

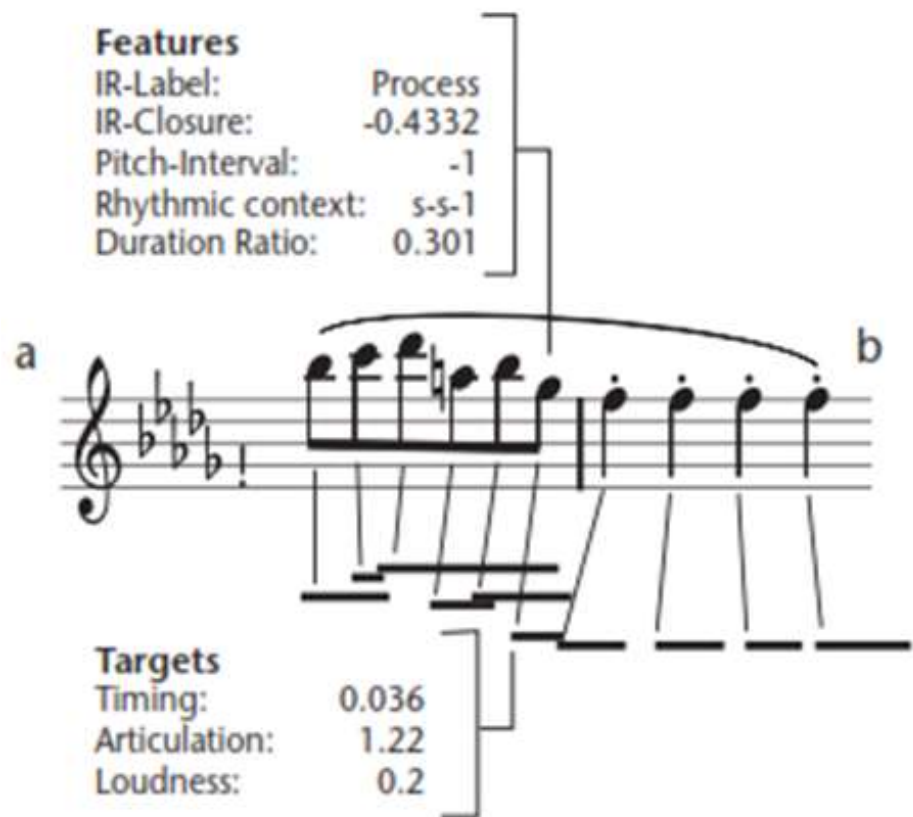
Education in the Age of Exponential Technology

@Cornell University

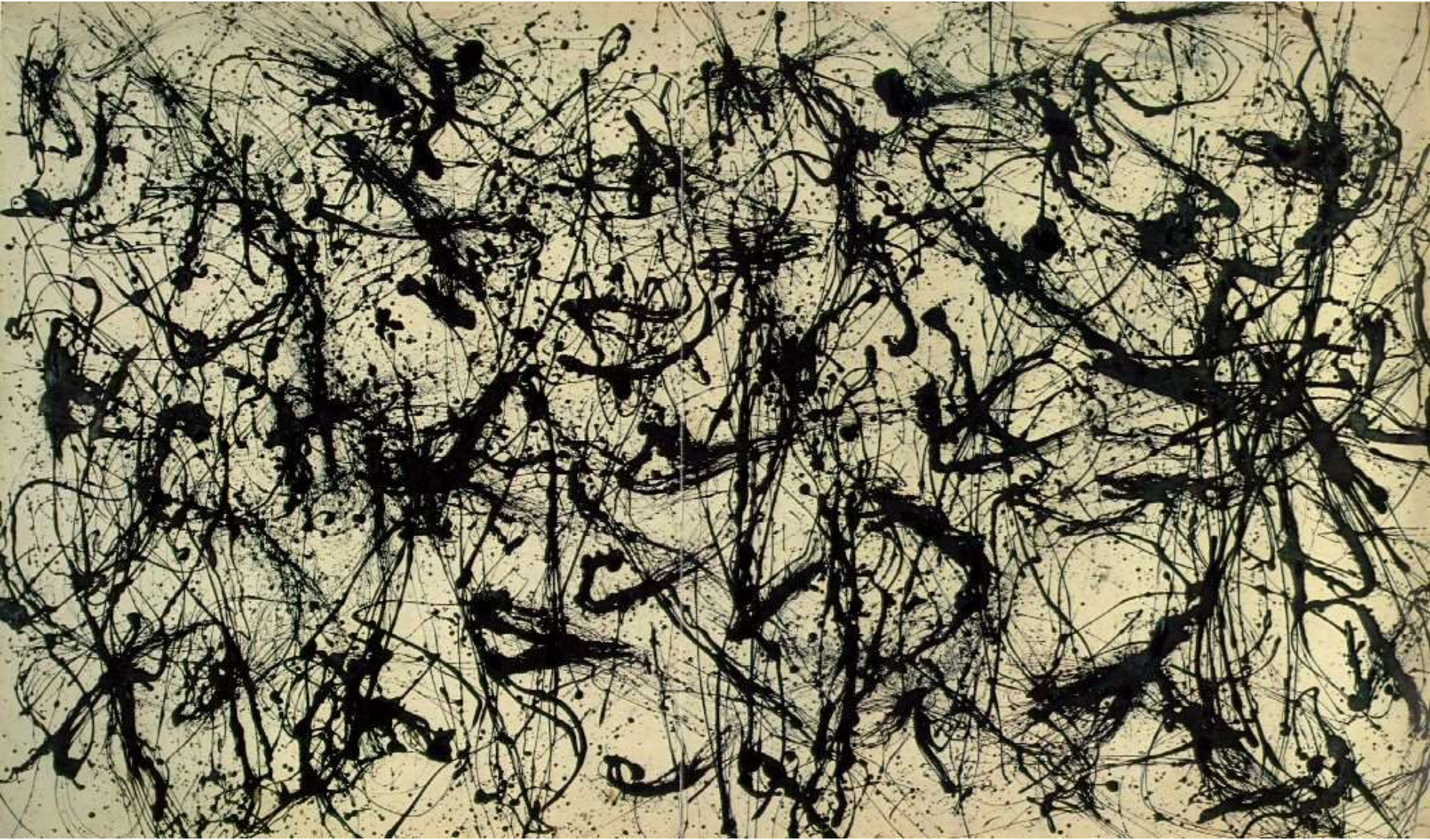


Charles@curriculumredesign.org #4DEdu @CurrRedesign

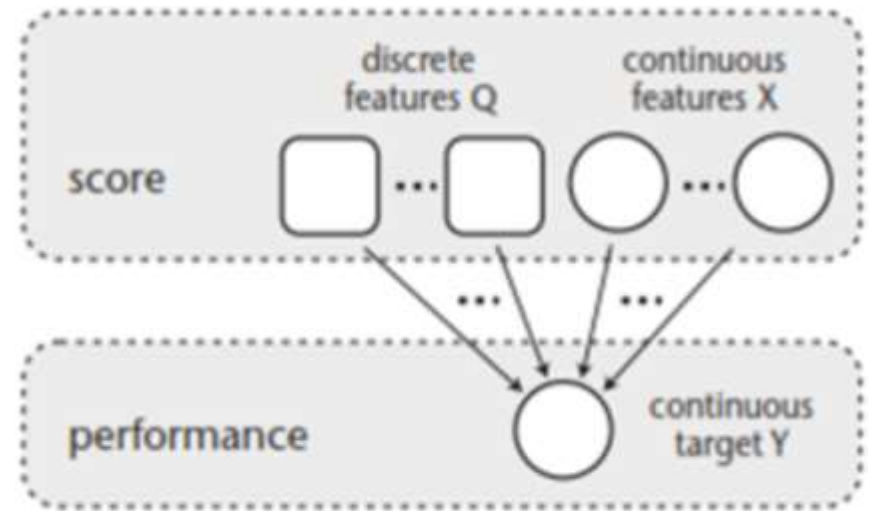
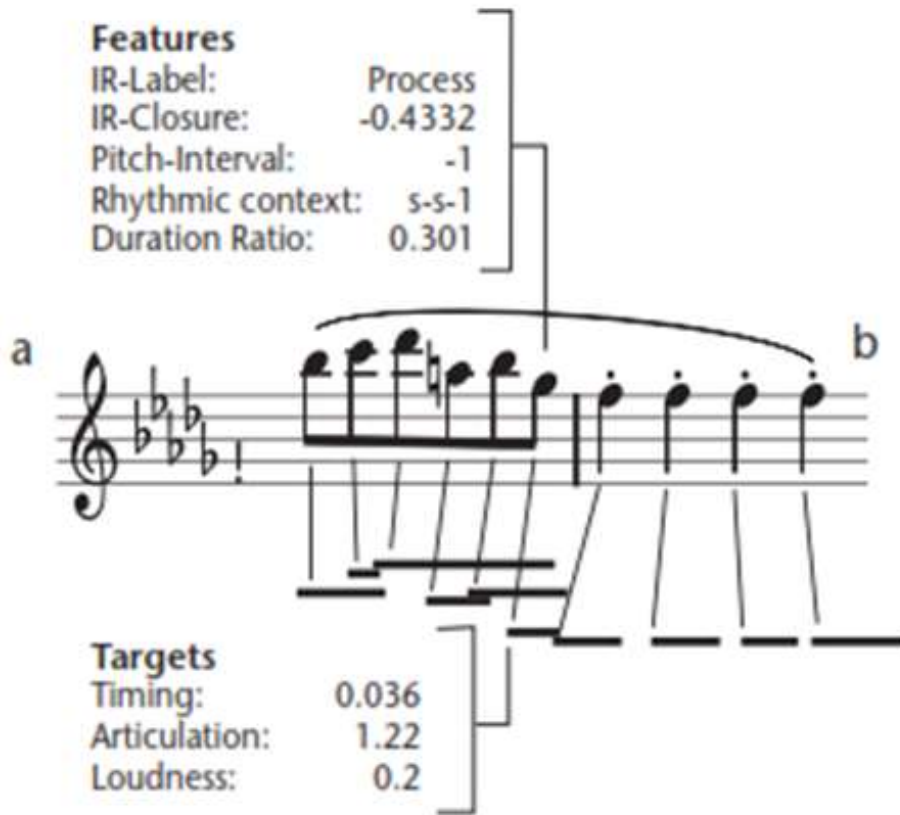
Music exercise – Audio



“1950”



Music exercise – Audio



Computers can sketch too !

- Seven artists generated about 8,000 pen strokes
- Disney's software analyzed distance between facial features

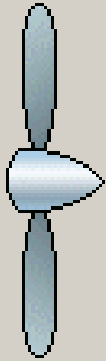


Innovation follows patterns → *automatable*

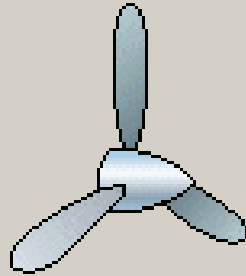
Source: Invention Machine "IM Labs"



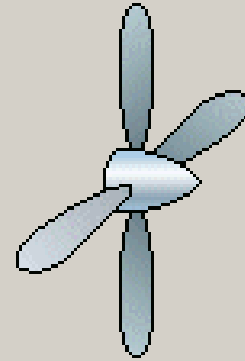
One-blade propeller



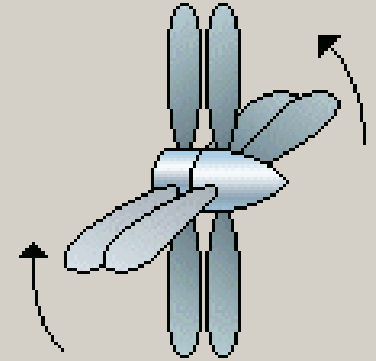
Two-blades



Three-blades



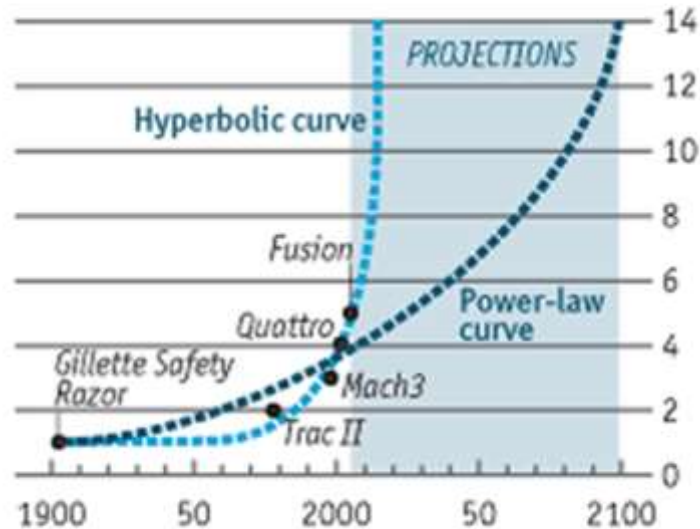
Four-blades



Double four-blades

Blade running

Number of blades per razor system



Source: *The Economist*



Incremental vs Radical Innovation

- Incremental innovation = improving existing “state”
- Radical innovation = inventing completely new “state”

Good news: Computers unlikely capable of radical innovation soon

Bad news: Incremental innovation is estimated at 95% of total (Clayton Christensen)

Question

What will the world be like 20 years from now?



The road ahead is challenging...

Technological disruptions

Climate change

Personal privacy

Financial instability

Political partisanship

Religious intolerance

Inequities

Our New World



VUCA

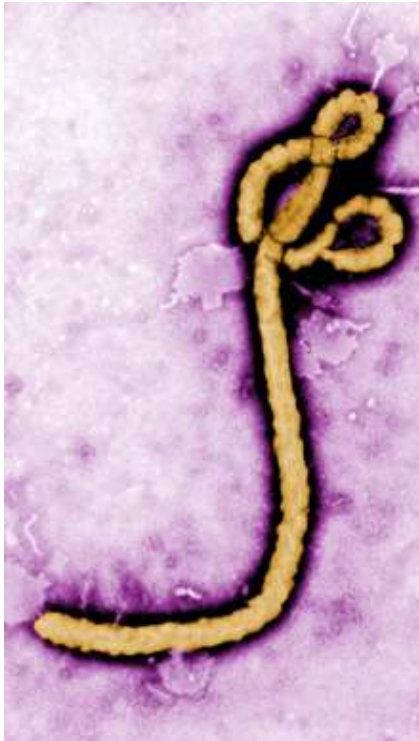
Volatile

Uncertain

Complex

Ambiguous

At the mercy of the weakest link



Second Question

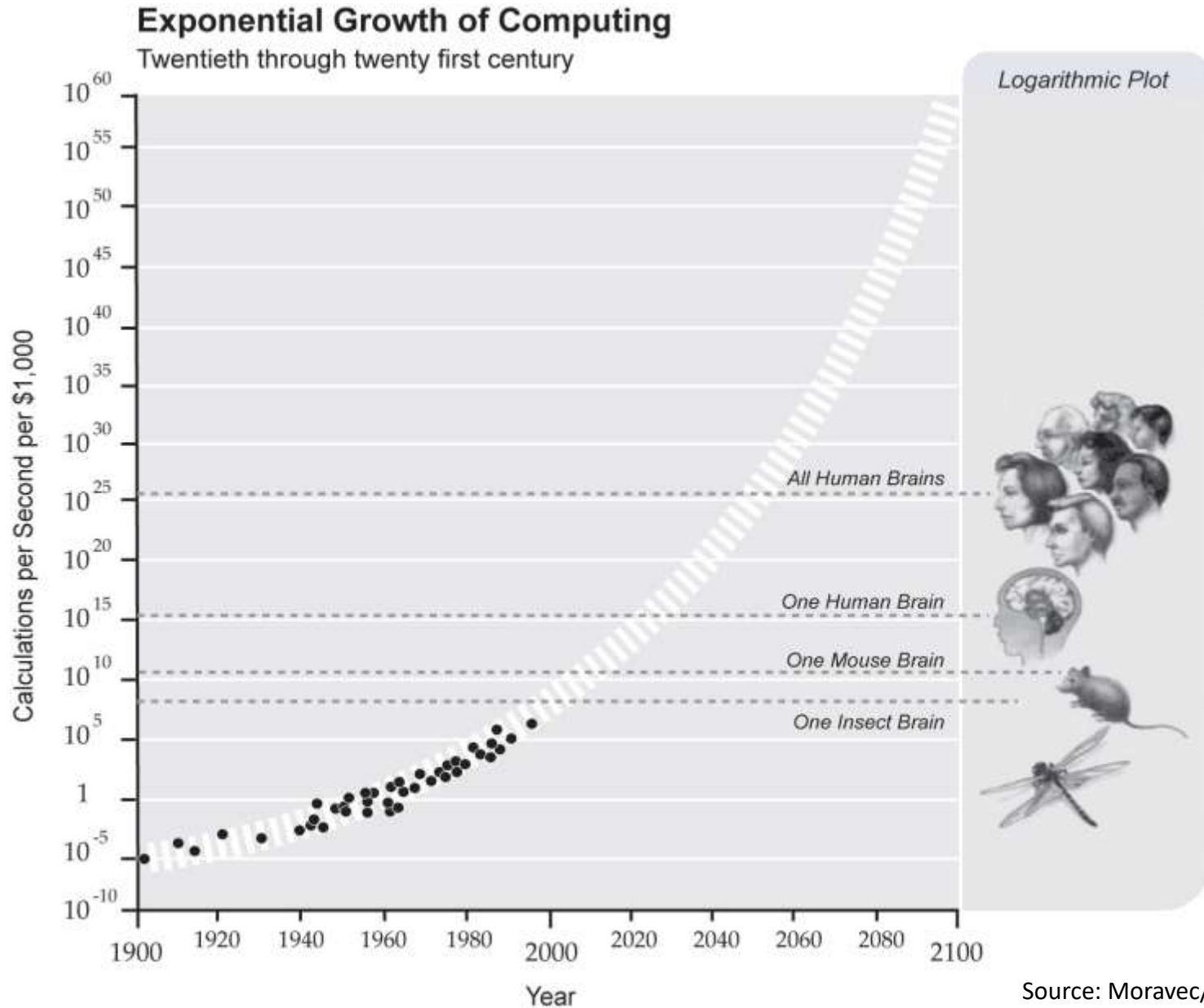
What will the world be like 20 years from now?

*What will you need to be successful
in that world?*

The Power of Exponential Technologies



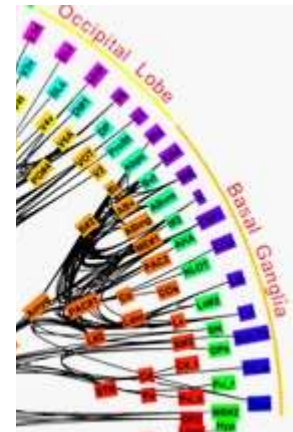
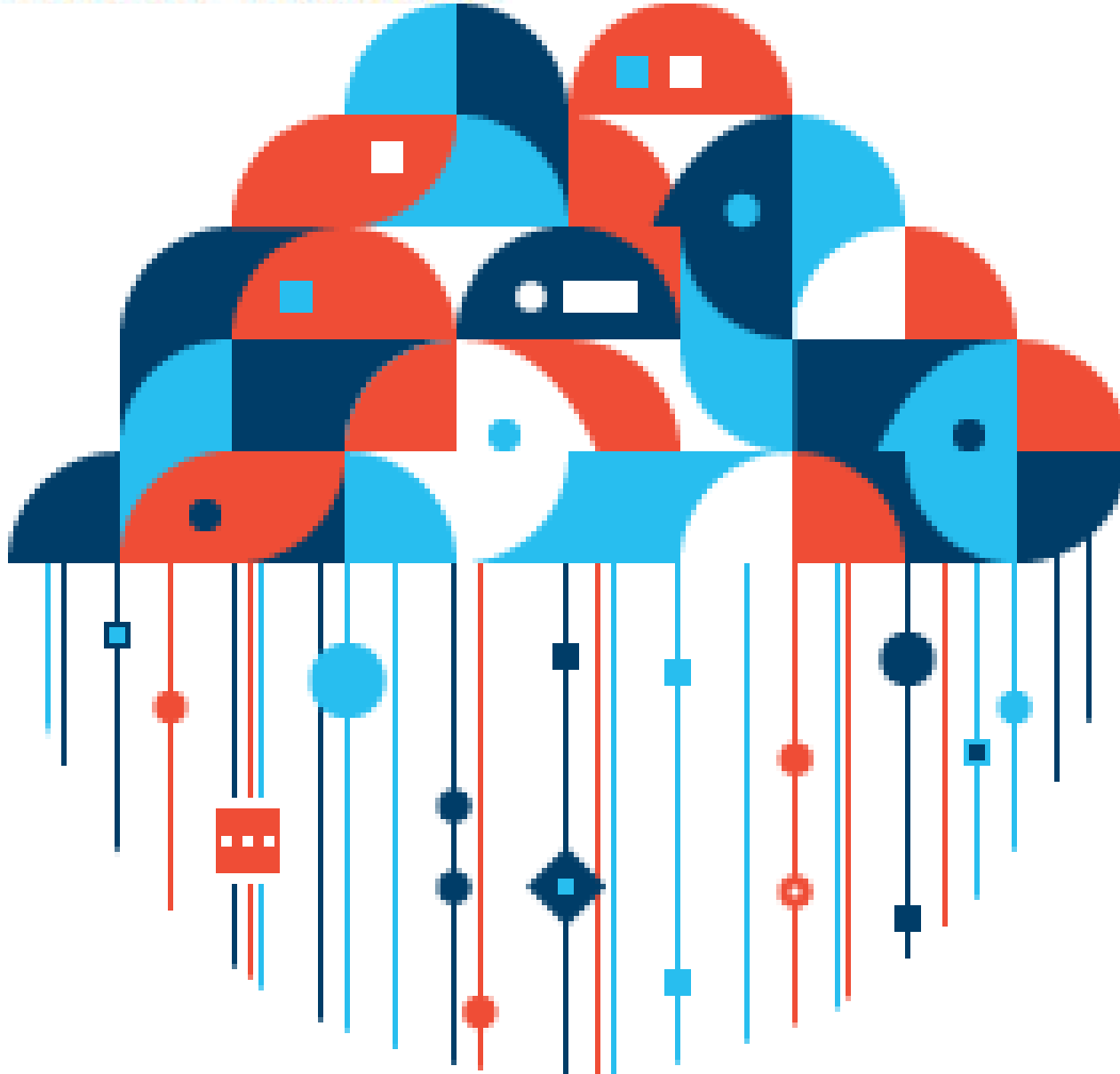
On the road to ExoBrain



One-Two-Three-Four punches

SyNAPSE (chip) + BlueBrain (system) + Watson (software) + Cloud Computing (infrastructure)

THE BLUE



The Impact of Big Data & Machine Learning

Three key areas in which machine bests humans:

- consume huge amounts of data
- receive thousands of inputs at once
- create a unified model of knowledge across that *scale* of information and make judgments from it

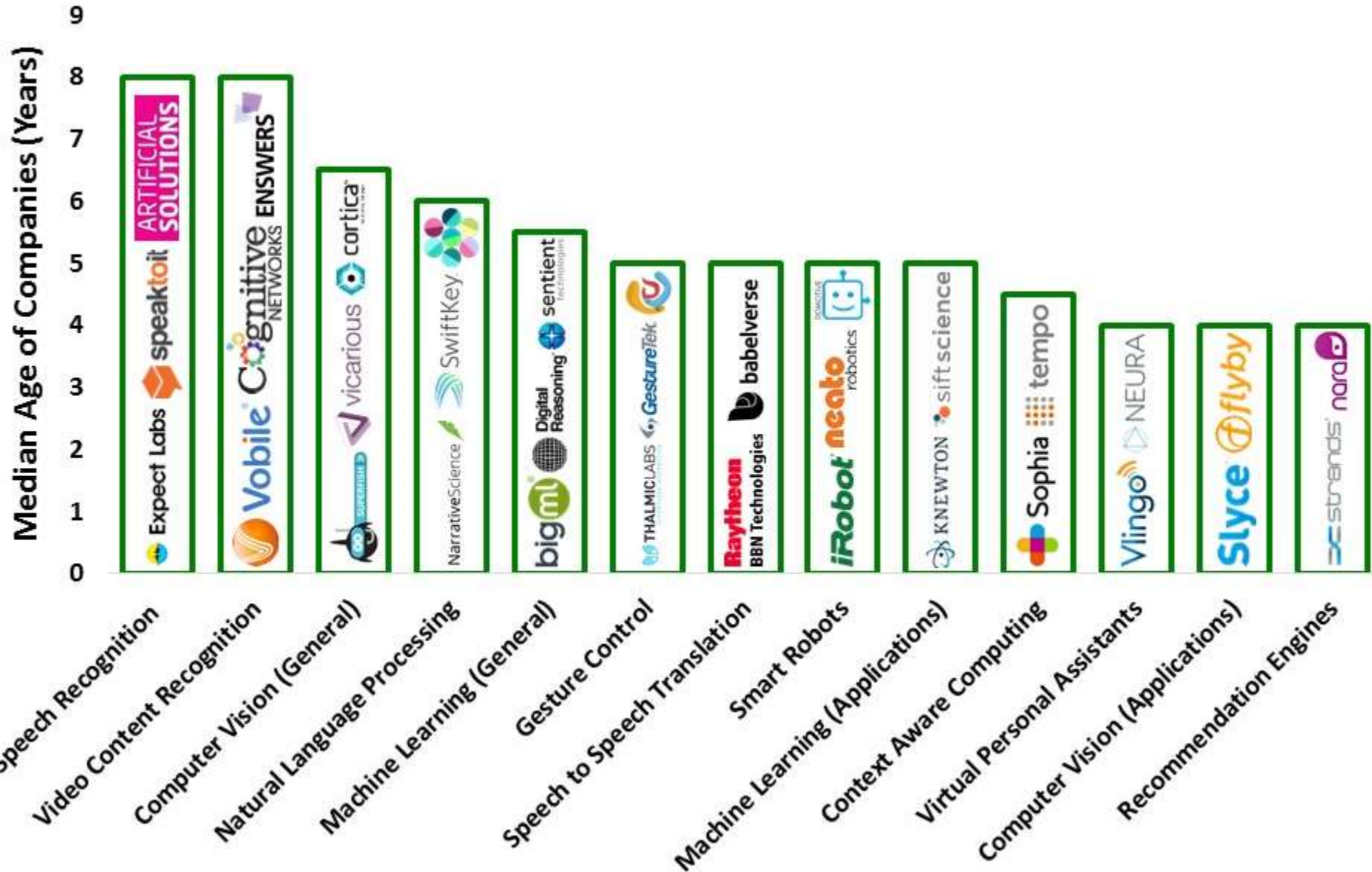
Timothy Estes, founder and CEO of Digital Reasoning

And do so with fewer human cognitive biases...

But Humans...

- Have access to a LOT more [diverse] data than a machine:
 - building intuitions and holistic pictures in our mind
 - seeing connections that the machine might not even have the possibility of seeing because it doesn't have the right data.
- Have a powerful role in figuring out the sources of data to give the machine and projecting their intuition.

Artificial Intelligence applied everywhere



WikiBots



Bots vs.



Wikipedians

42% of
Wikipedia is
edited by 12
bots !

Who edits more?





Dilbert.com DilbertCartoonist@gmail.com



© 2011 Scott Adams, Inc./Dist. by Universal Uclick



Magically schedule meetings

That's us. That's all we think about.

<https://x.ai/about/>

Human workers, managed by an algorithm

“The latest trend in crowdsourcing is organizing foreign workers on a mass scale to do routine tasks that computers aren’t yet good at, assigned by an algorithm”

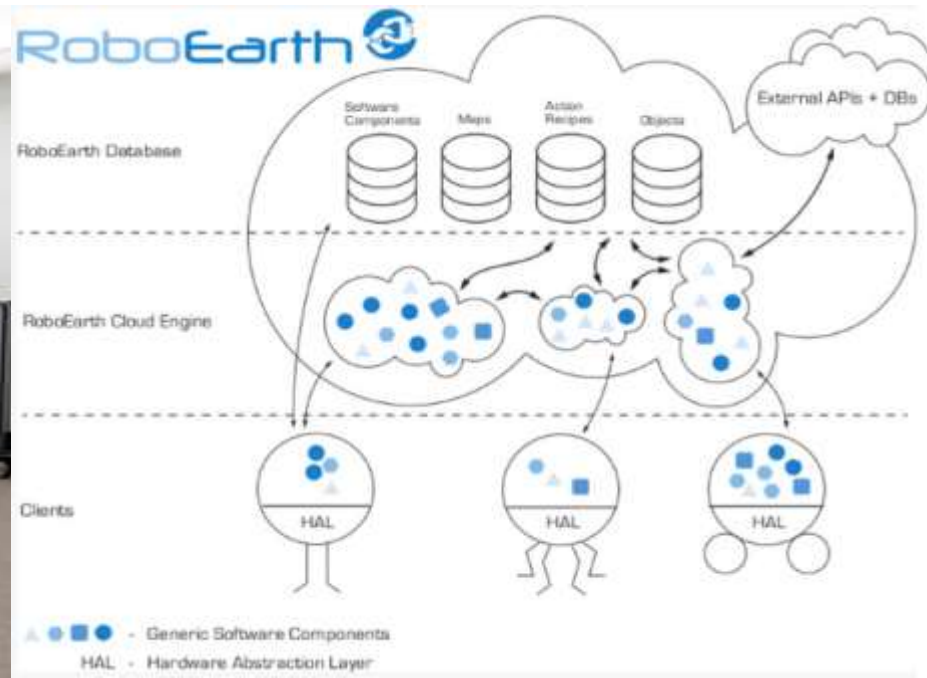
The screenshot displays the mobileworks website interface. At the top, the logo 'mobileworks' is on the left, and navigation links for 'SIGN UP FREE', 'Solutions', 'Developers', 'Social Mission', and 'Sign In' are on the right. A secondary navigation link 'Request a free consultation!' is also present. The main headline reads 'The world's most accurate virtual workforce.' Below this, a sub-headline states 'Crowdsource your work the no-nonsense way, with accurate, qualified workers and reliable security.'

A central workflow diagram illustrates the process of posting a project. It begins with 'Generate Leads' (represented by a laptop icon), which leads to 'Categories Items' (folder icon) and 'Digital Documents' (document icon). Both of these lead to a central orange box labeled 'Post a Project' with the subtext 'View all projects'. From this central box, the process continues to 'Collect Feedback' (circular arrows icon), 'Label Data' (document with tag icon), and finally 'And More!' (star icon). A cloud with gears icon is positioned above the 'Post a Project' box, suggesting a cloud-based or algorithmic management system.

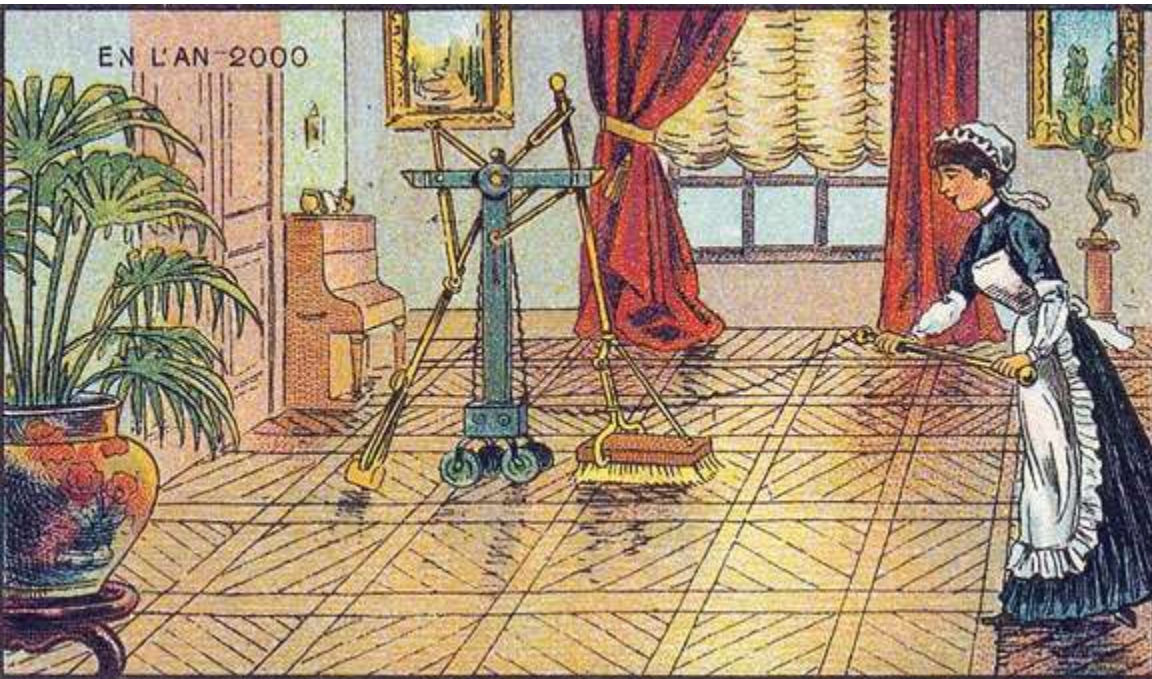
Robots learning from each other

- Knowledge and experience shared worldwide
- Computing tasks carried out in the Cloud

→ *Hyperbolic improvement*



Our Limited Imagination



Source: Jean-Marc Côté, 1899

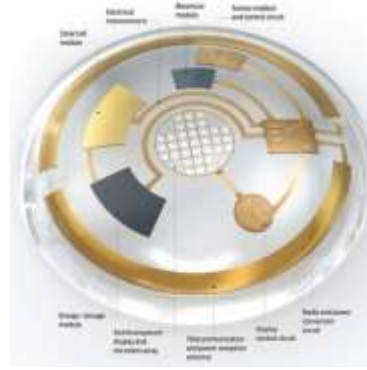


Robot Serves Up 360 Hamburgers Per Hour

- Pays for itself in a year
- No cashiers or servers
- Will never forget to ask “do you want fries with your order?”



Augmented Reality



46°00'N, 8°57'E Piazza Riforma Lugano

Bar/Ristoranti 500m

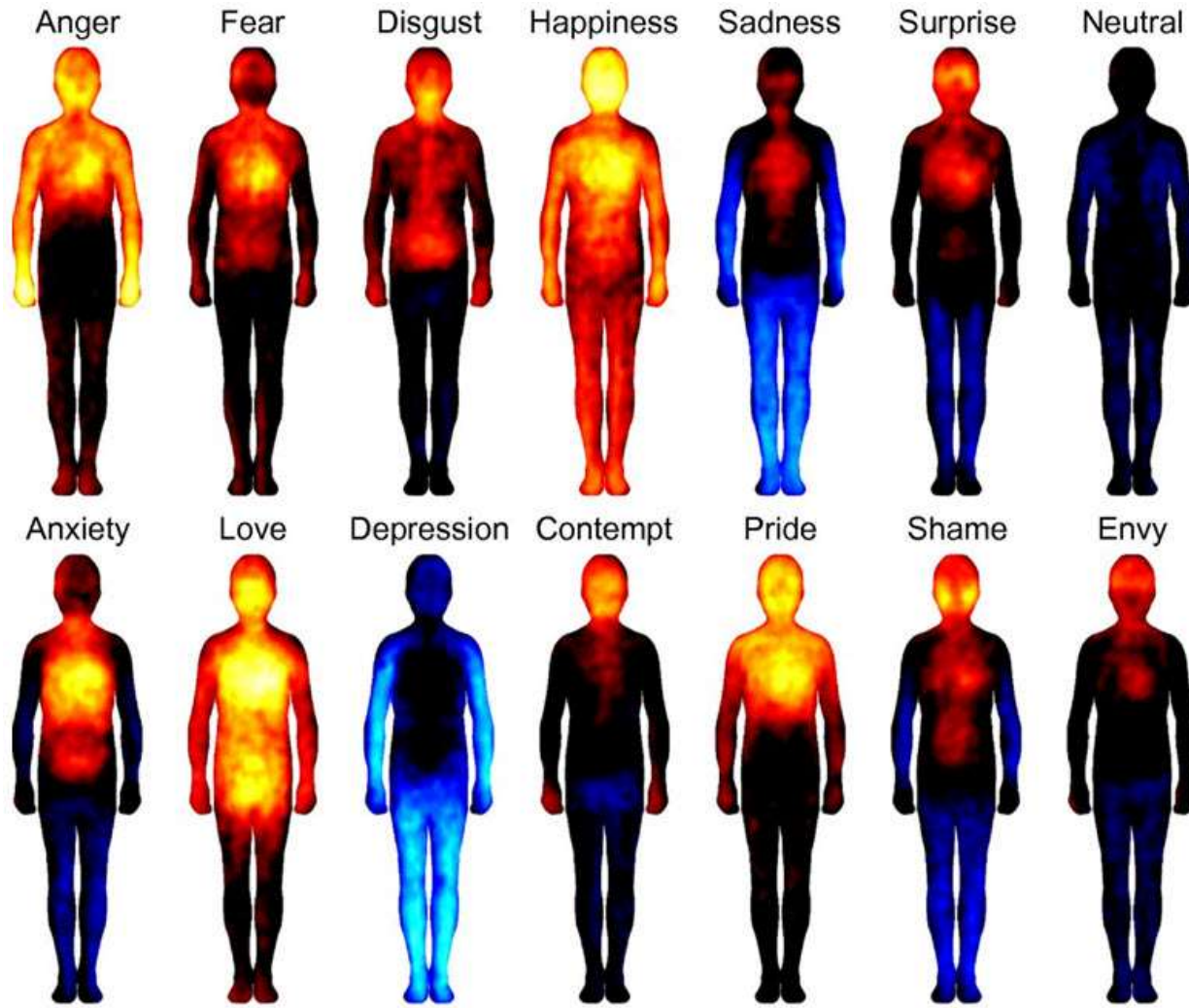
- Caffé Federale
Menu Mostra Navigazione
- Bar Vanini
Menu Mostra Navigazione
- Bar Argentino
Menu Mostra Navigazione

Mostra:
Bar / Ristoranti

Distanza:
500 m

OK Cancel

Emotions detected in the body

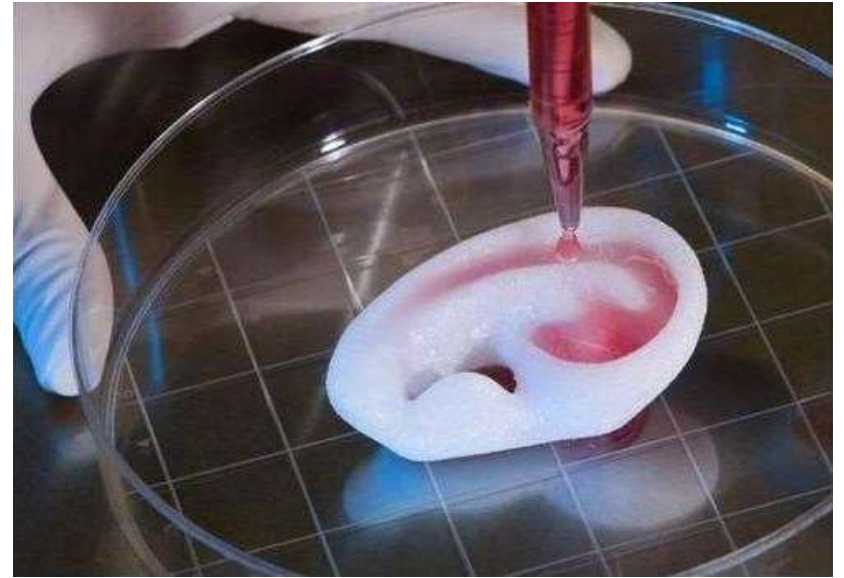


Source: [Lauri Nummenmaa et al., Bodily maps of emotions, PNAS, 646–651, doi: 10.1073/pnas.1321664111 \(open access\)](https://doi.org/10.1073/pnas.1321664111)

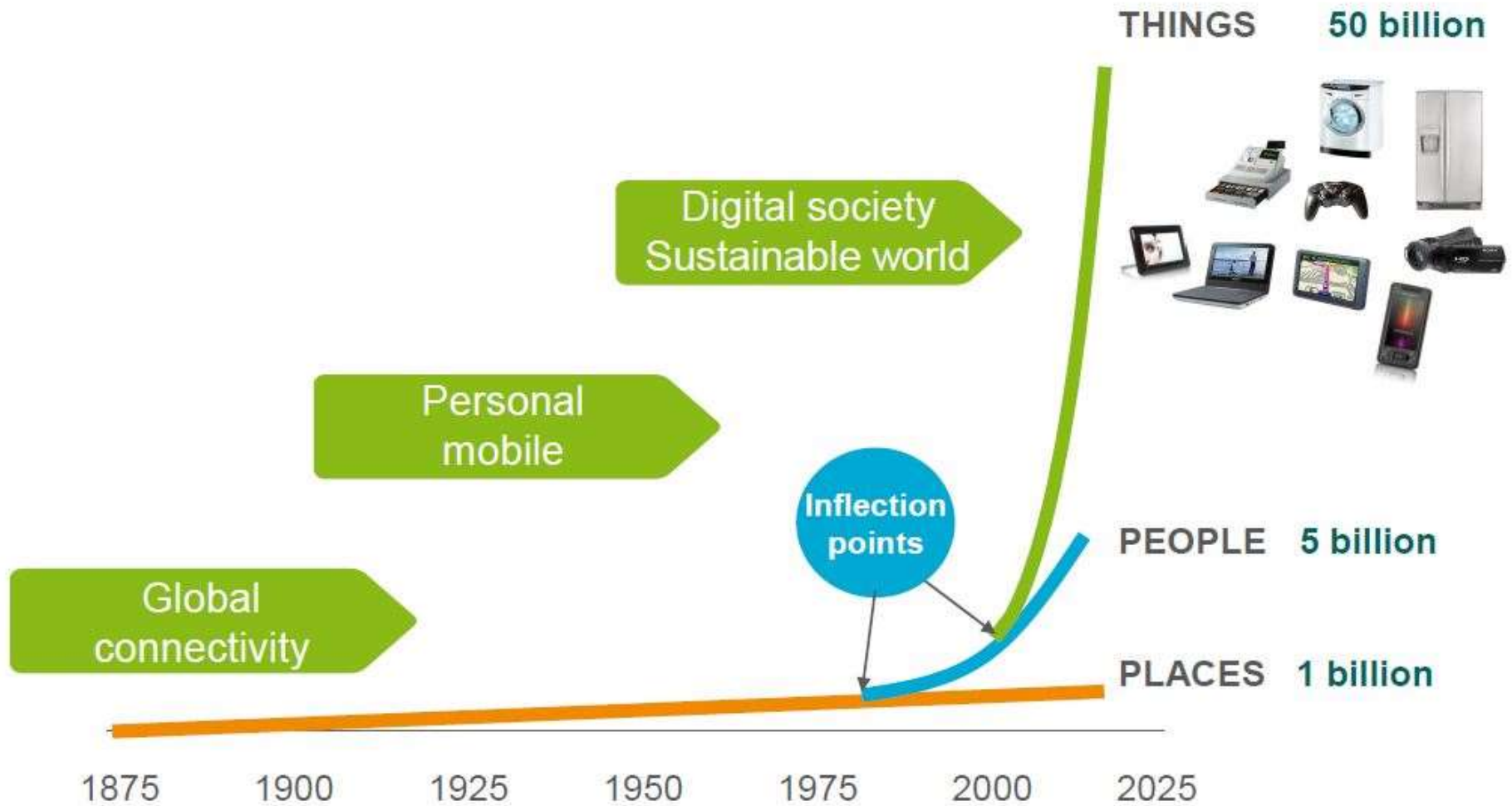
Virtual Reality



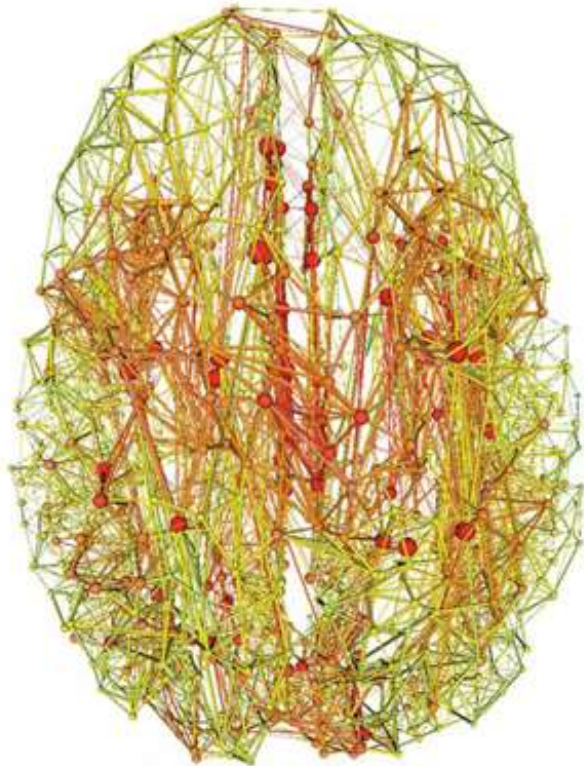
3-D Printing



Internet of Things



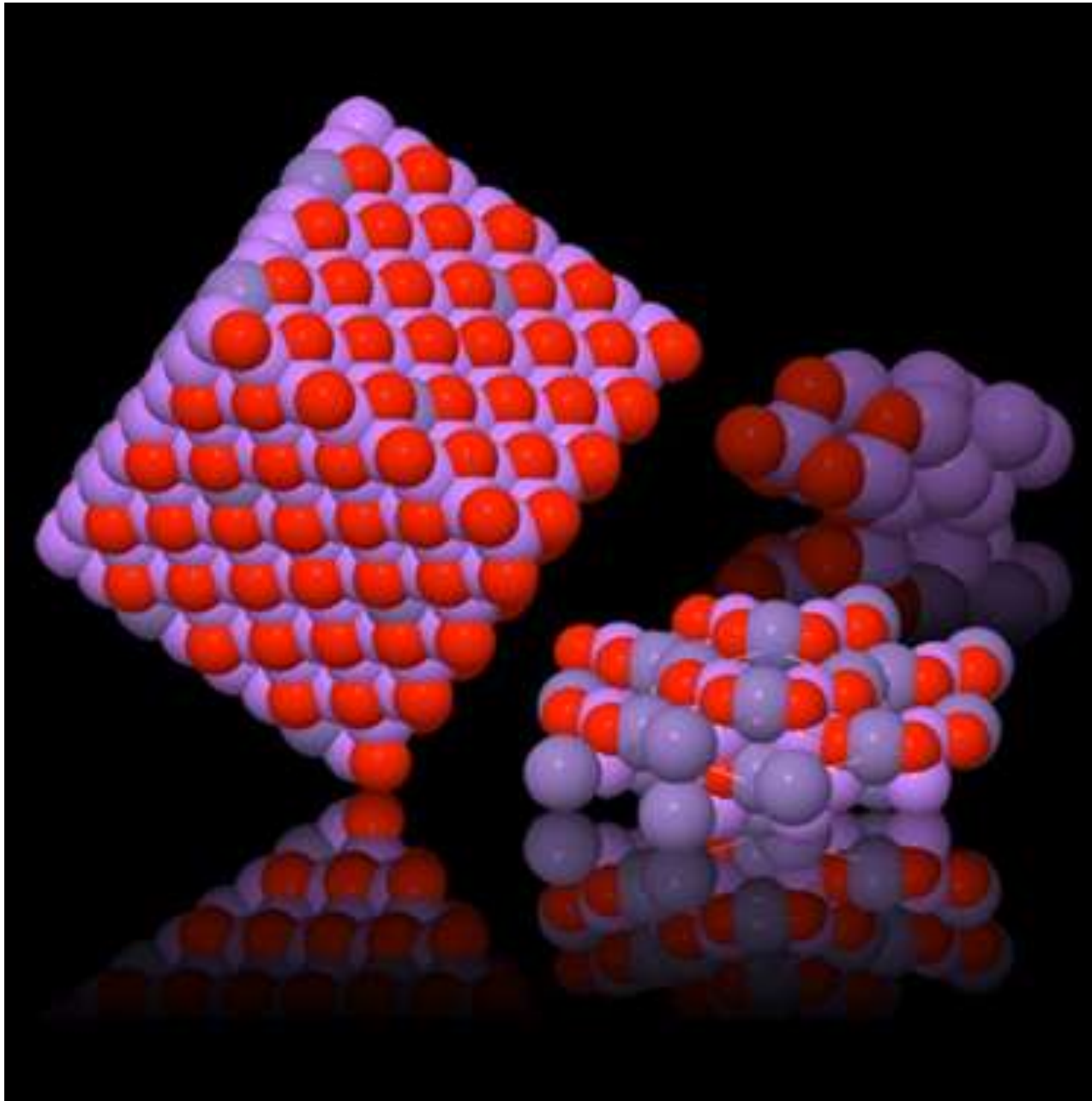
Brain Enhancers



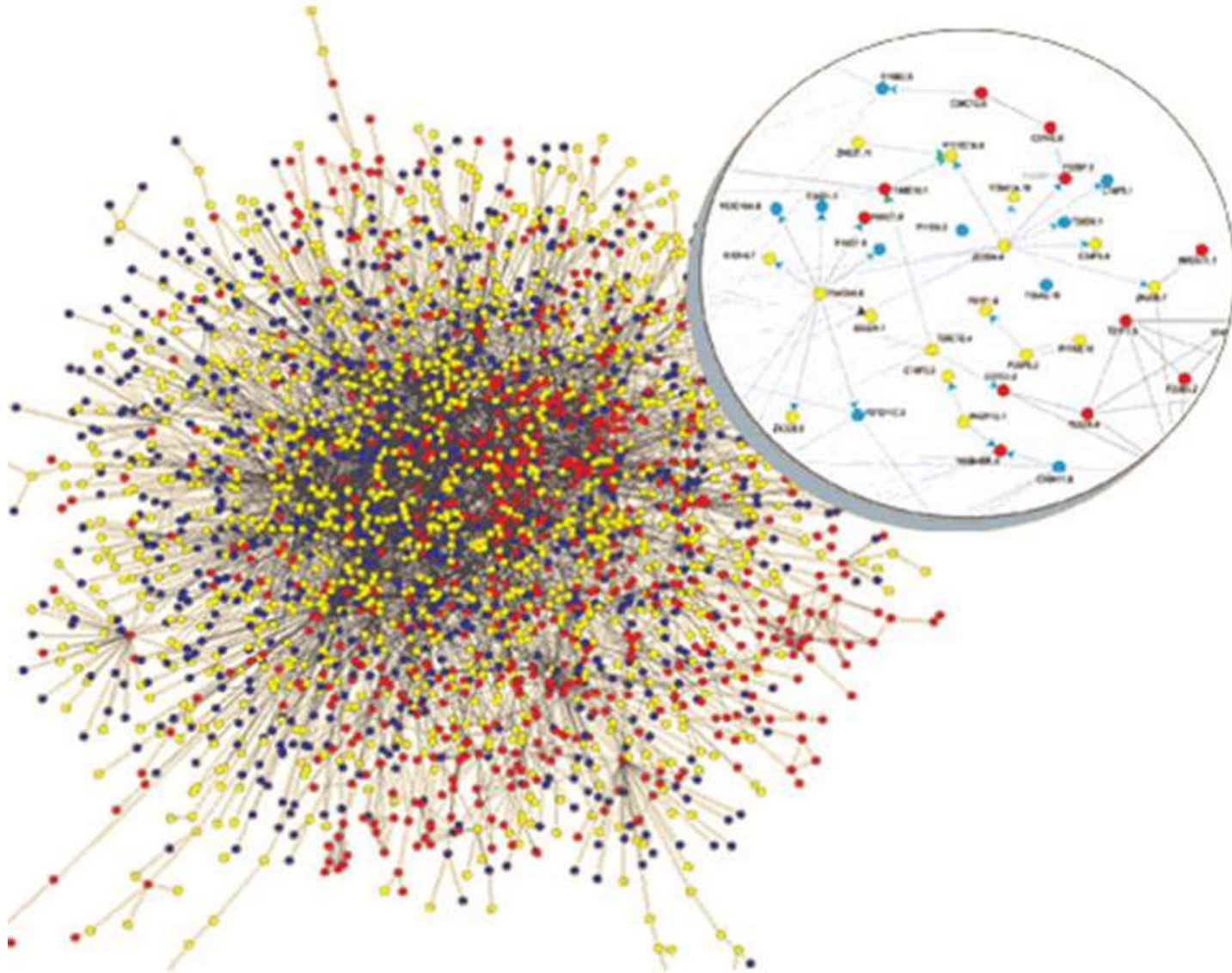
Quantified Self



Nanomaterials



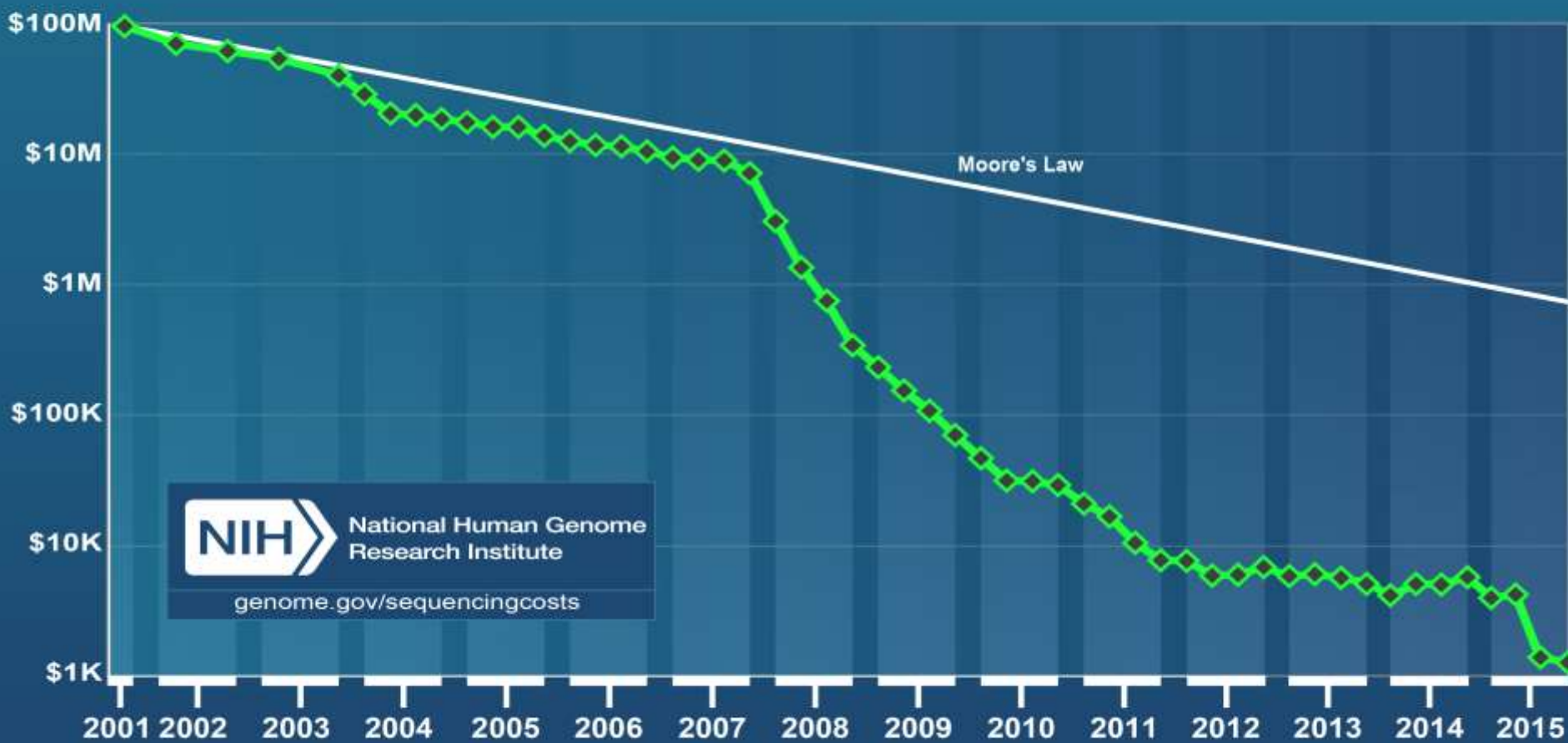
Biotech



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

Sequencing costs dropping faster than Moore's Law

Cost per Genome



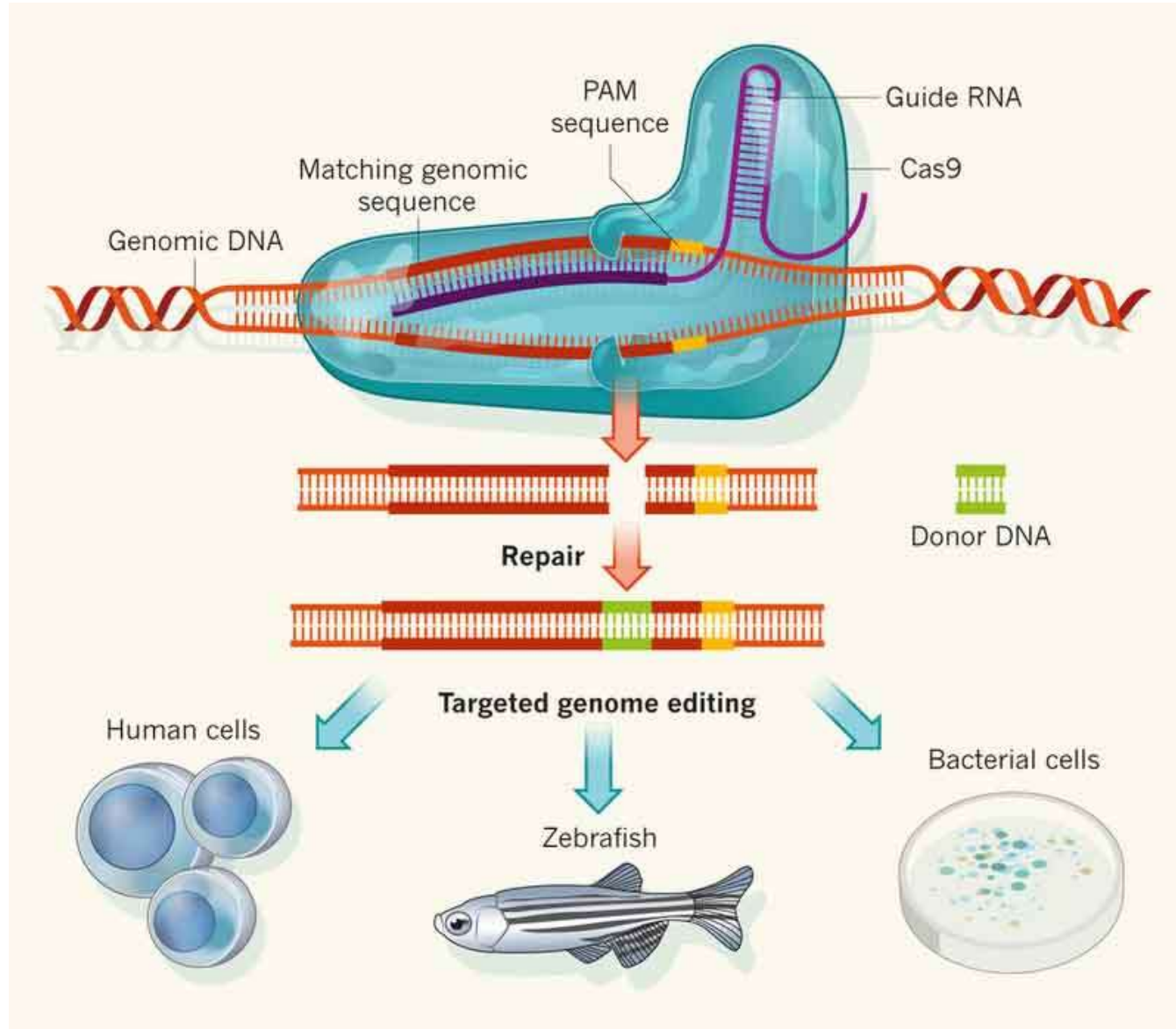
Genome Sequencing

From \$1.5B to \$1k in 15 years; @10c in another 15?

23 Pairs of chromosomes.
One unique you.



Genome Editing



Unintentional vs Intentional?



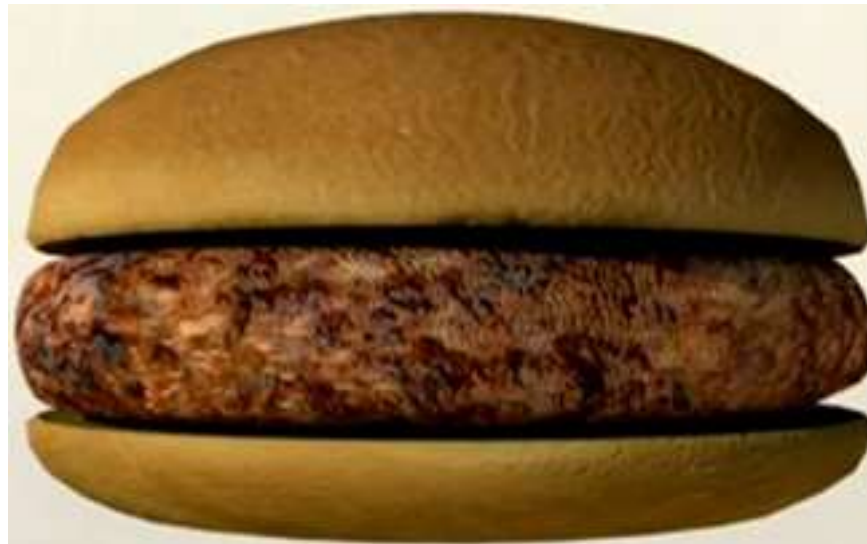
The Beijing Genomics Institute's Cognitive Genomics Project is currently doing whole-genome sequencing of 1,000 very-high-IQ people around the world, hunting for sets of sets of IQ-predicting alleles... Kids produced by any one couple typically differ by 5 to 15 IQ points. So this method of "preimplantation embryo selection" might allow IQ within every Chinese family to increase by 5 to 15 IQ points per generation...

Geoffrey Miller, Evolutionary psychologist, NYU in EDGE 2013

STEM Cells

Miniature 'human brain' grown in lab

...will transform the understanding of neurological disorders.
The pea-sized structures reached the same level of development as in a nine-week-old fetus...





Synthetic Biology

based on standard parts

“BioBricks” that produce for instance:

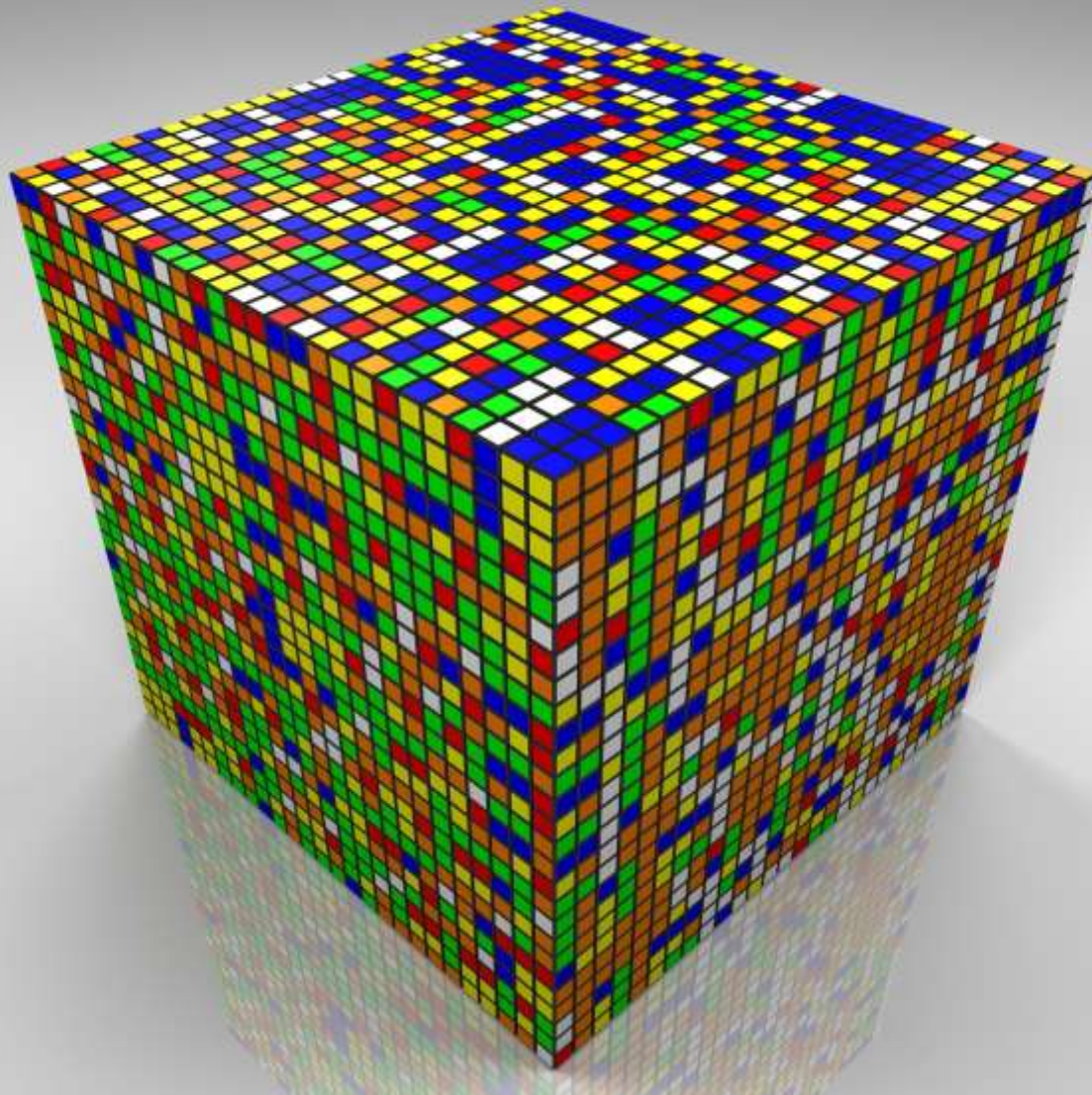
- Arsenic biodetector: to detect arsenic contamination in water.
- BactoBlood: cost-effective red blood cell substitute constructed from engineered E. coli.

FIRST SELF-REPLICATING SYNTHETIC BACTERIAL CELL



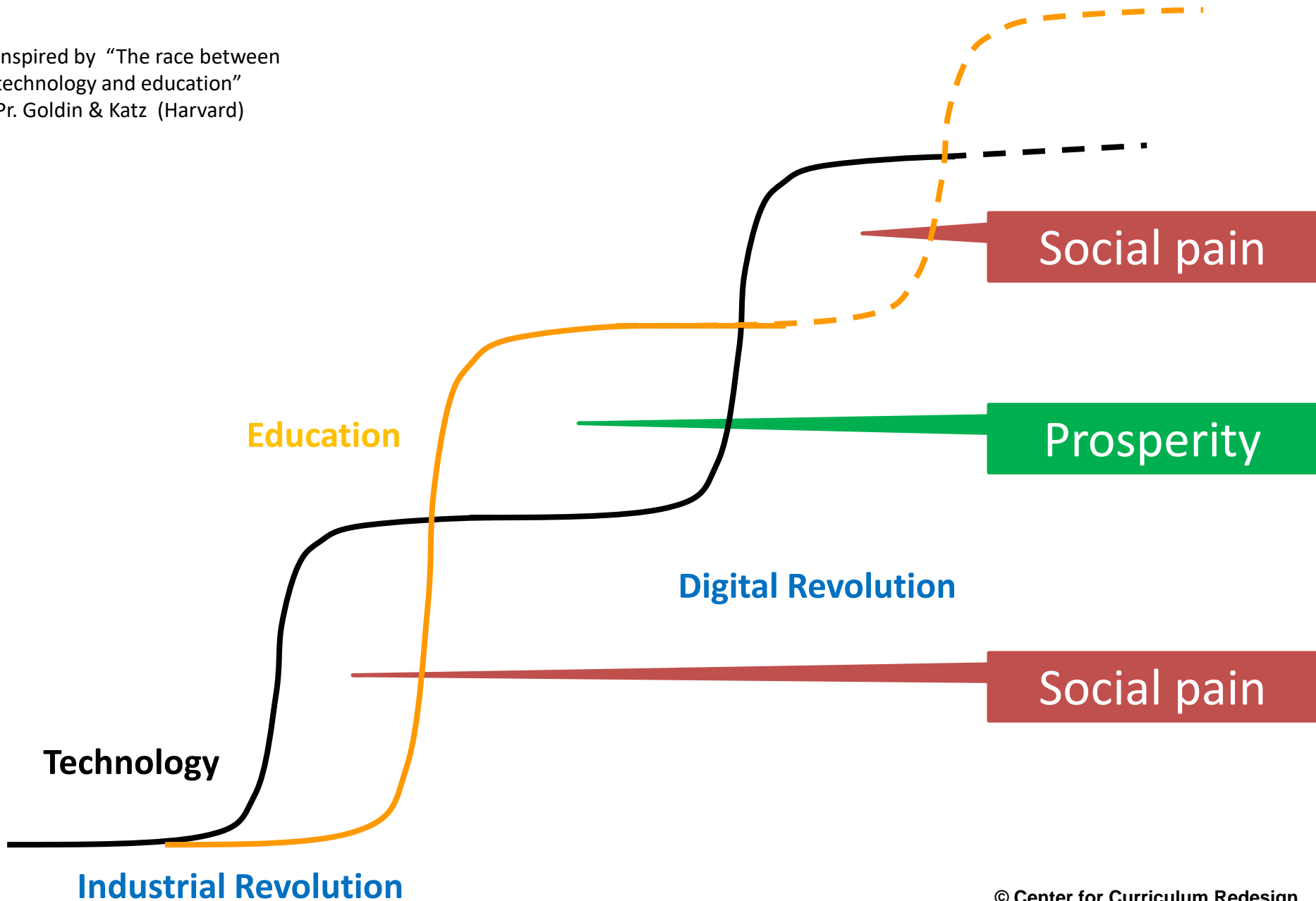
A combinatorial explosion of possibilities

→ *Accelerating change!*



The Race between Technology and Education

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



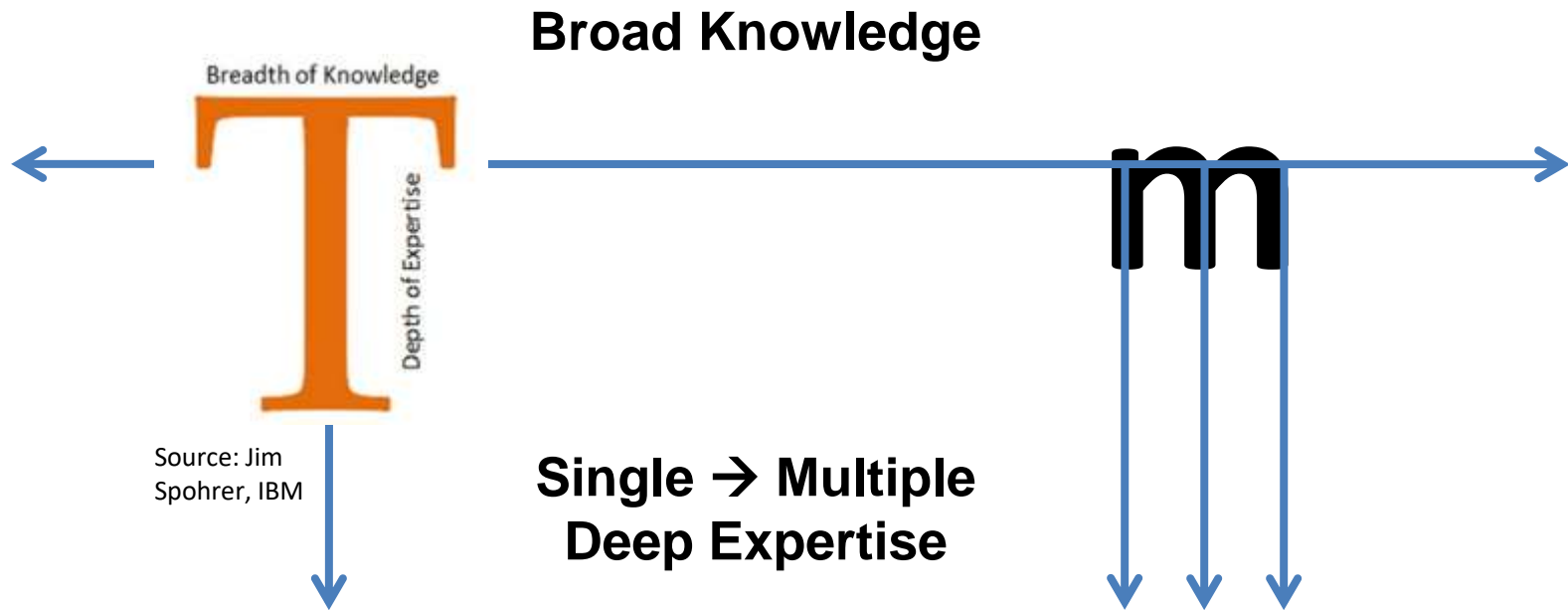


“Event Horizon”: What if formal education cannot catch up ?

Present/Future world → Adaptability
→ Versatility as key strategy



From T-shaped to m-shaped

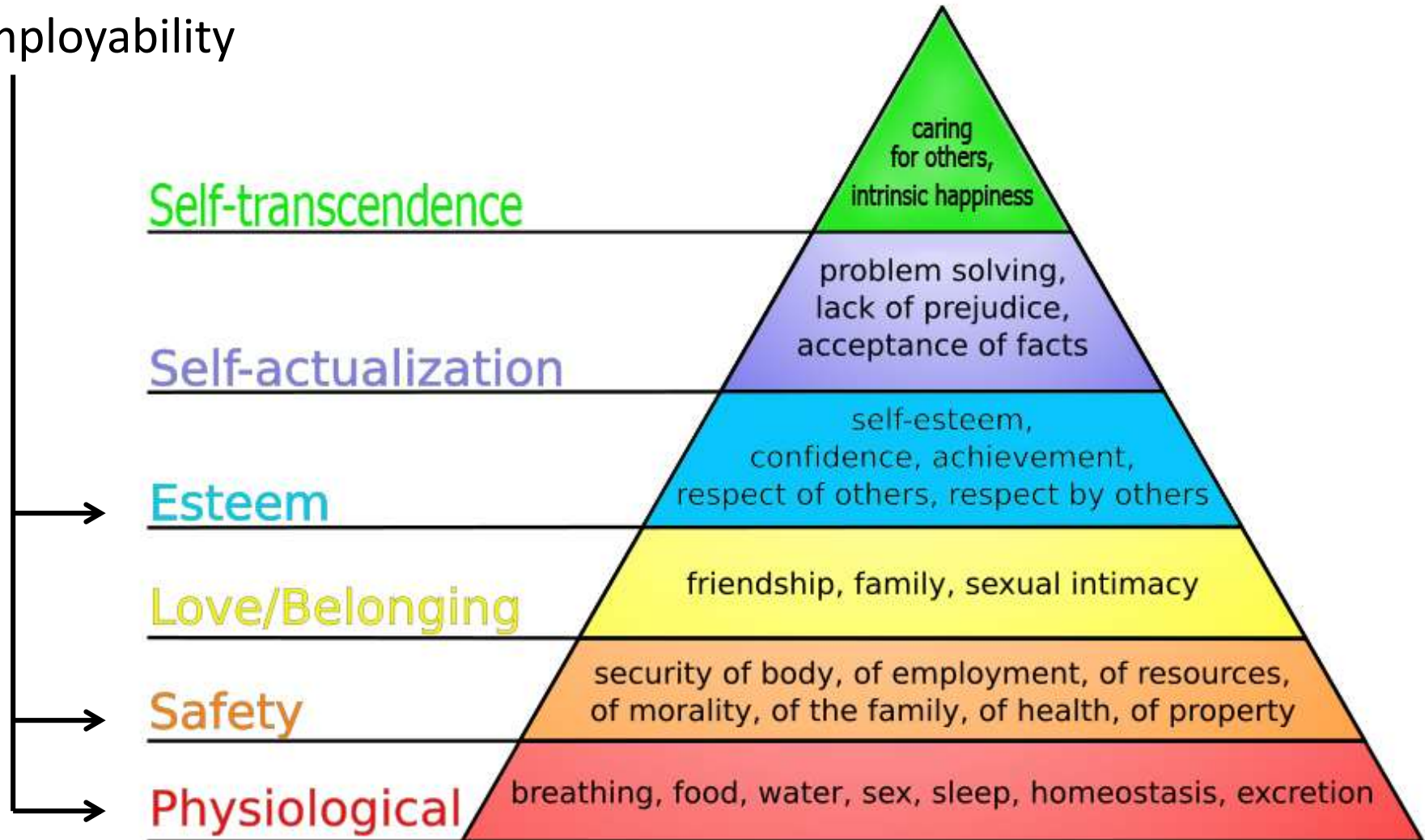


**STEM AND Humanities AND Arts
Knowledge AND Competencies**



Goal of Education: Fulfilled Individuals *and* Sustainable Humanity

Employability



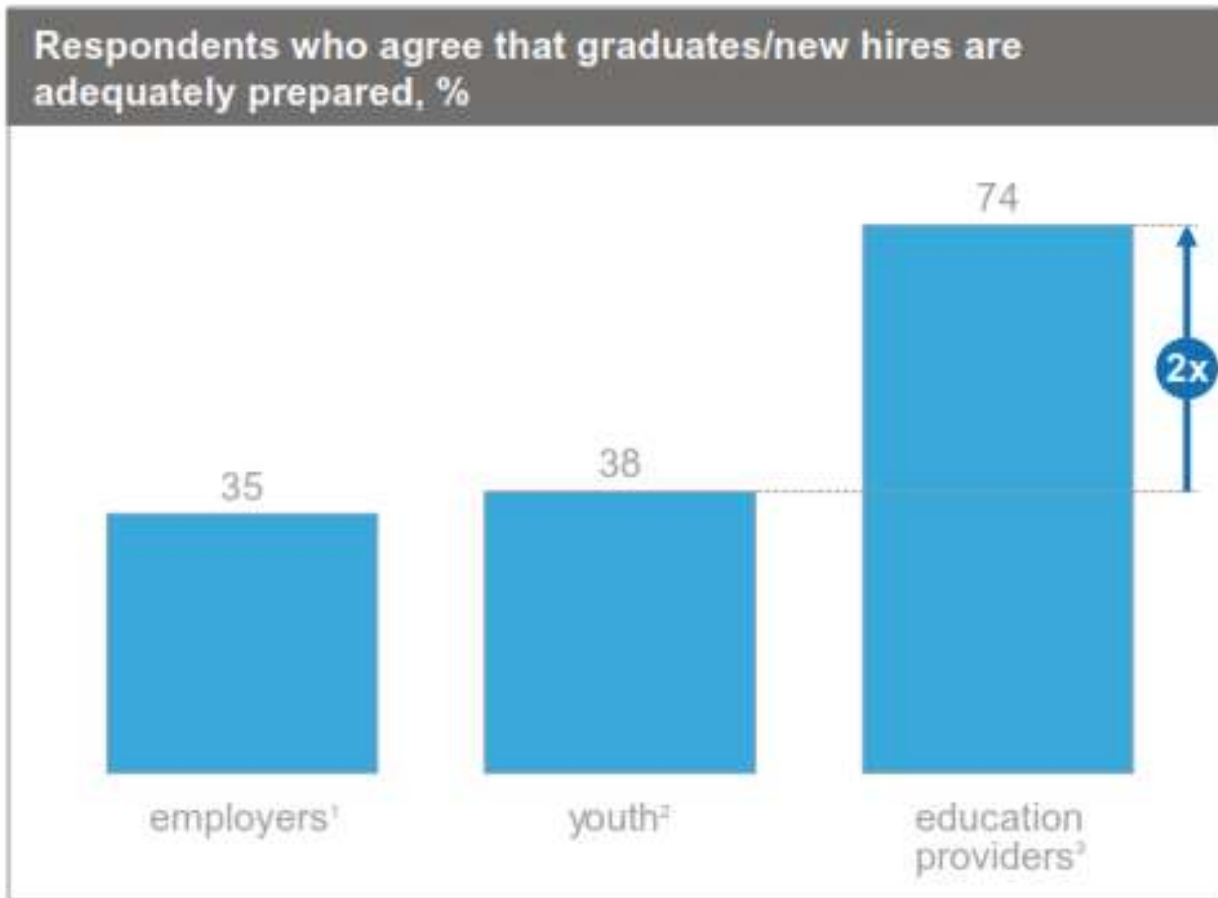
10 Jobs that did not exist 10 years ago

Job	Pay level
App developer	High
Social media manager	Medium
Uber driver	Low
Driverless car engineer	High
Cloud computing specialist	High
Big data analyst/data scientist	High
Sustainability manager	Medium
YouTube content creators	Medium
Drone operators	Medium
Millennial generational expert	Medium

Disconnect between youth, employers and educators

Exhibit 2

Providers are twice as likely as employers and youth to rate youth as prepared



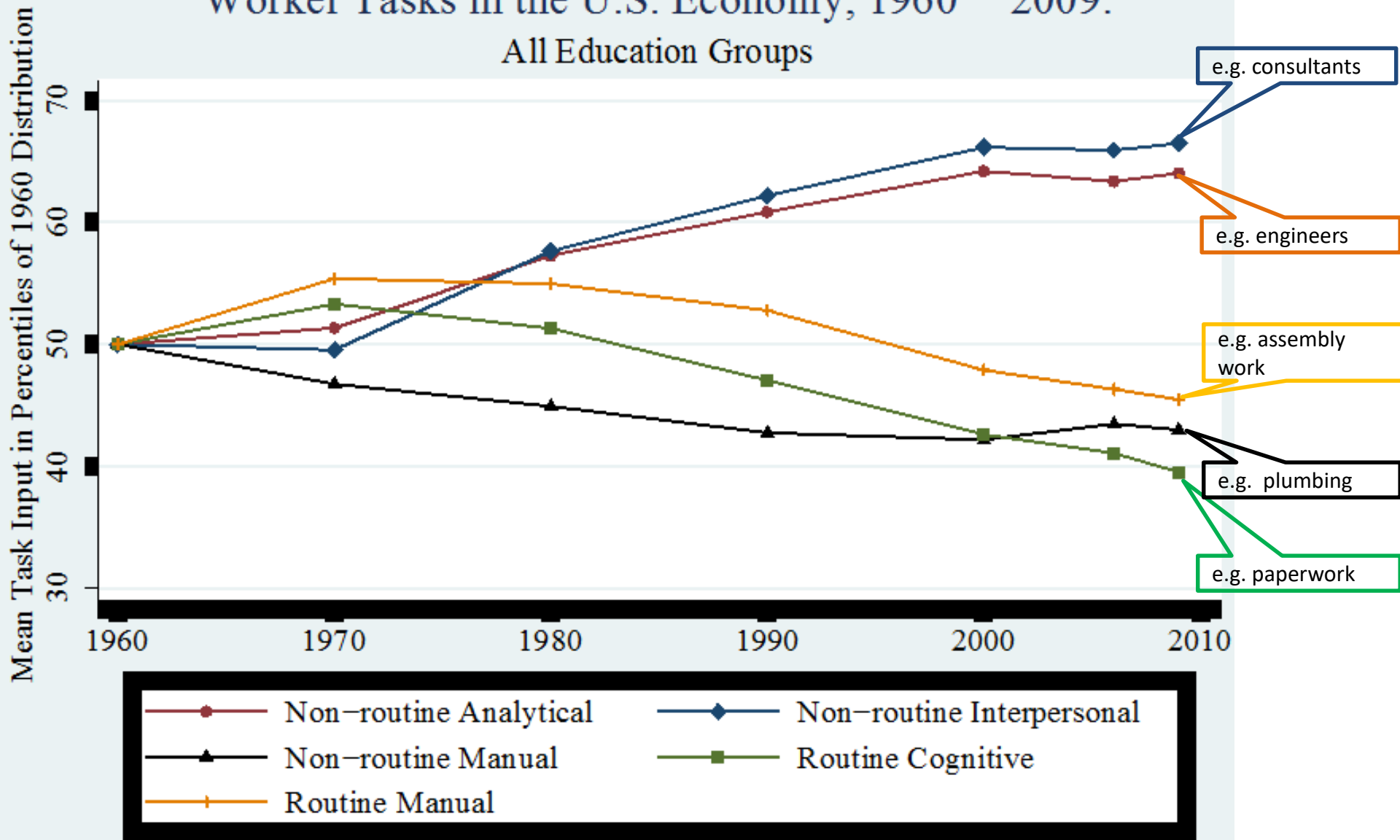
1 Overall, the entry-level employees we hired in the past year have been adequately prepared by their prehire education and/or training.

2 Overall, I think I was adequately prepared for an entry-level position in my chosen career field.

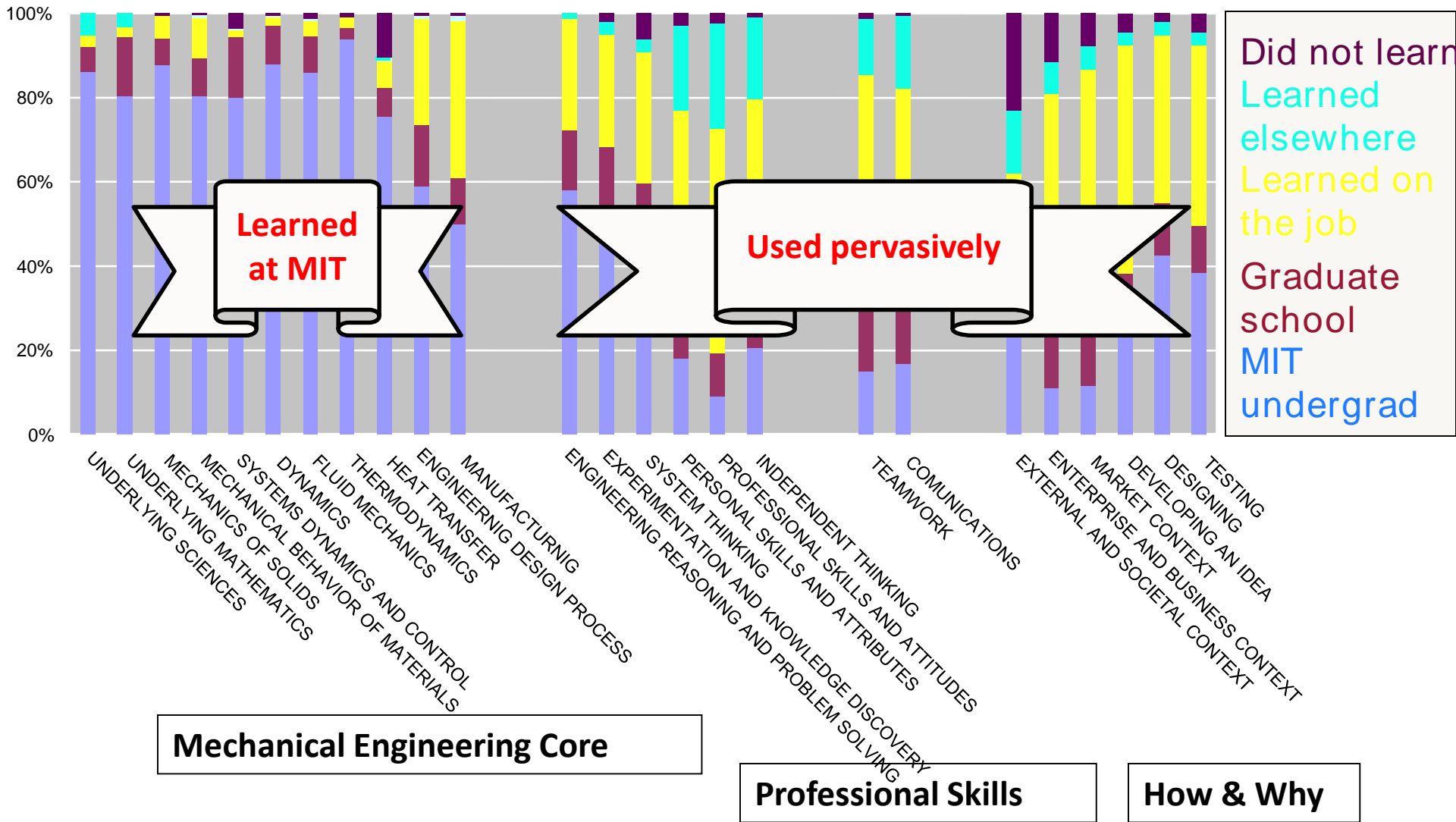
3 Overall, graduates from my institution are adequately prepared for entry-level positions in their chosen field of study.

Accelerating Change Demands Different Skills

Worker Tasks in the U.S. Economy, 1960 – 2009:
All Education Groups

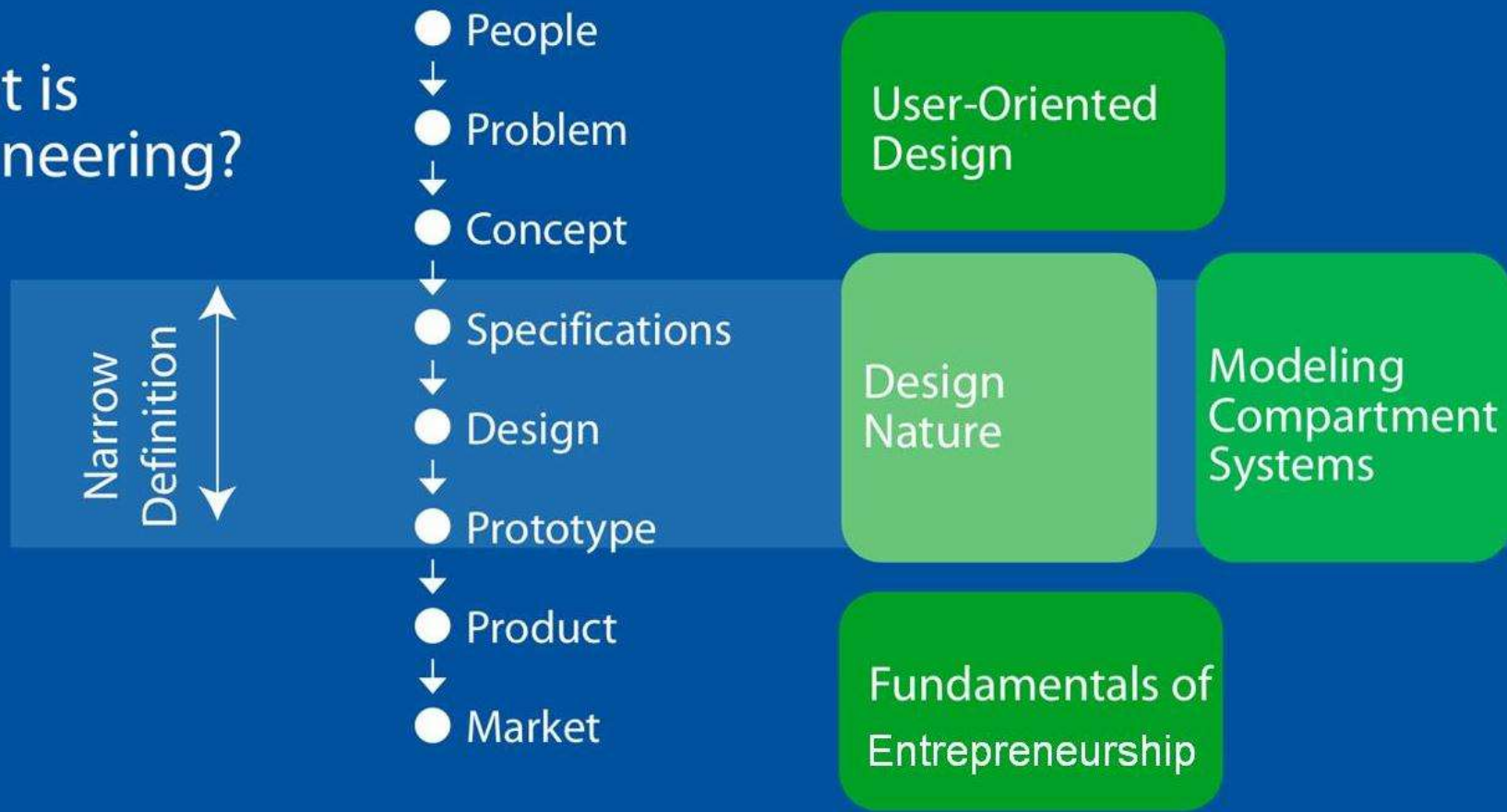


Mechanical Engineering



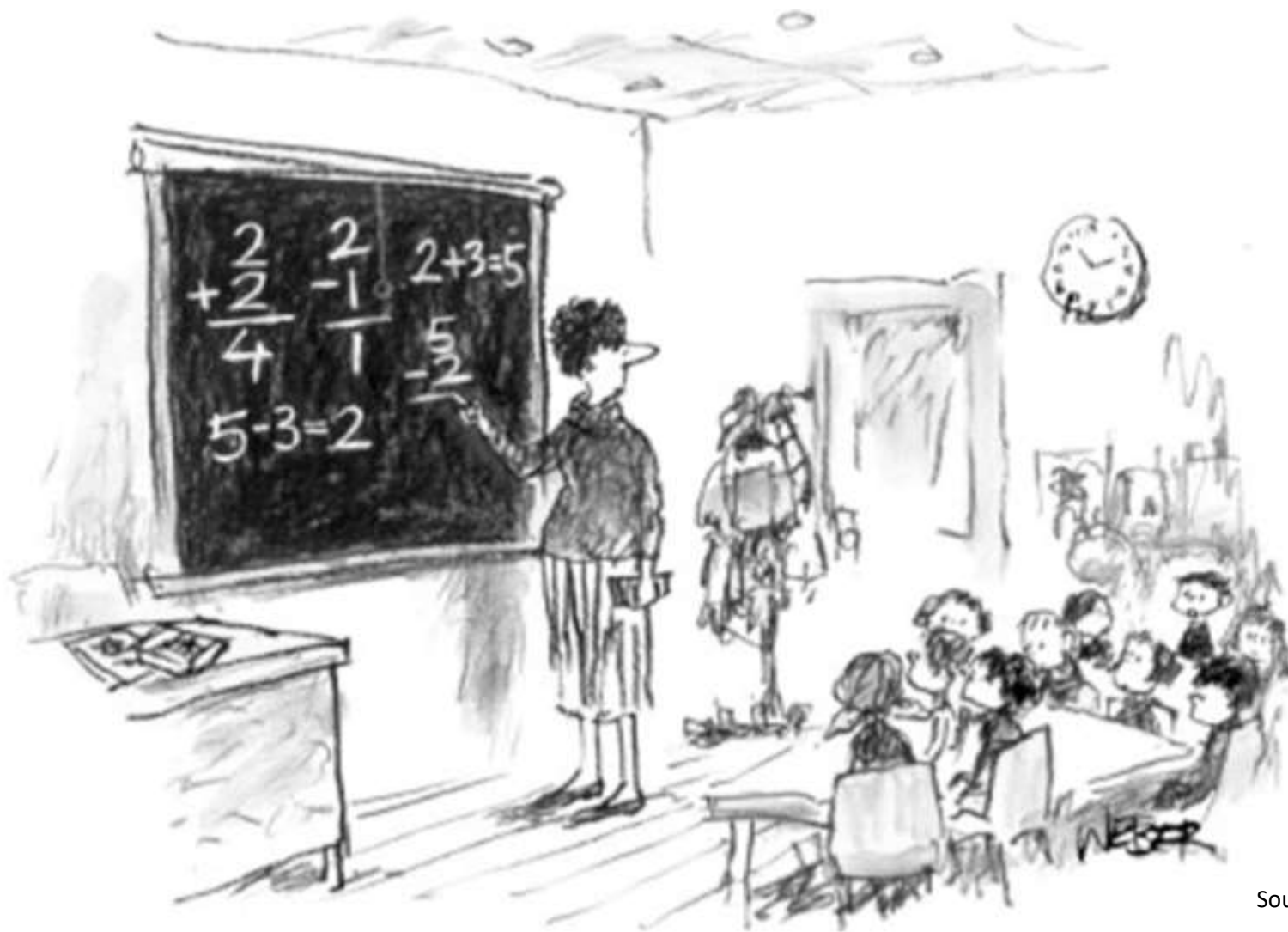
Expanding the Mindset

What is engineering?



Franklin W. Olin
College of Engineering

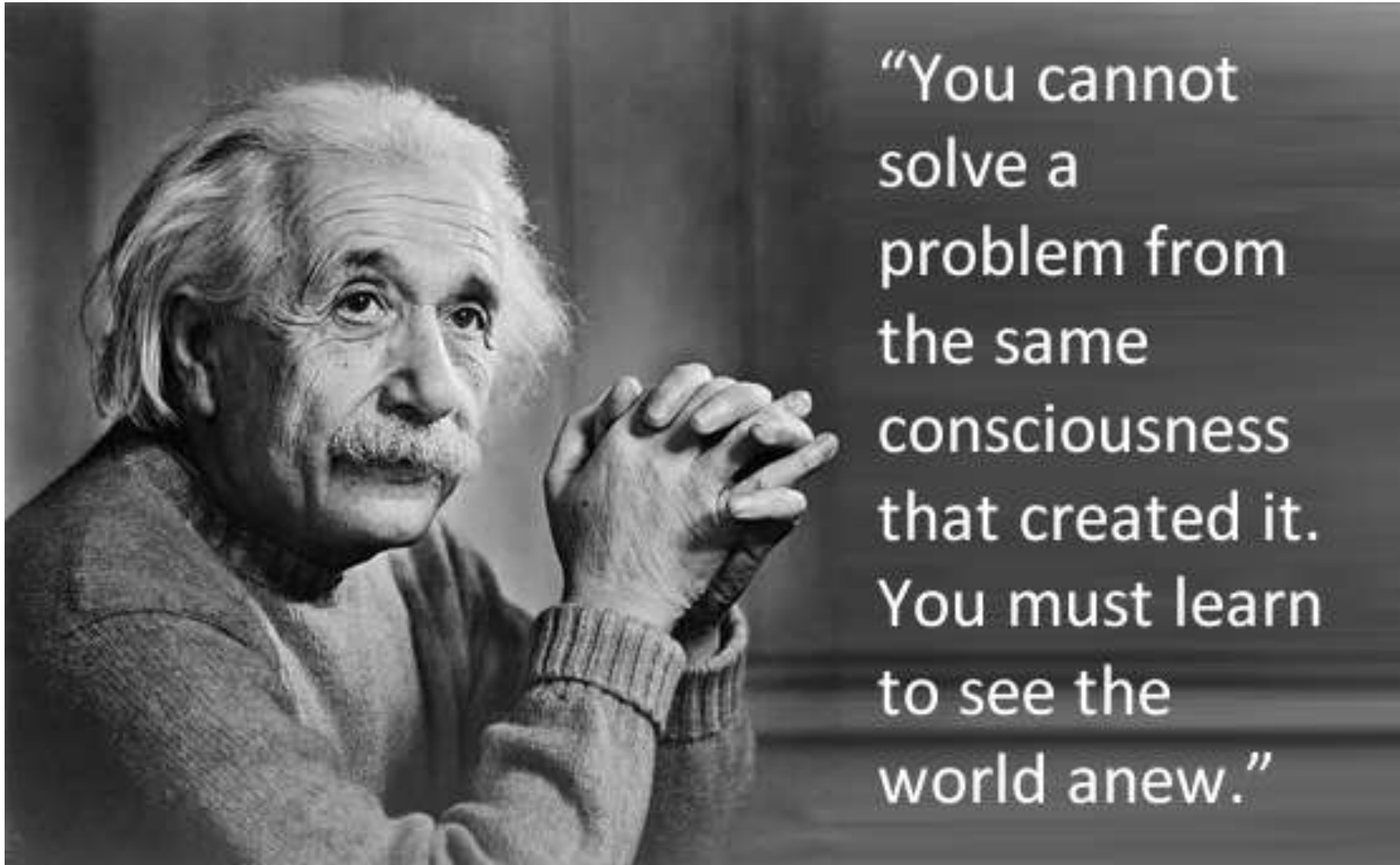
Students beg for Relevance



Source: New Yorker

“Please, may I ask where you’re going with all this?”

We agree



“You cannot solve a problem from the same consciousness that created it. You must learn to see the world anew.”

A LOT MORE

Making Education [√]Relevant



CENTER FOR
CURRICULUM
REDESIGN

The Benefits of Education



Human Potential

Societal Wellbeing

Collective Prosperity

with key global players

<p>International Organizations</p>	
<p>Jurisdictions</p>	
<p>Academia</p>	
<p>Foundations & Non-Profits</p>	
<p>Corporations</p>	

An underwater photograph of a coral reef. In the foreground, there are large, brown, porous coral structures and green, feathery coral. In the background, a school of silver fish swims in the blue water.

Introduce Modern Knowledge and Harness Interdisciplinarity

Robotics
Entrepreneurship
Wellness
and more...

Embed Cross Cutting Themes

Global Literacy
Information Literacy
Environmental Literacy
Digital Literacy
Systems Thinking
Design Thinking



Learn skills

4 C's

- Creativity
- Critical Thinking
- Communication
- Collaboration

Build Character



- Mindfulness
- Curiosity
- Courage

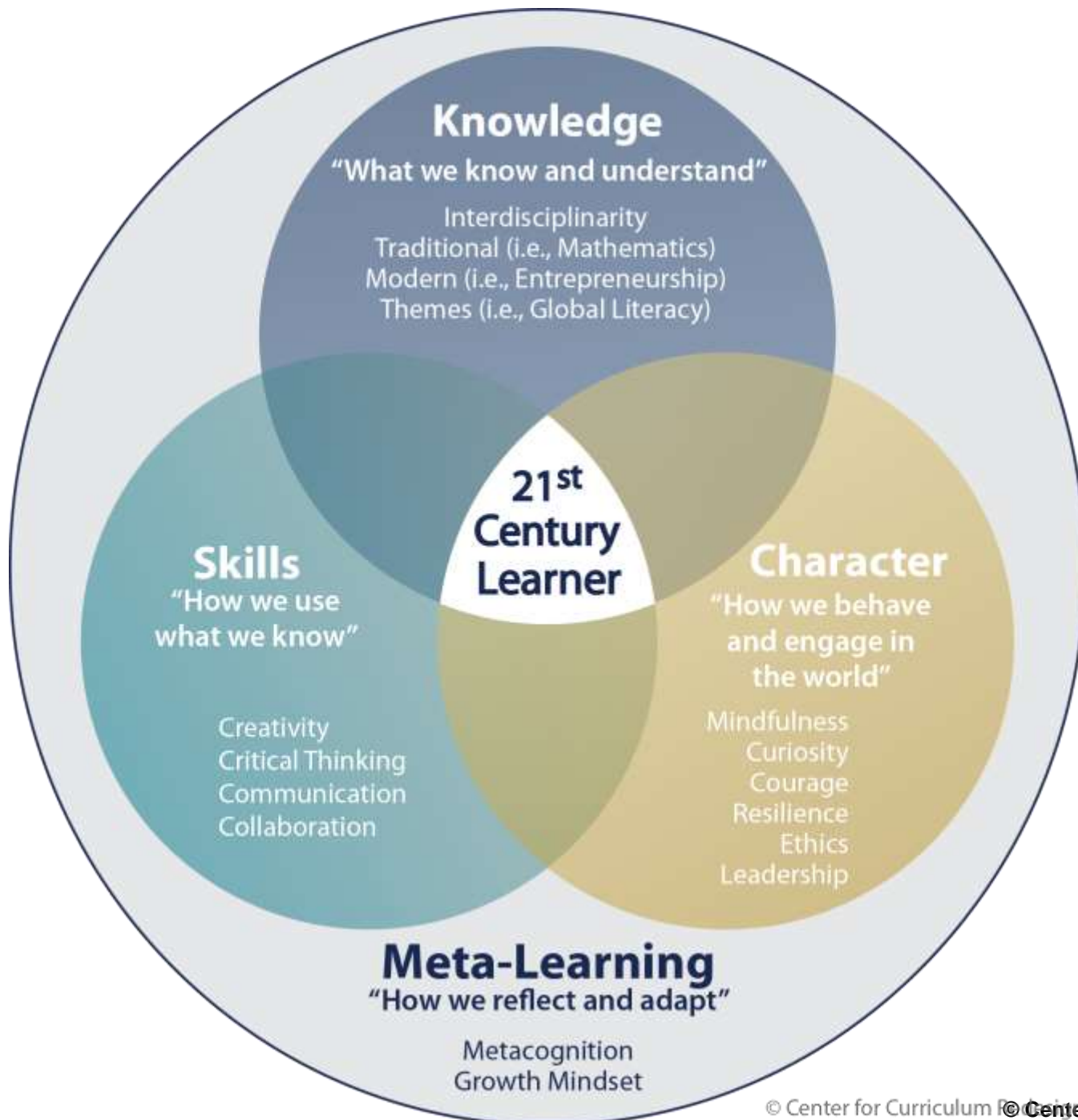
- Resilience
- Ethics
- Leadership



Train Meta-Learning

Growth mindset
Metacognition



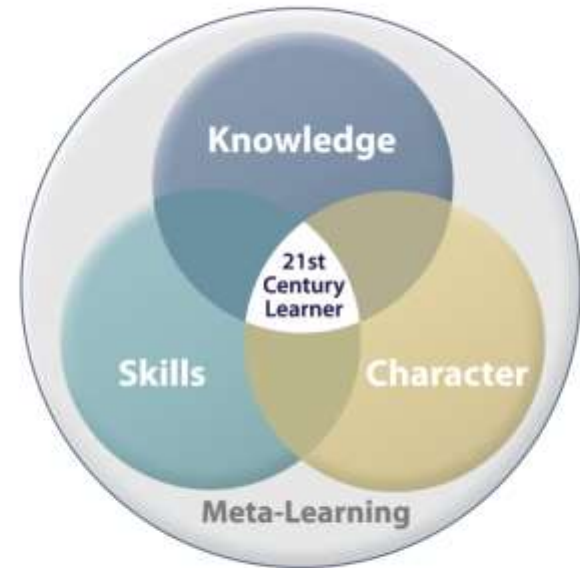


“Educators worldwide [need] to rapidly operationalize these dimensions”

Todd Rose,
Harvard University

<http://bit.ly/4DEdu>

From the authors* of best-seller *21st Century Skills*
CHARLES FADEL*, MAYA BIALIK, AND BERNIE TRILLING*



FOUR-DIMENSIONAL EDUCATION

THE COMPETENCIES LEARNERS NEED TO SUCCEED

Prologue by **Andreas Schleicher, OECD**

“A very thoughtful treatment of the competencies our students need to thrive in today’s (and tomorrow’s) world. This book will help educators understand and navigate the critical choices we are facing.”

-**Carol Dweck, Stanford University**

So...

What do we remove ?

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

Change Management - Inertia



Shaping (globally caring) Leaders



Are we doing so decisively, and fast enough?

Let's shape education for the
future we want!



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