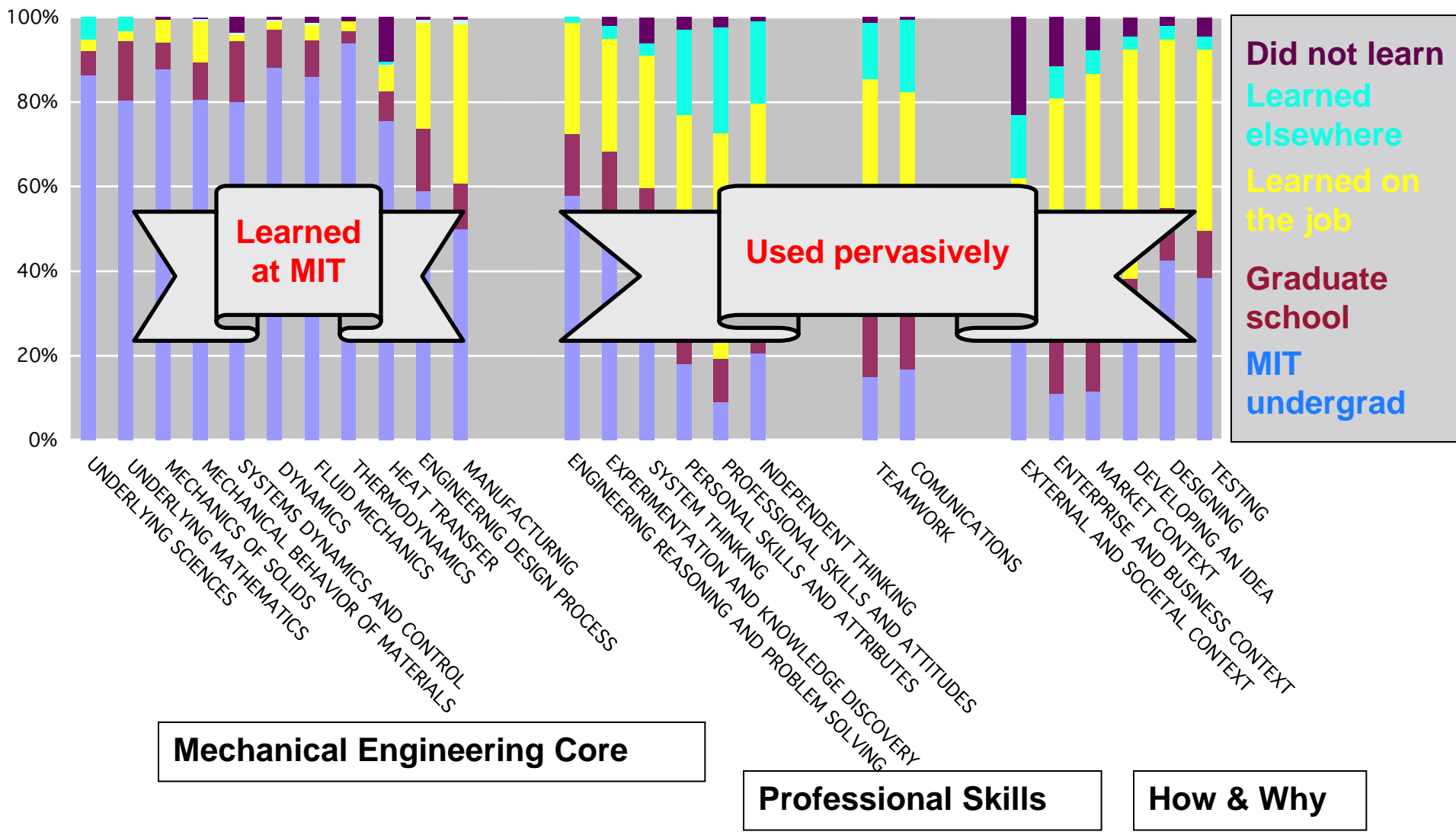
***What do we remove, and  
replace with more relevance ?***

Deep re-examination of every single discipline's branches, topics, items...

# Rethinking Skills



# Mechanical Engineering



# The Popular Press Gets It

“This is a story about... whether an entire generation of kids will fail to make the grade in the global economy because they *can't think their way through abstract problems, work in teams, distinguish good information from bad, or speak a language other than English.*”

*How to Build a Student for the 21<sup>st</sup> Century*, TIME Magazine, December 18, 2006





# The Leadership Gets It

**“I'm calling on our nation... to develop standards and assessments that don't simply measure whether students can fill in a bubble on a test, but *whether they possess 21st century skills like problem-solving and critical thinking and entrepreneurship and creativity*”**

**U.S. President Barack Obama, March 2009**



# 21<sup>st</sup> Century Skills Framework

## Learning & Innovation Skills

- Critical Thinking & Problem Solving
- Creativity & Innovation
- Communication & Collaboration

## Information, Media & Technology Skills

- Information Literacy
- Media Literacy
- ICT (Information, Communications & Technology) Literacy

## Life & Career Skills

- Flexibility & Adaptability
- Initiative & Self-Direction
- Social & Cross-Cultural Skills
- Productivity & Accountability
- Leadership & Responsibility

# Practical book + DVD classroom examples

“The authors have done nothing less than provide a bold framework for designing a 21st century approach to education, an approach aimed at preparing all of our children to successfully meet the challenges of this brave, new world.”

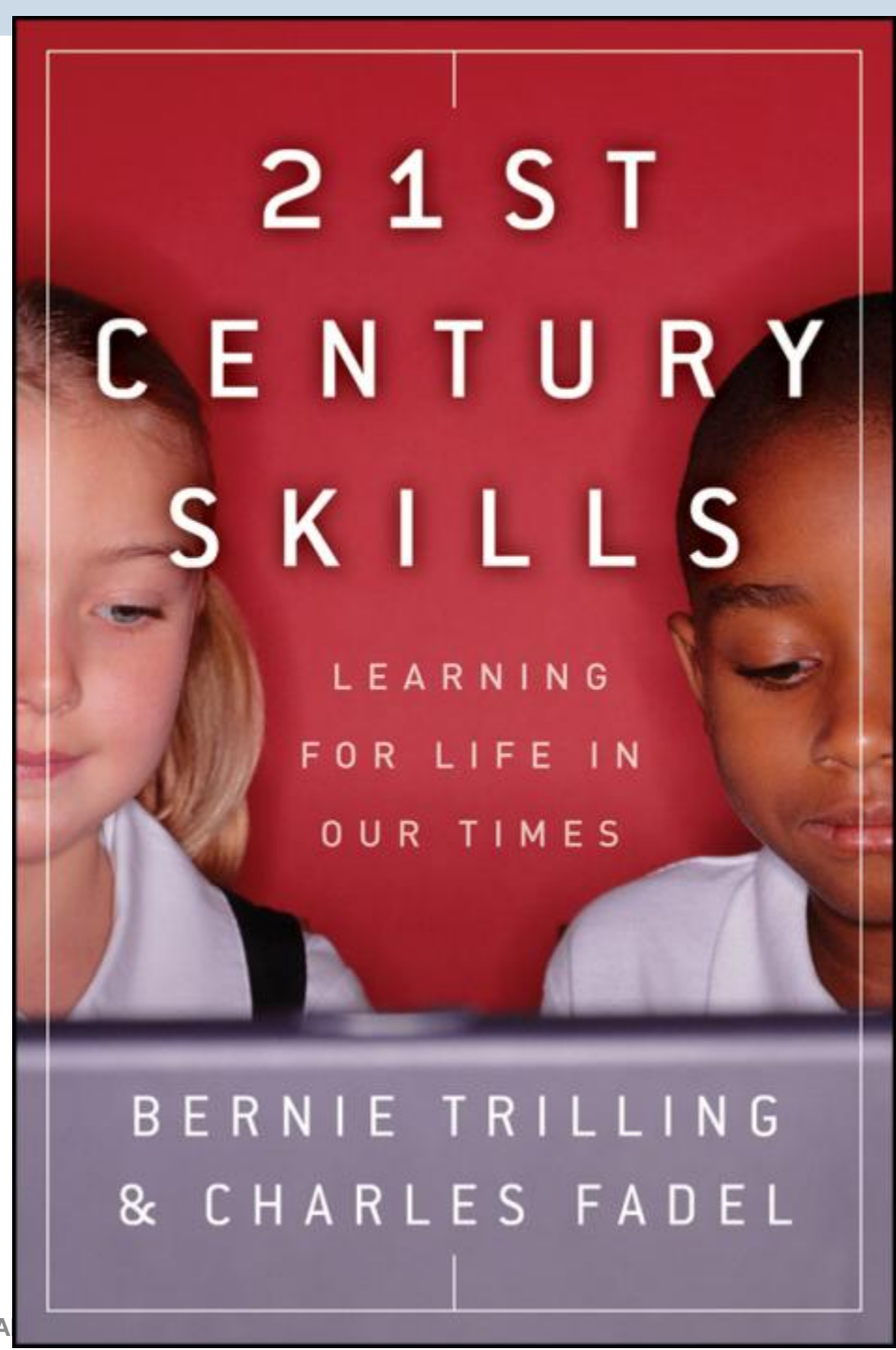
Paul Reville, Secretary of Education,  
**Commonwealth of Massachusetts;**  
former director of the Education Policy and  
Management Program,  
**Harvard Graduate School of Education**

“It’s about time that we have such an accessible and wise book about the 21st century skills that so many companies, policymakers, and educators are talking about”

Roy Pea, Professor,  
Education and the Learning Sciences,  
**Stanford University**

<http://www.21stcenturyskillsbook.com>

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# The Role of Character



# The Perfect Storm



Globalization

Financial Meltdown

Overconsumption

Global Warming

Source: "In the Hollow of a Wave off the Coast at Kanagawa" 18<sup>th</sup> century by Katsushika Hokusai, Metropolitan Museum, NY

# Battling with Ourselves

“We have evolved traits [such as group selfishness] that will lead to humanity's extinction – so we must learn how to overcome them”

Christian de Duve

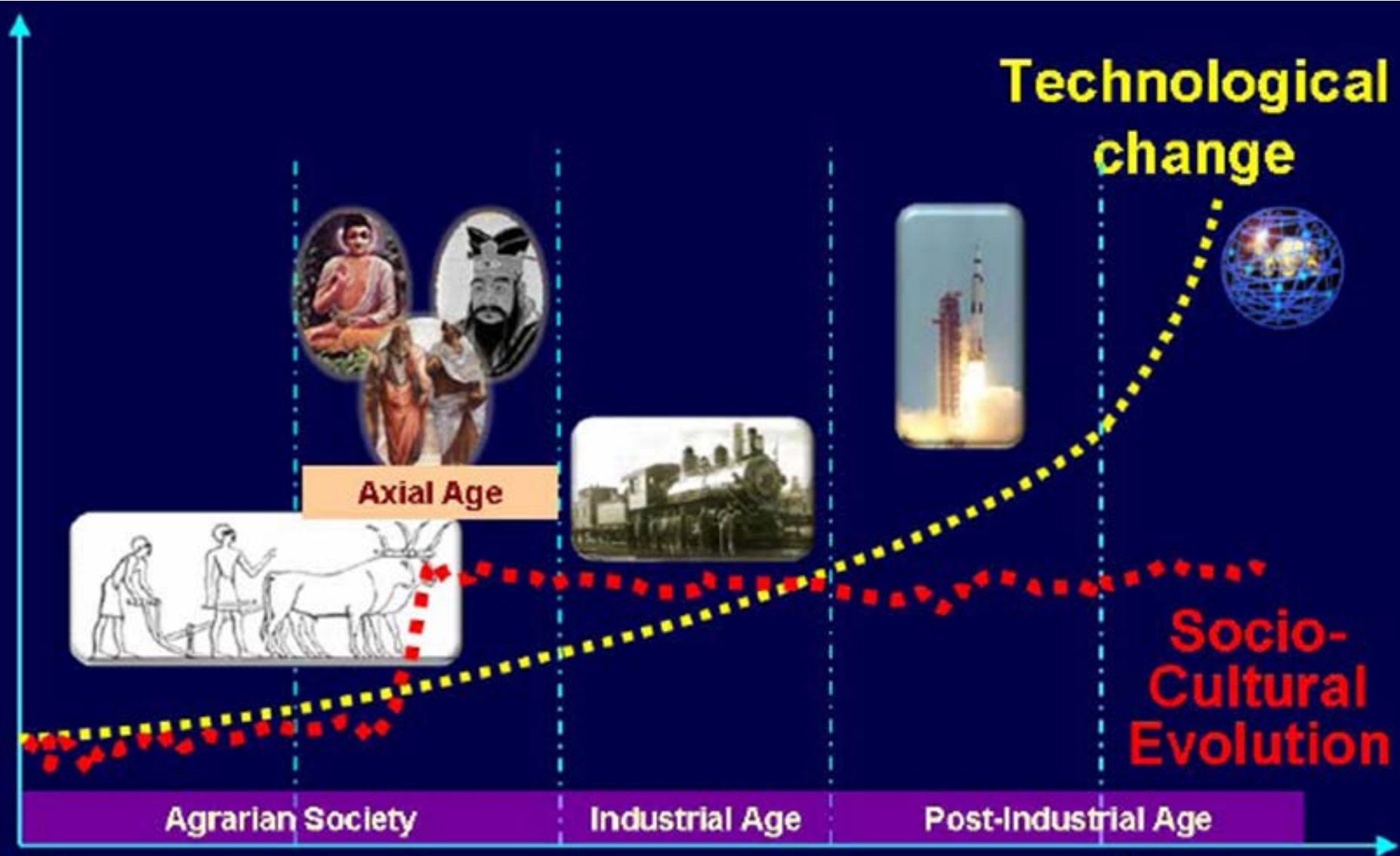
Nobel prize in Medicine 1974

“Genetics of original sin”

Yale University Press



# Divergence Between Technology & Culture



Source: Professor SHIH Choon Fong President, National University of Singapore, 2007

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# Character means

## □ Performance character

- one's mastery and thrust for excellence in school, the workplace, and in other experiences: effort, diligence, perseverance, and self-discipline.

## □ Moral character

- relational and ethical, how one treats others in interpersonal and social matters: integrity, justice, caring, respect, and empathy.

# Conclusion: AND not OR

Knowledge + Skills + Character  
+ Metacognition



head

hand

heart



Logic + Action + Emotion



감사합니다 Natick

Grazie Danke Ευχαριστίες Dalu

Thank You Köszönöm

Спасибо Dank Gracias

谢谢 Merci Seé  
ありがとう

Obrigado



<http://curriculumredesign.org/>