Artificial Intelligence, Automation & The Future of Public Education

June 5, 2019 Evening Public Lecture



Dominic Barton

Global Managing Partner Emeritus
McKinsey & Company

Dr Philip McRae

Associate Coordinator, Government-Research
Alberta Teachers' Association



Full Recorded Evening Public Lecture

Available at:

YouTube.com/albertateachers

(un)Intended consequences



Artificial intelligence, automation

AND

the future of public education

Dominic Barton
Philip McRae

June 5, 2019
6–9 PM

Fantasyland Hotel
West Edmonton Mall
Beverly Hills Ballroom

TICKETS AND EVENT DETAILS: HTTP://BIT.LY/JUNE5AI

The Alberta Teachers' Association

(un)Intended consequences

June 5, 2019
6–9 PM

Fantasyland Hotel
West Edmonton Mall
Beverly Hills Ballroom
17700 87 Ave, Edmonton

Please join the Alberta Teachers' Association for an evening public lecture with Dominic Barton, an internationally renowned business leader and strategic advisor, former global managing partner of McKinsey & Company and chancellor of the University of Waterloo.

Mr Barton will discuss the impact of artificial intelligence and automation on Alberta children, youth, families, schools and communities, and open up an important conversation about how this rapidly coming change to our society may impact public education systems in Alberta from kindergarten to postsecondary education.

Agenda

6:00 PM
Registration and Reception
light hors d'oeuvres and no-host bar

7:00 PM
Evening Public Lecture Opening and Table-Based Discussions
Philip McRae, PhD
Alberta Teachers' Association

7:30 PM
Public Lecture
Dominic Barton
Global Managing Partner Emeritus, McKinsey & Company

8:30 PM
Questions and Answers

9:00 PM
Adjournment

The Alberta Teachers' Association

TICKETS AND EVENT DETAILS: http://bit.ly/june5ai

Artificial Intelligence, Automation & The Future of Public Education

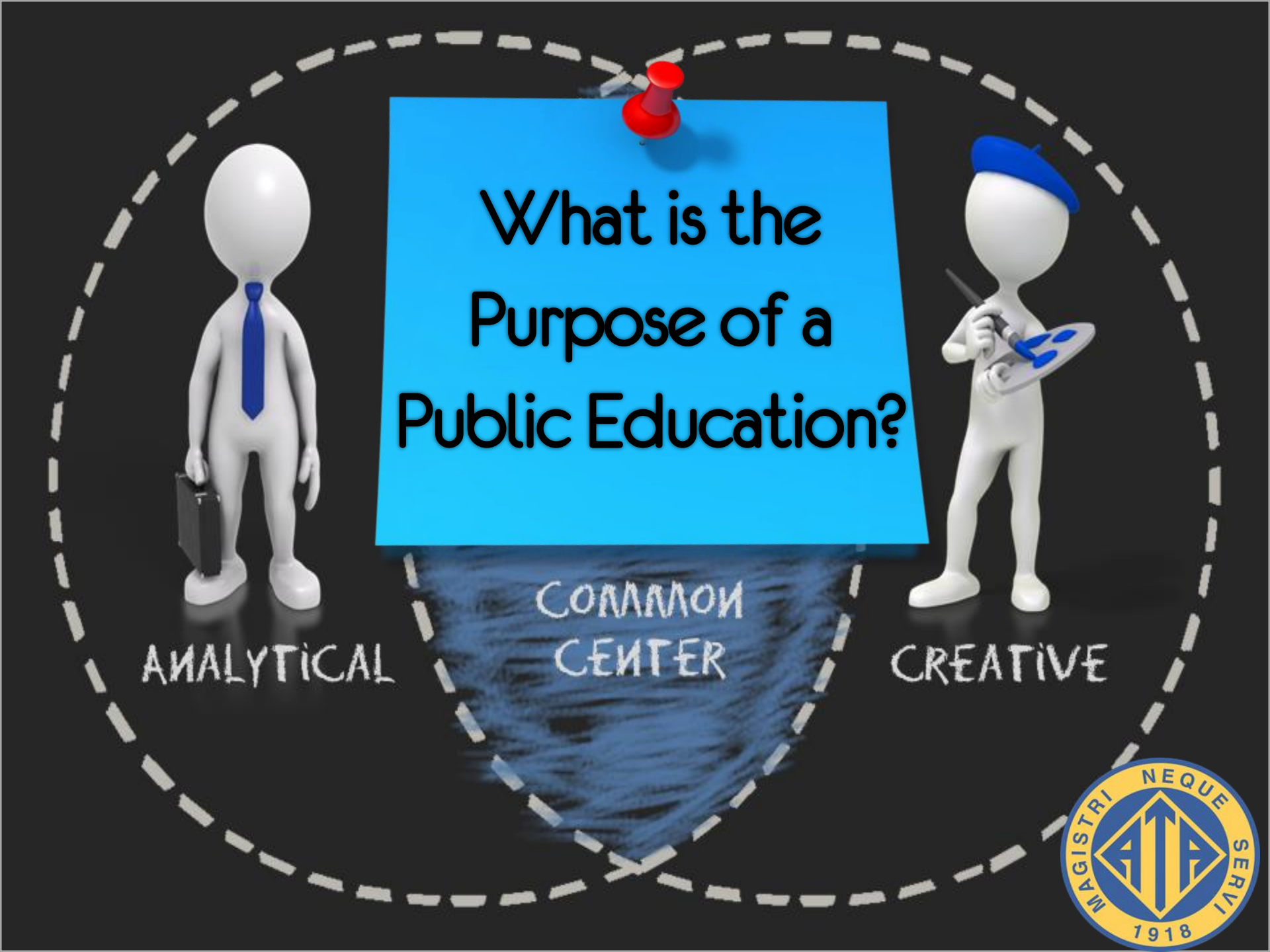


Dr Philip McRae

Associate Coordinator, Government-Research
Alberta Teachers' Association

There is no power for change greater than a community discovering what it cares about.

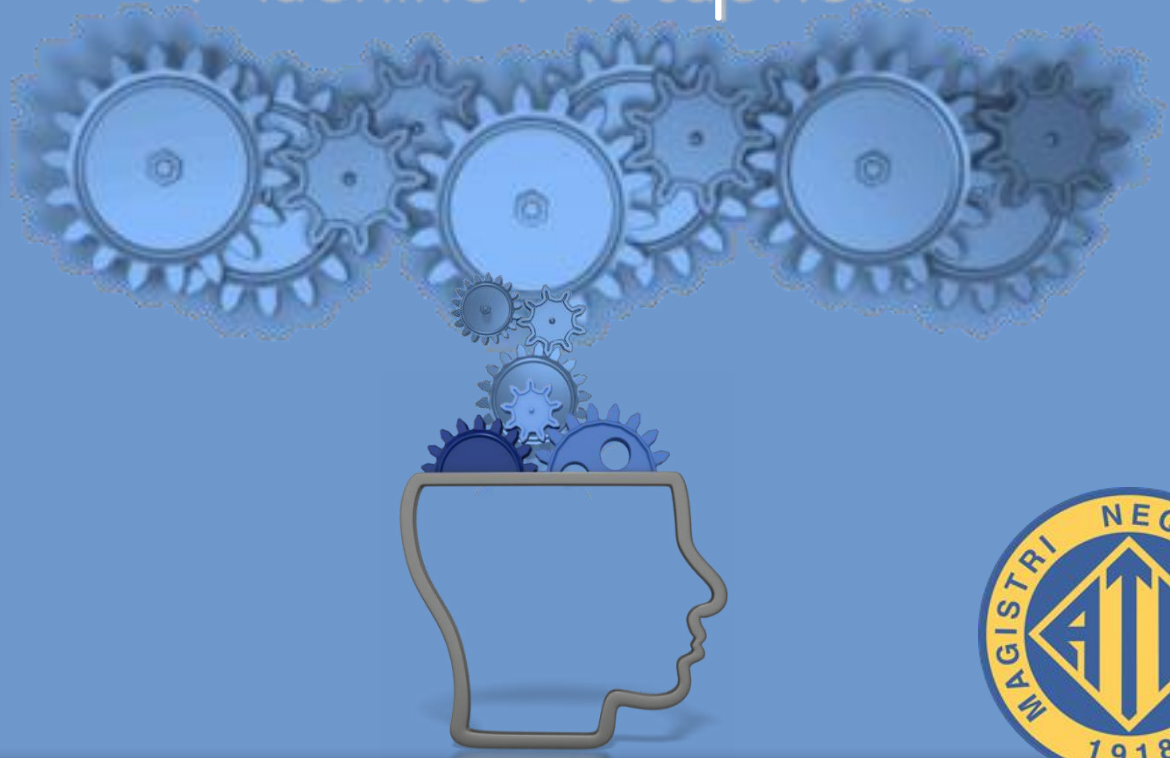
— Margaret J. Wheatley —

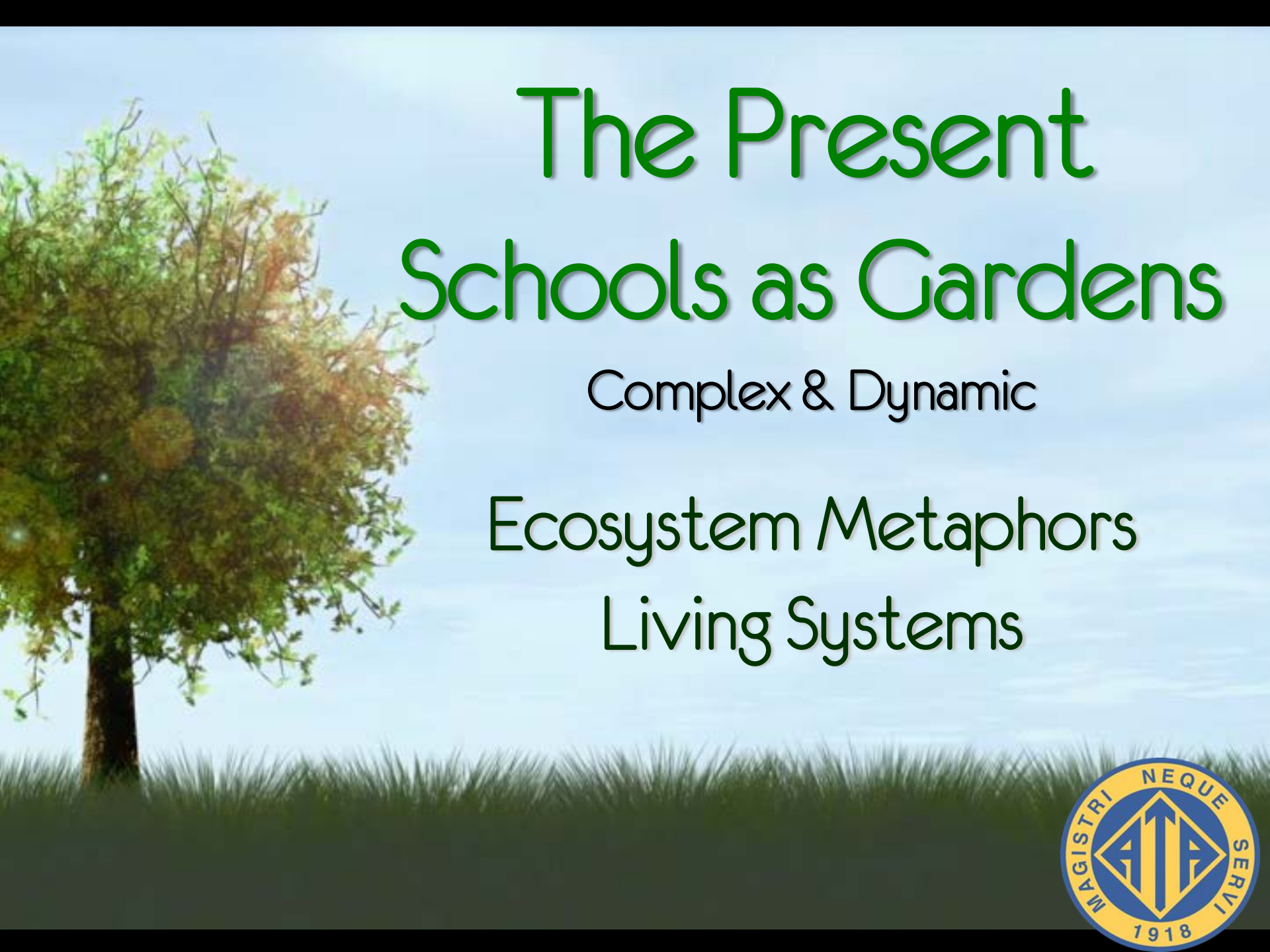

What is the Purpose of a Public Education?
ANALYTICAL
COMMON CENTER
CREATIVE
MAGISTRI NEQUE SERVI
ATA
1918

The Past
Schools as Factories

Complicated & Linear

Machine Metaphors




The Present
Schools as Gardens
Complex & Dynamic
Ecosystem Metaphors
Living Systems
MAGISTRI NEQUE SERVI
ATA
1918

Reworking of Economies



2020 - 2040

"Artificial intelligence (A.I.) will reach human levels by around 2029. By 2045 we will have multiplied our human biological intelligence a billion fold."

— Ray Kurzweil

Inventor, Futurist, Google's Director of Engineering

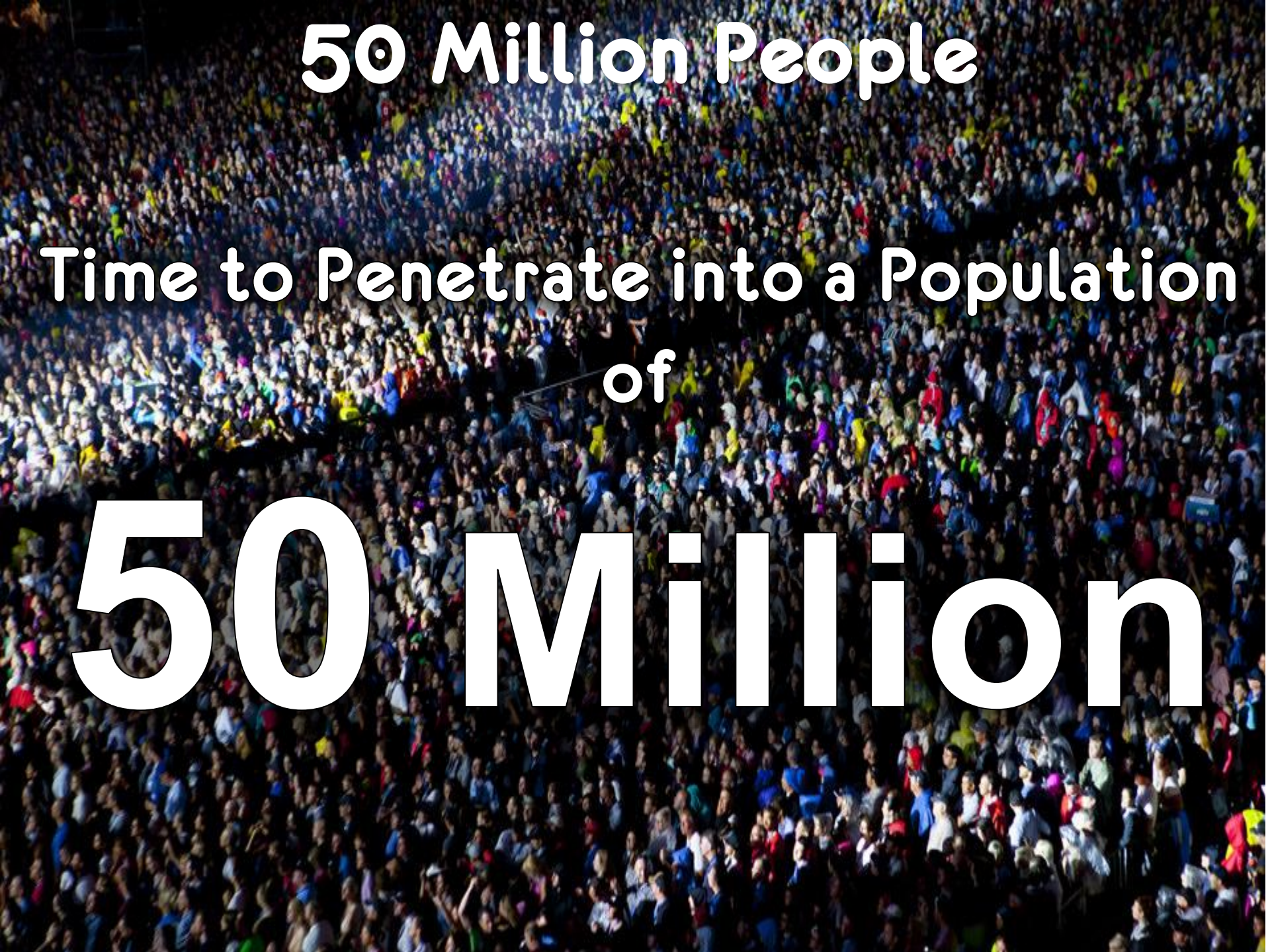




Rapid Technological Shift

~

Exponential Growth


50 Million People
Time to Penetrate into a Population
of
50 Million

50 Million People



Radio took 38 years



Telephone 20 years



Television 13 years



Cell phones 12 years

Internet 4 years

Blogs 3 years



Facebook 2 years

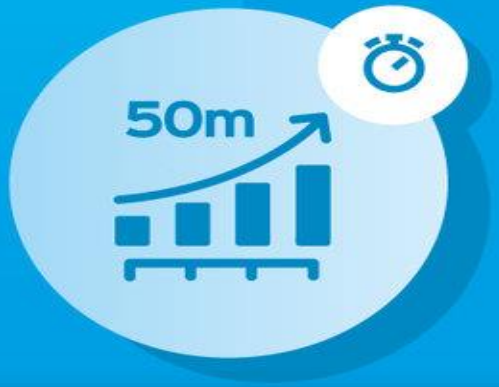


Youtube 1 year



Angry birds 35 days

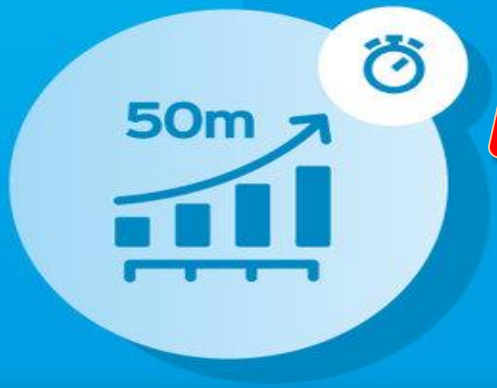
50 Million People



19 Days



50 Million People



May 2016 24 HOURS



Moore's Law (1965)

Computing Power & Capacity Double Every 18 Months

Measure	MIT's IBM 7094	Laptop Circa 2019
Year	1967	2019
Processor Speed (MIPS)	0.25	16 GHz
Main Memory (Bytes)	144	1 000 000 000 000 (10^{12})
Approximate Cost (2013 $)	$ 14 000 000	$ 429





Moore's Law (1965)

Computing Power & Capacity Double Every 18 Months

Measure	Sunway Taihulight [CHINA]	Quantum A.I. Circa 2023
Year	2019	2023
Processor Speed (Cal./Sec.)	93 Quadrillion	?
Main Memory (Bytes)	5591 TB	?
Approximate Cost (2019 $)	$237 000 000	$1000 ?





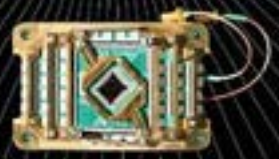
French Advances / My Doctor Fired Me / Love App-tually

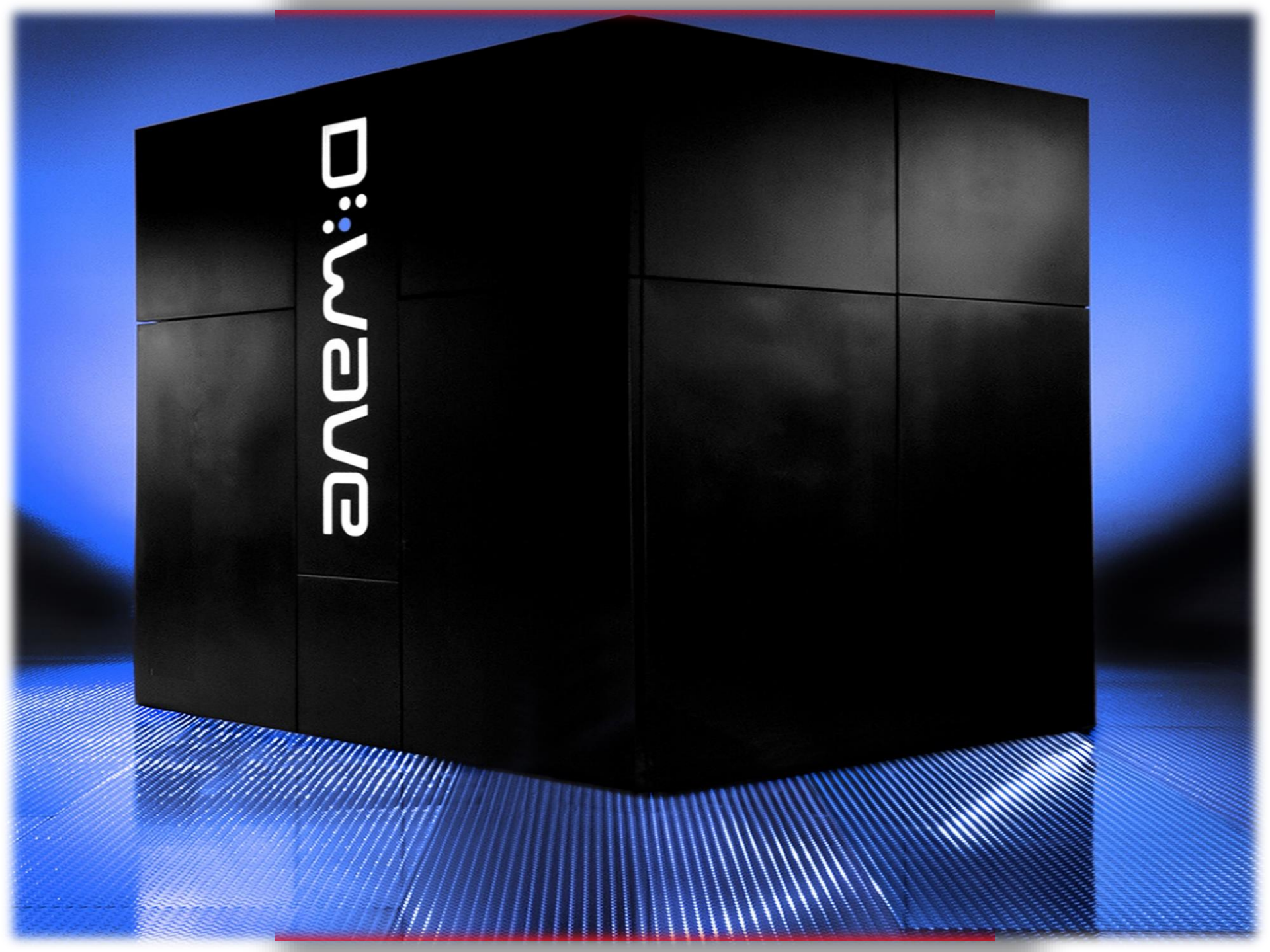
TIME

IT PROMISES TO SOLVE SOME OF HUMANITY'S MOST COMPLEX PROBLEMS. IT'S BACKED BY JEFF BEZOS, NASA AND THE CIA. EACH ONE COSTS $10,000,000 AND OPERATES AT 459° BELOW ZERO. AND NOBODY KNOWS HOW IT ACTUALLY WORKS

THE INFINITY MACHINE

BY LEV GROSSMAN

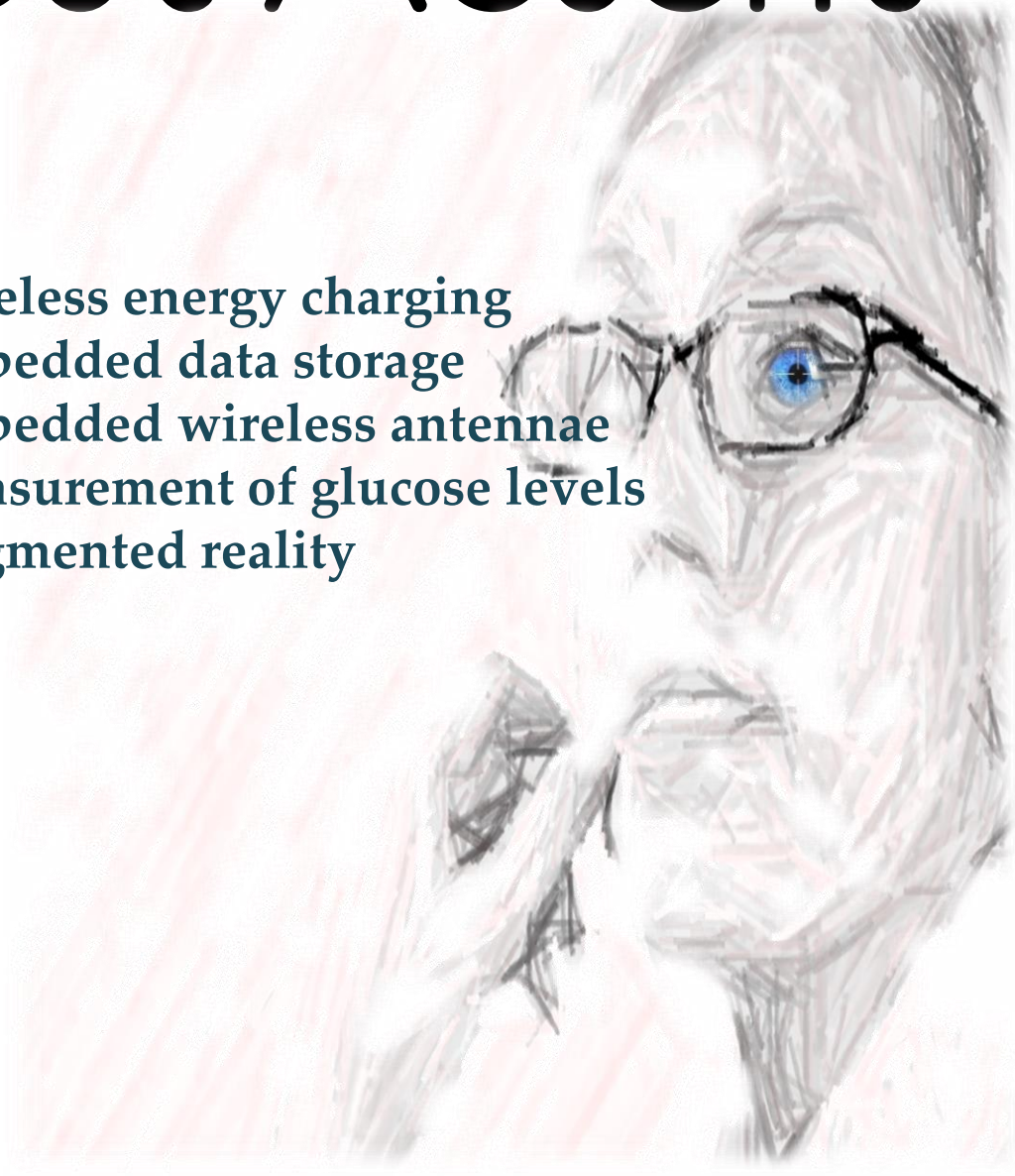



D-Wave

Present but Absent



- Wireless energy charging
- Embedded data storage
- Embedded wireless antennae
- Measurement of glucose levels
- Augmented reality



Smart Contacts

Patent No. 13/64738

October 8, 2012

Blurring Boundaries

Nokia Patent: Vibrating Haptic Tattoos





Fig. 2a



Fig. 2c

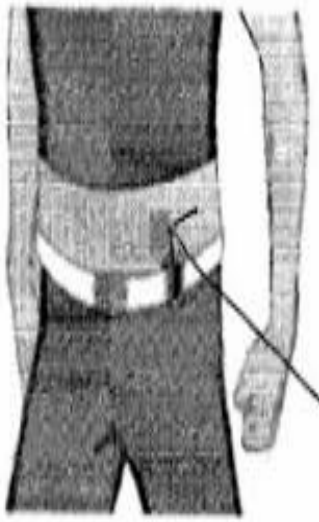


Fig. 2b

15

The Internet of Me



SEPTEMBER 22, 2014

TIME



Never Offline.

The Apple Watch is just the start. How wearable tech will change your life—like it or not

BY LEV GROSSMAN AND MATT VELLA

Now, a videotape recorder that goes anywhere you go.



He's taping that thrilling number, "Serenade in Peep Major" with the new portable, battery-operated Sony Videocorder.

It records both picture and sound. (The camera weighs only 6 pounds. The recorder pack just 12.) Needs only you to operate it. And costs only $1250.* Yet it can do just about everything one of those gargantuan mobile video units can do. Maybe even more.

It doesn't have yards of power cable to tie it down. (One thin cable connects the Camera and Recorder. That's all.) So it can go up in a plane and tape aerial views of potential factory sites. Tag along on an archaeological expedition. Or on a trip to the zoo with a bunch of first graders. Or it can even wiggle into tight places and crawl beneath machinery to record damage. (So only one person has to get his clothes dirty.)

Anyone can operate this Sony Videocorder. All its level controls are fully automatic. And there's a TV monitor right inside the camera. So it's almost impossible to botch things up. (If you manage to do it anyway, no sweat. The tape is reusable.)

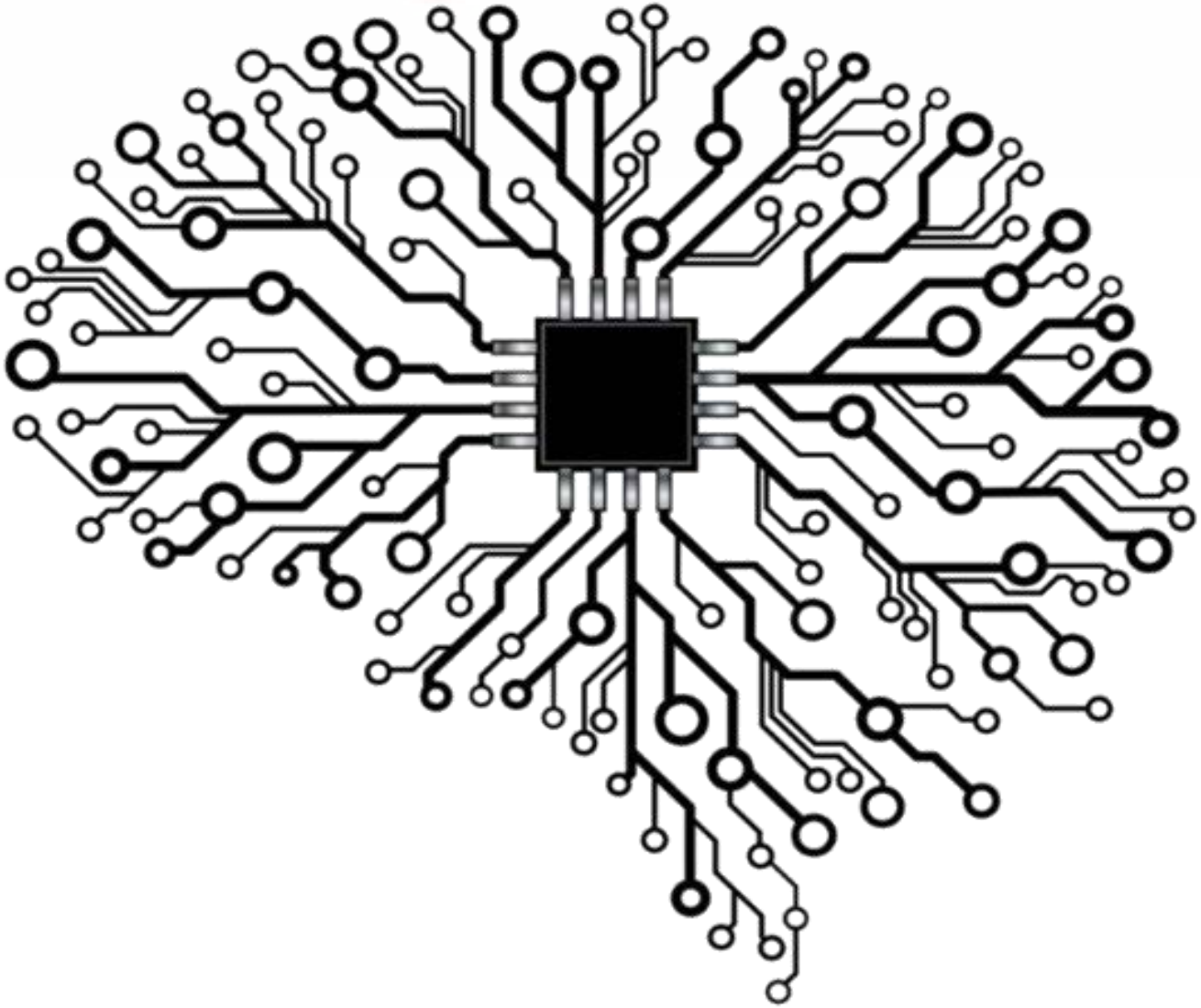
The nicest thing about the Videocorder: when you come back with everything behind you, it instantly lets you have it all in front of you.

SONY® PORTABLE VIDEOCORDER®

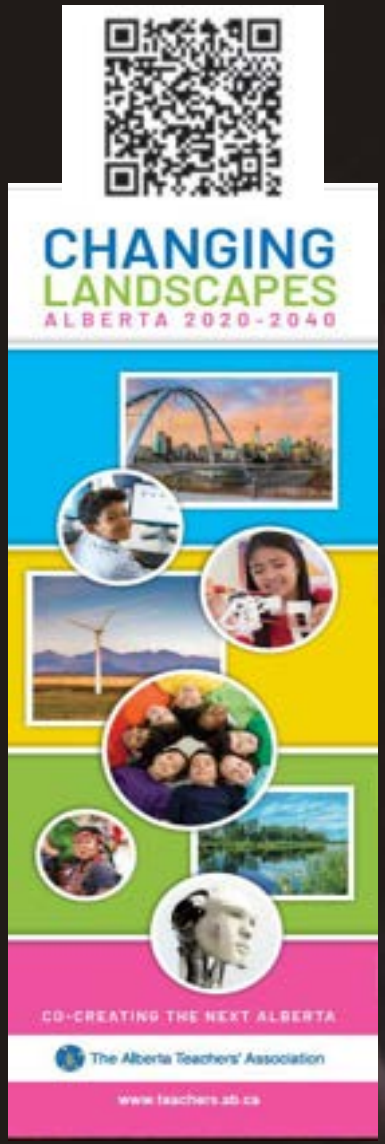
*Manufacturer's suggested retail price—including battery charger and zoom lens.

© 1967 Sony Corp. of America, 47-47 Van Dam Street, L.I.C., N.Y.

Neuroprosthetics



Surrender of theSelf

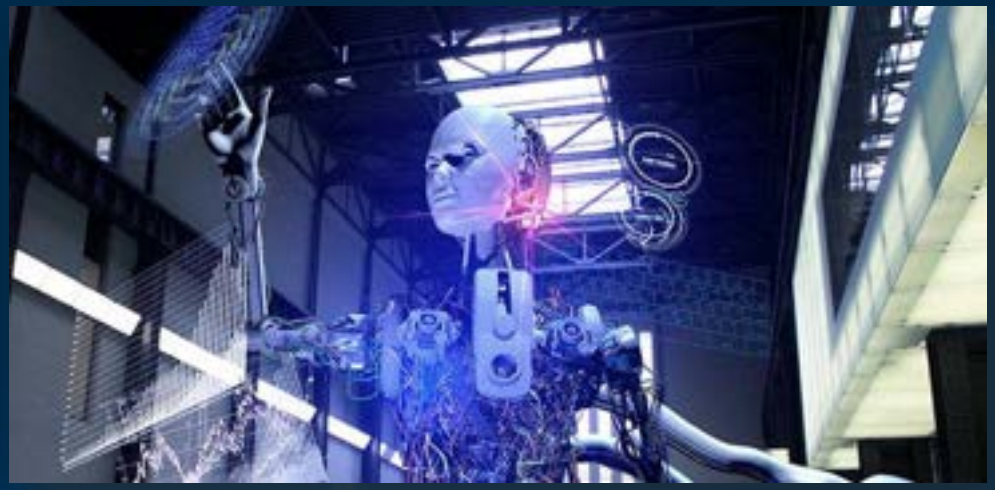


2020 - 2040

MAGISTRI NEQUE SERVI
ATA
1918

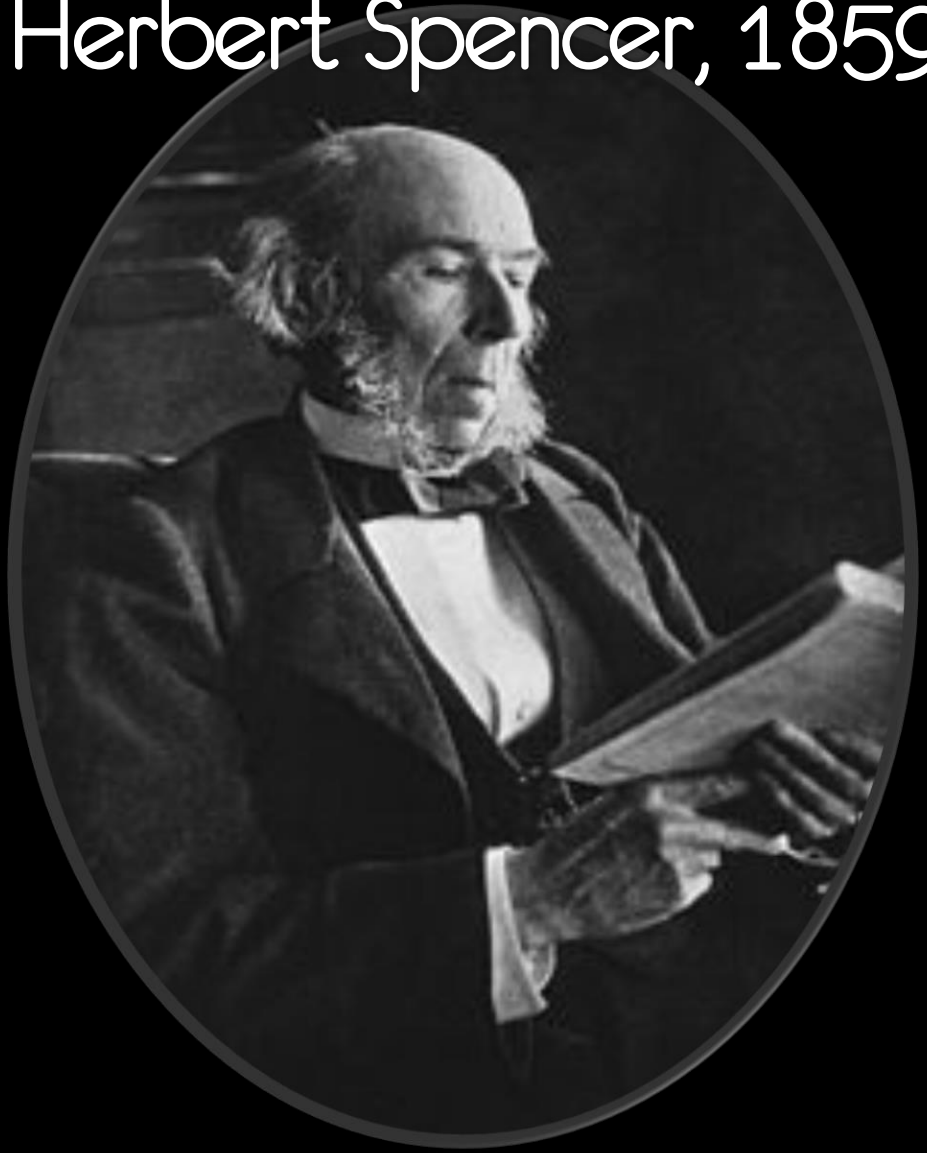
"47% of US jobs are at risk of automation in the next decade."

— University of Oxford, Oxford-Martin School



What Knowledge is of Most Worth?

Herbert Spencer, 1859



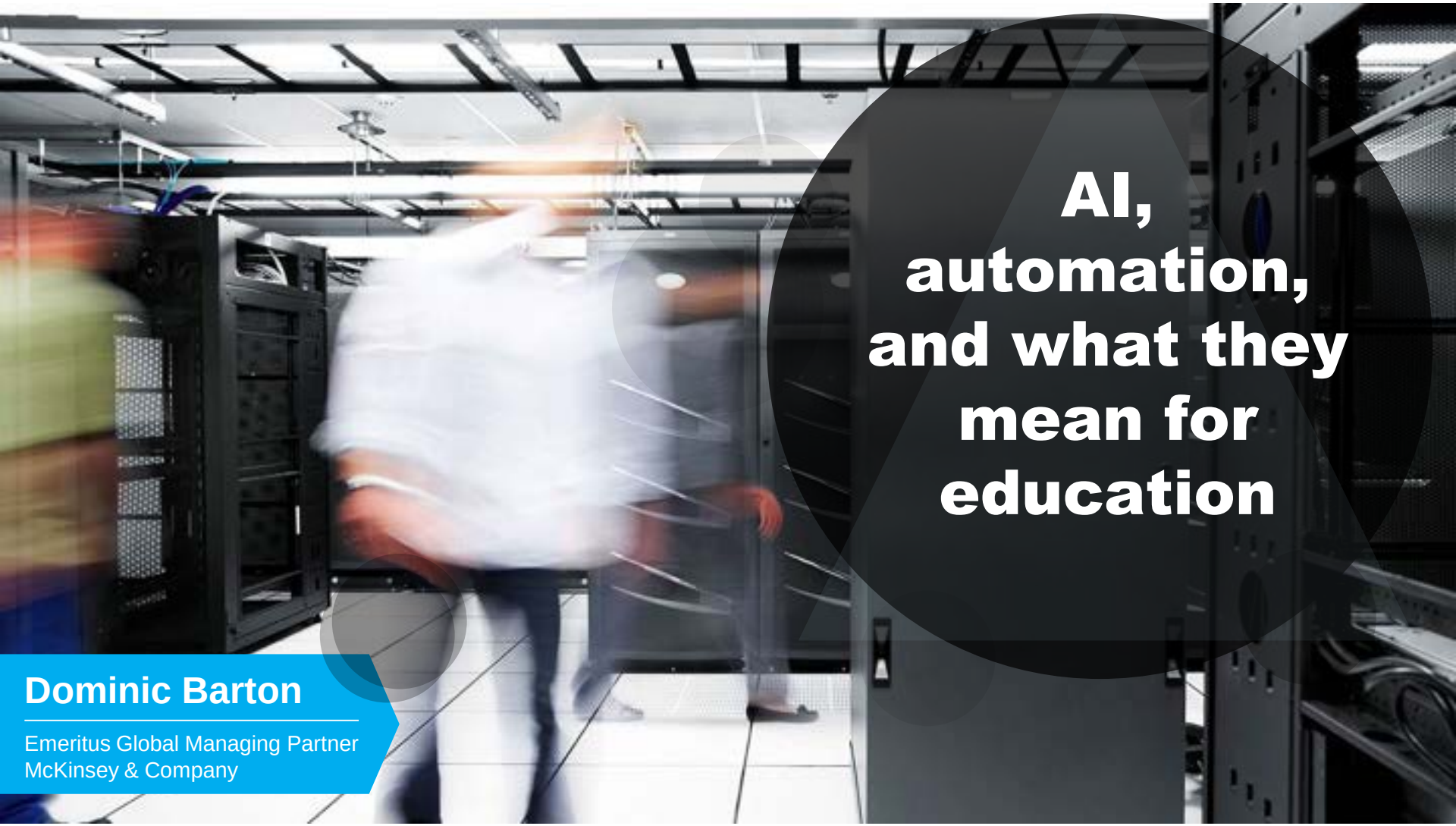
Artificial Intelligence, Automation & What They Mean for Education



Dominic Barton

Global Managing Partner Emeritus

McKinsey & Company



AI, automation, and what they mean for education

Dominic Barton

Emeritus Global Managing Partner
McKinsey & Company

Overview

1. **We're in the midst of a massive economic and social transition with automation and AI at the core**

2. **Automation and AI are changing the nature of work. However, employment is likely to increase with automation and AI**

3. **Education is the Gamechanger**

   - **Technological, socio-emotional, and higher cognitive skills** are the "skills of the future"
   - We need to reskill people in a way we've never done before. **Lifelong learning has never been more important**
   - **We need to take a hard look at K-12** – what we teach and how we teach



Four forces are transforming the global landscape



Economic power shift from West to East and South



Technology accelerating industry disruption

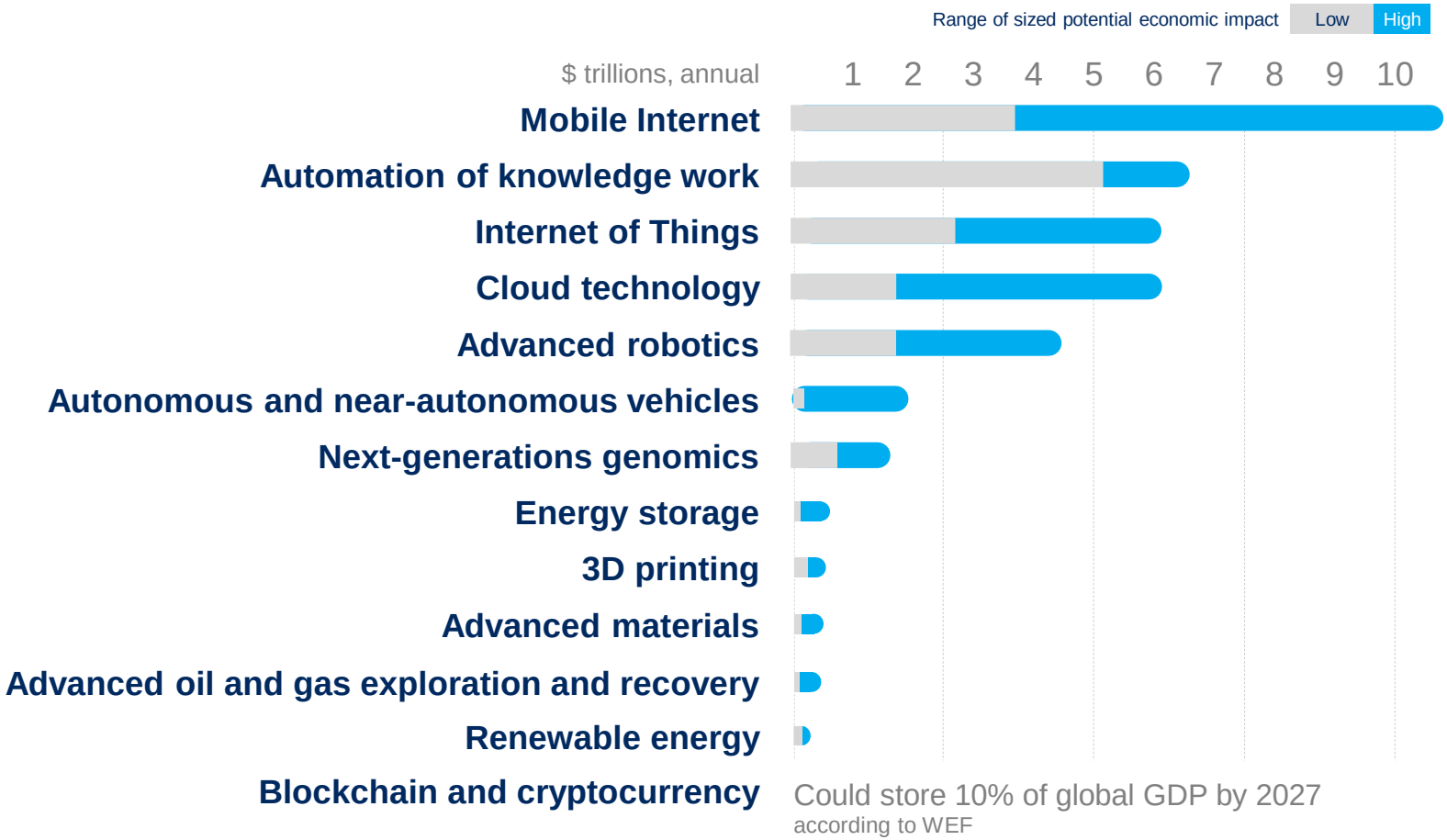


Bifurcating demographics; rapidly aging overall but with very young parts of the world



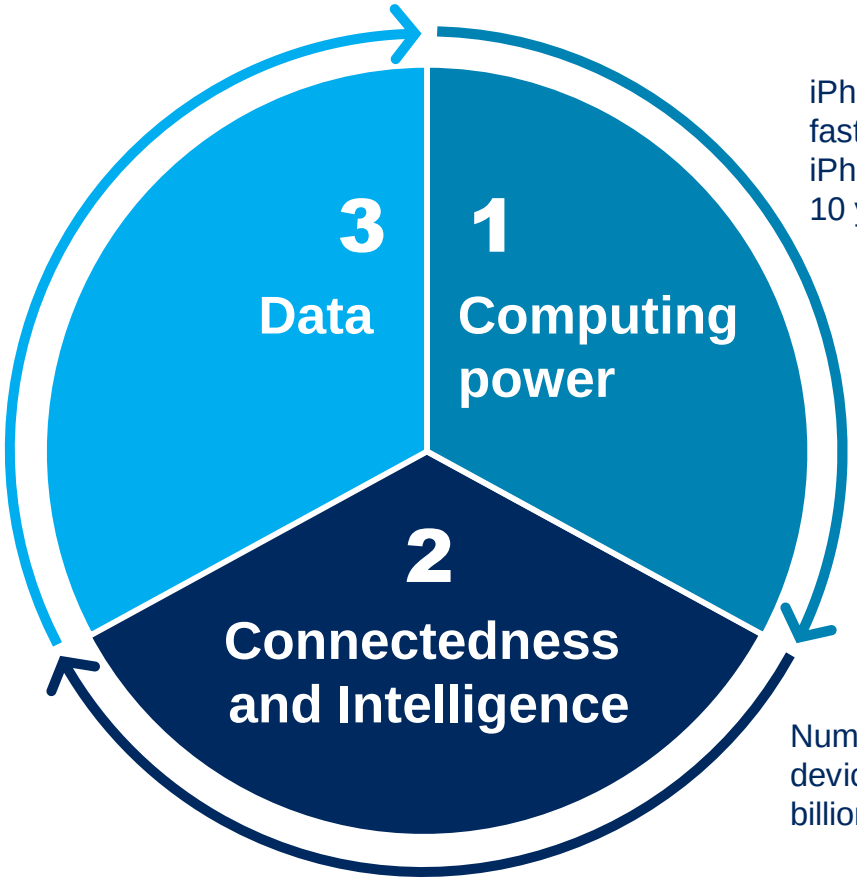
Searching for a new "societal ideal"

13 disruptive technologies are transforming business and society



SOURCE: McKinsey Global Institute, World Economic Forum

The pace of technological change is accelerating



iPhone Xs is 300x faster than the first iPhone released just 10 years ago

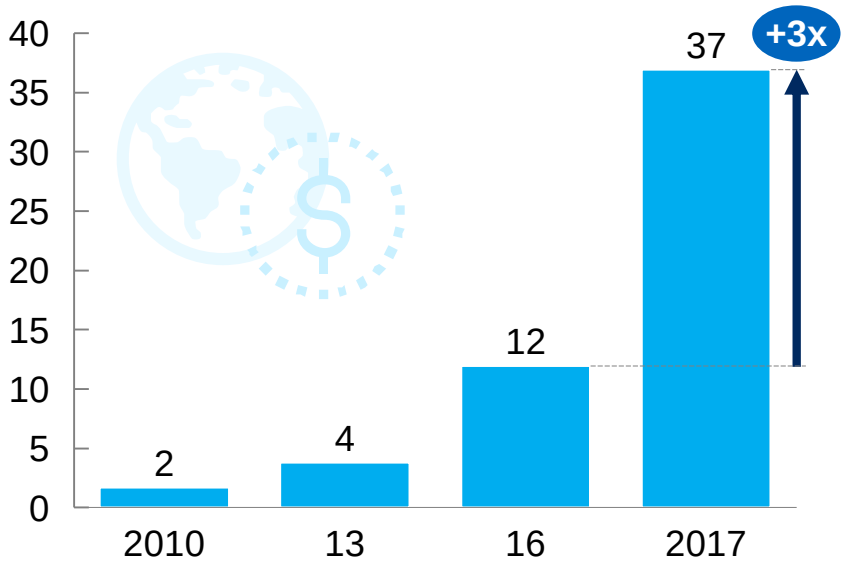
More data has been created in the past two years than the entire previous history of the human race

Number of connected devices will triple to +30 billion by 2020

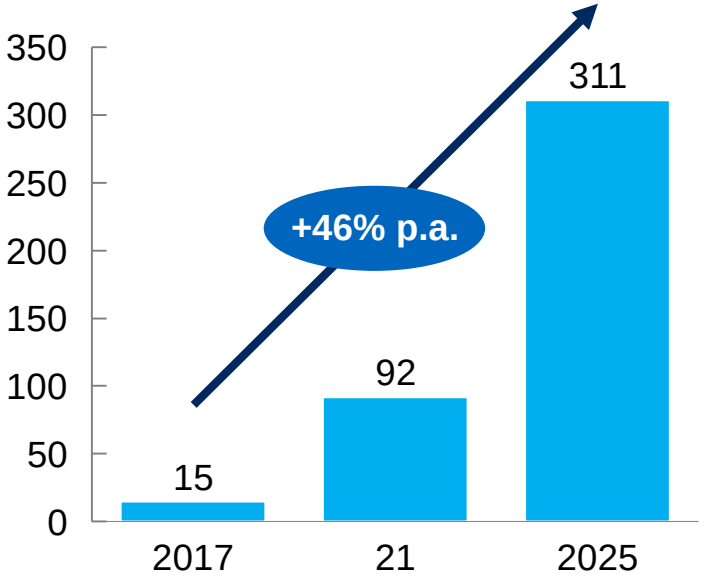
SOURCE: Gartner; IBM, Apple

Investment in AI has continued to grow exponentially fueled by expectations of an AI market that will be over $300Bn by 2025

Global investment in AI companies has been tripling every 3 years[1], $Bn



AI expected to be a +$300Bn market by 2025, growing at ~50% CAGR[2] Enterprise AI revenue, $Bn



1 Estimates consist of annual VC investment in AI-focused companies, PE investment in AI-related companies, and M&A done by corporations. Includes only disclosed data available in databases, and assumes that all registered deals were completed within the year the transactions were announced.
2 Enterprise AI Revenue including software, applications, hardware, services

SOURCE: Pitchbook, Tractica

Some business leaders and scientists foresee an AI revolution coming soon

Take any old classification problem where you have a lot of data, and it's going to be solved by deep learning. There's going to be thousands of applications of deep learning



Geoffrey Hinton
Pioneering Canadian
AI researcher

Cloud technology integrating data analytics in agriculture could increase global crop yields by 10-15% – or $120-180 billion in annual value



Cloud-based data integration



Remote sensing to monitor soil variability



Analytics to optimize vehicle speed

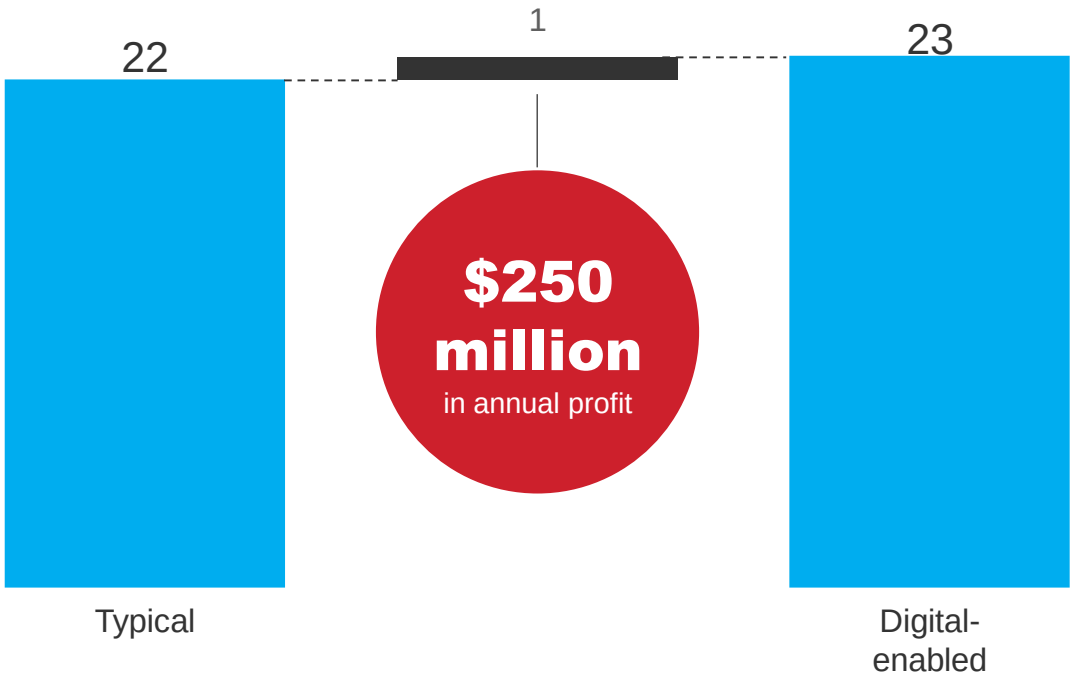
SOURCE: Goldman Sachs Innovation Symposium 2017

Automation of knowledge work

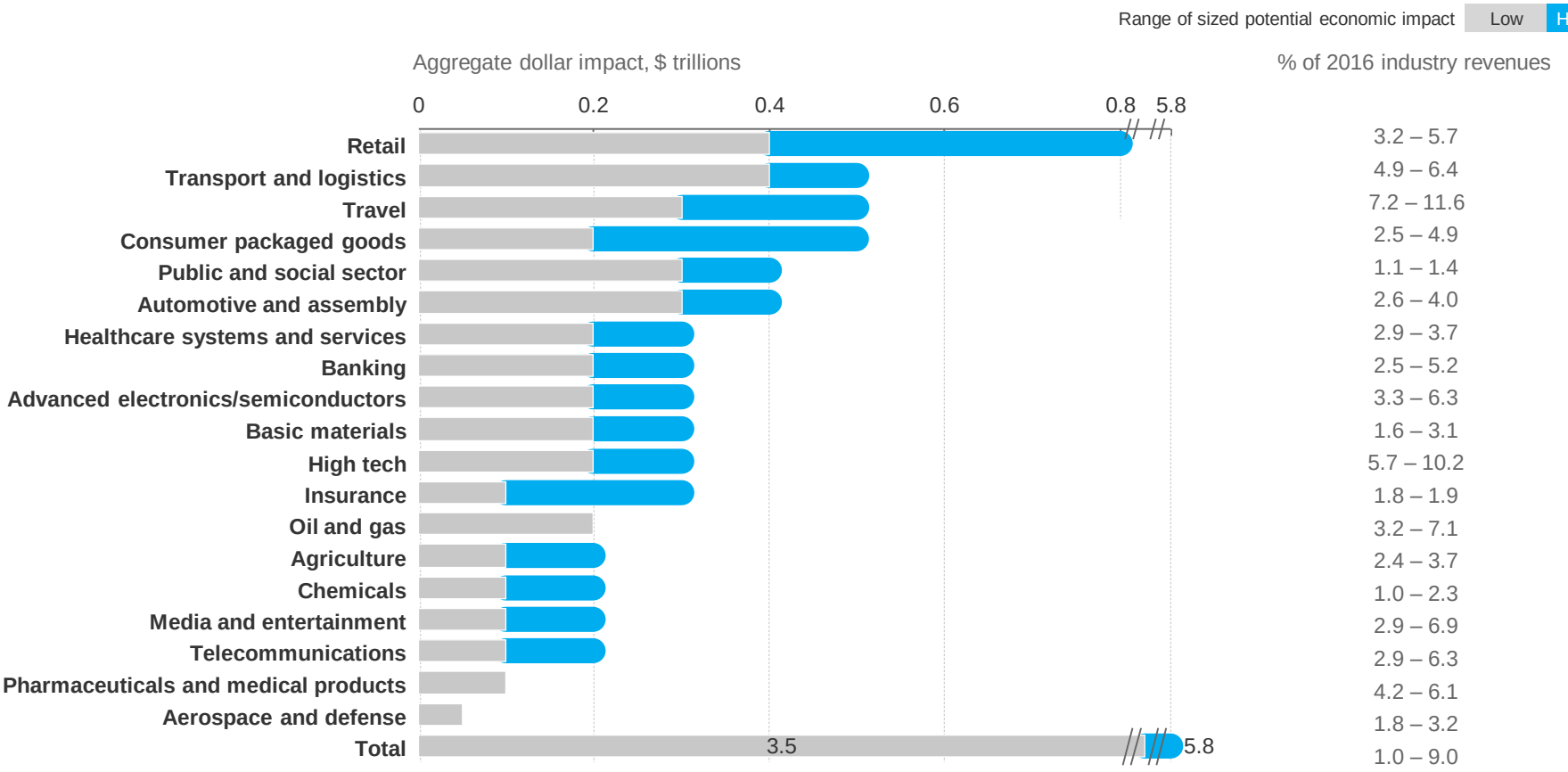


Locomotive velocity

Average miles per hour per day



Effective application of AI techniques could drive up to $5.8 trillion in incremental revenue – or up to 9% of total industry revenue



SOURCE: McKinsey Global Institute

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   - **We need to take a hard look at K-12** – what we teach and how we teach



By 2030...

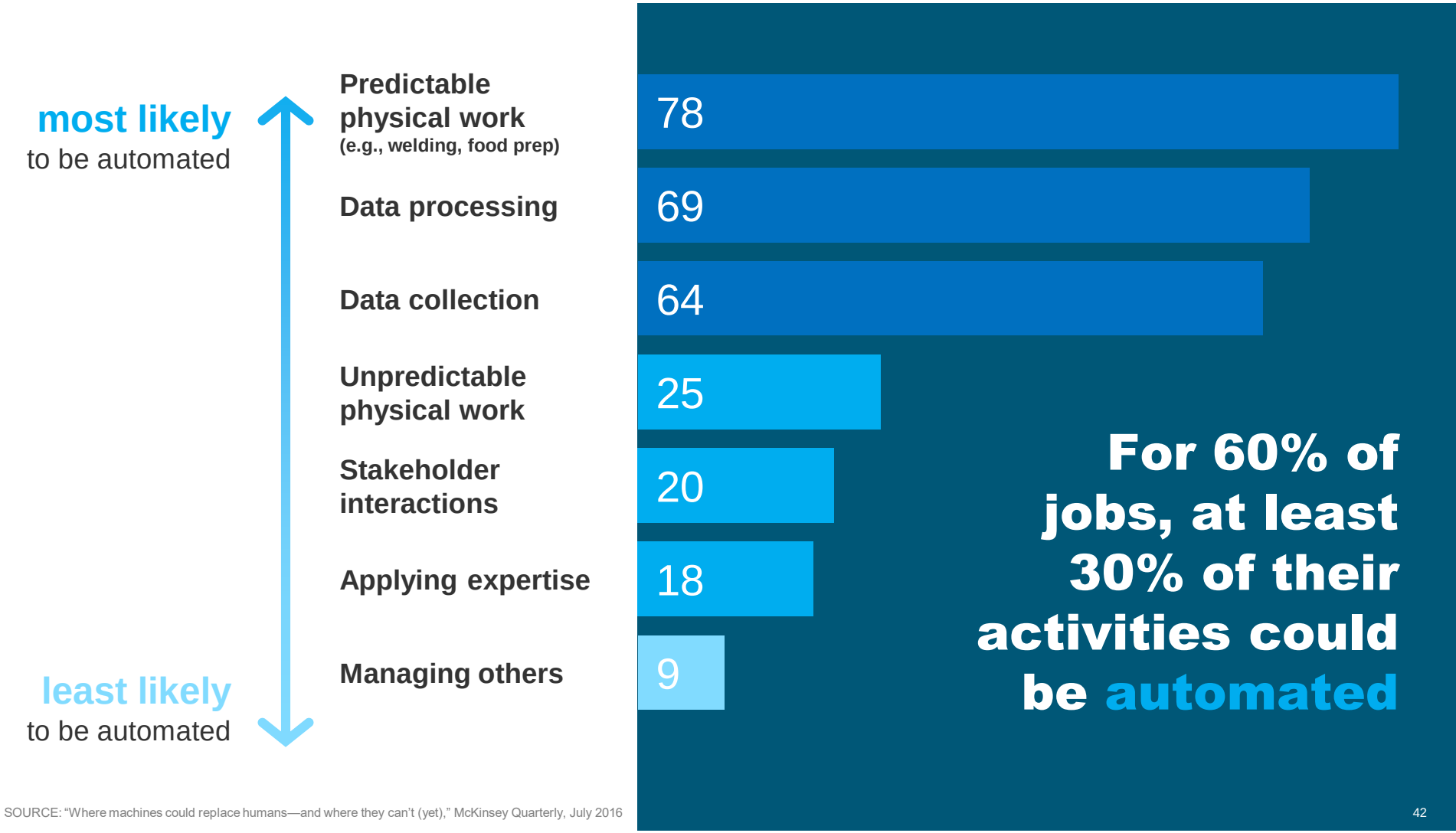
50% of Canadian jobs
will be disrupted significantly by automation

By 2022...

2.4 million additional new jobs will require a different set of “human skills[1]”

1 Critical thinking, coordination, social perceptiveness, active listening and complex problem solving

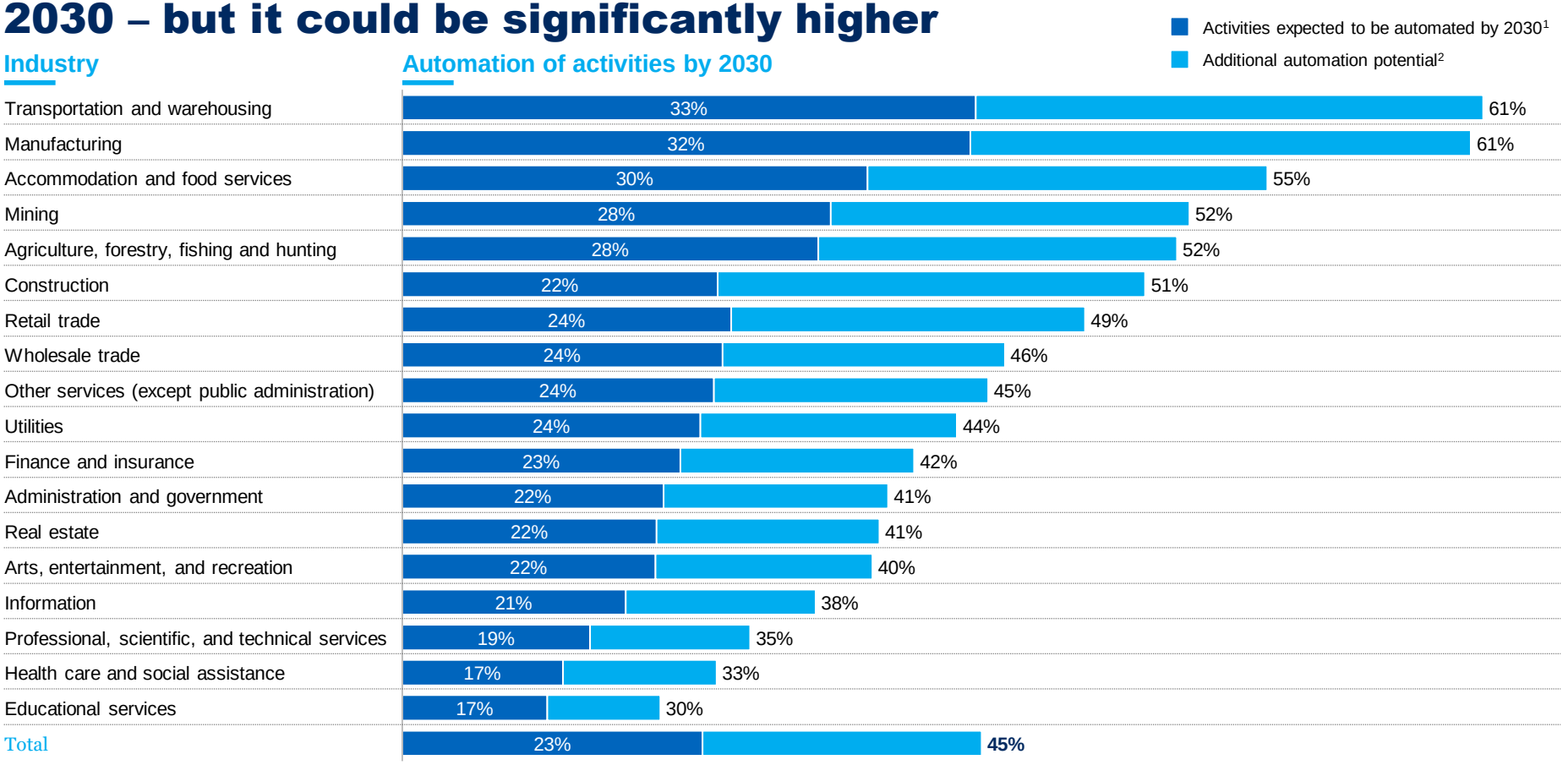




SOURCE: "Where machines could replace humans—and where they can't (yet)," McKinsey Quarterly, July 2016

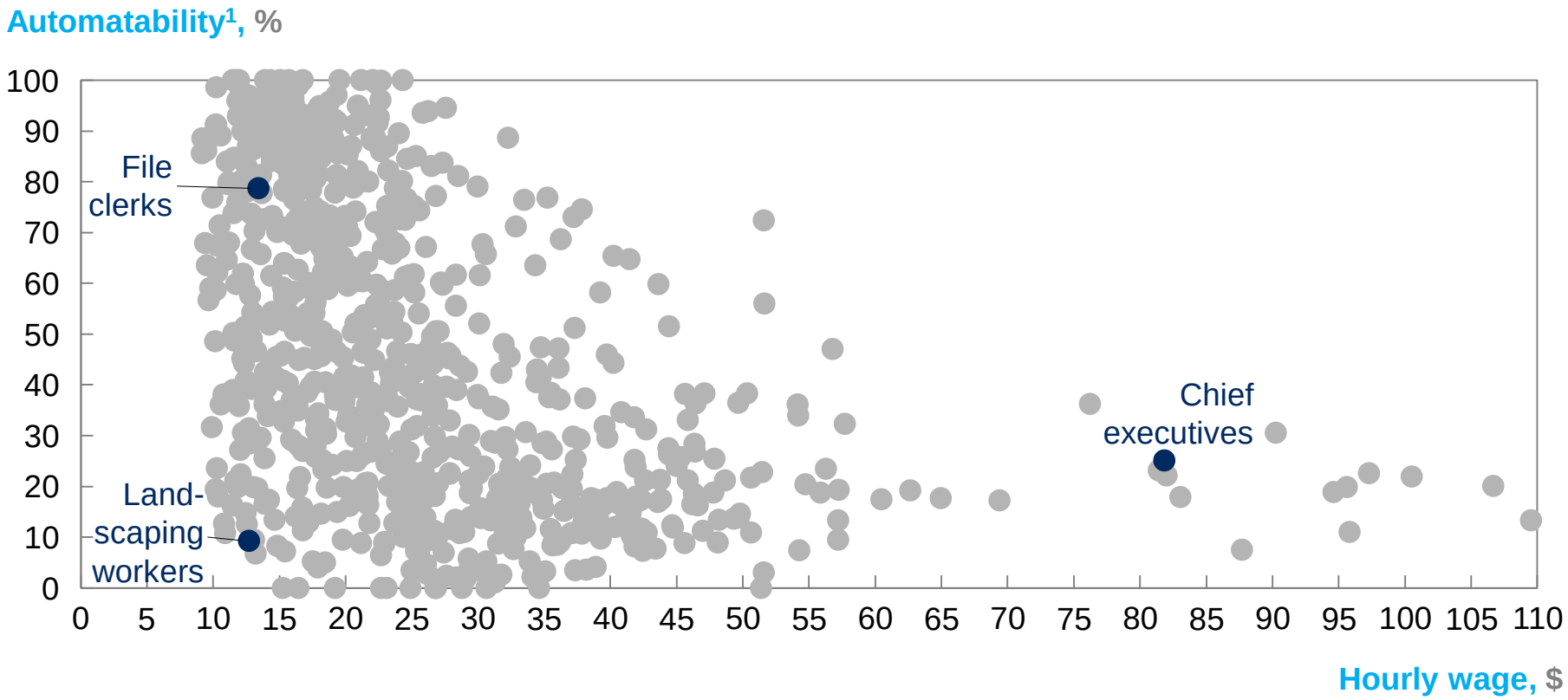
42

We expect nearly a quarter of all work activities to be automated by 2030 – but it could be significantly higher



1 Percent of work activities in the sector expected to be automated by 2030
2 Percent of work activities in the sector with potential for automation given current technology

Both low and high-wage occupations have significant technical automation potential



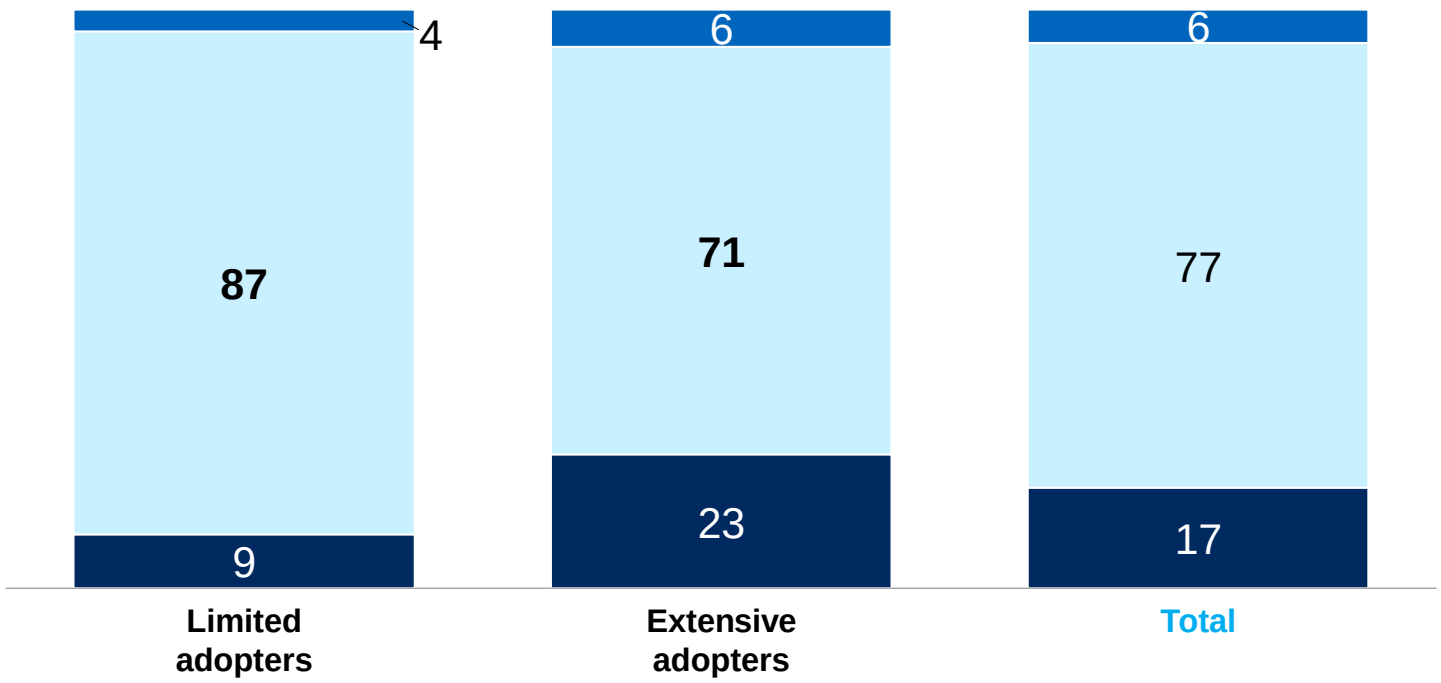
1 Our analysis used "detailed work activities," as defined by O*NET, a program sponsored by the US Department of Labor, Employment and Training Administration.

SOURCE: US Bureau of Labor Statistics; McKinsey Global Institute analysis

Yet only 6 percent of companies expect their workforce in the United States and Europe to shrink as a result of automation and AI

Impact of adopting automation and AI on size of operations

% of respondents

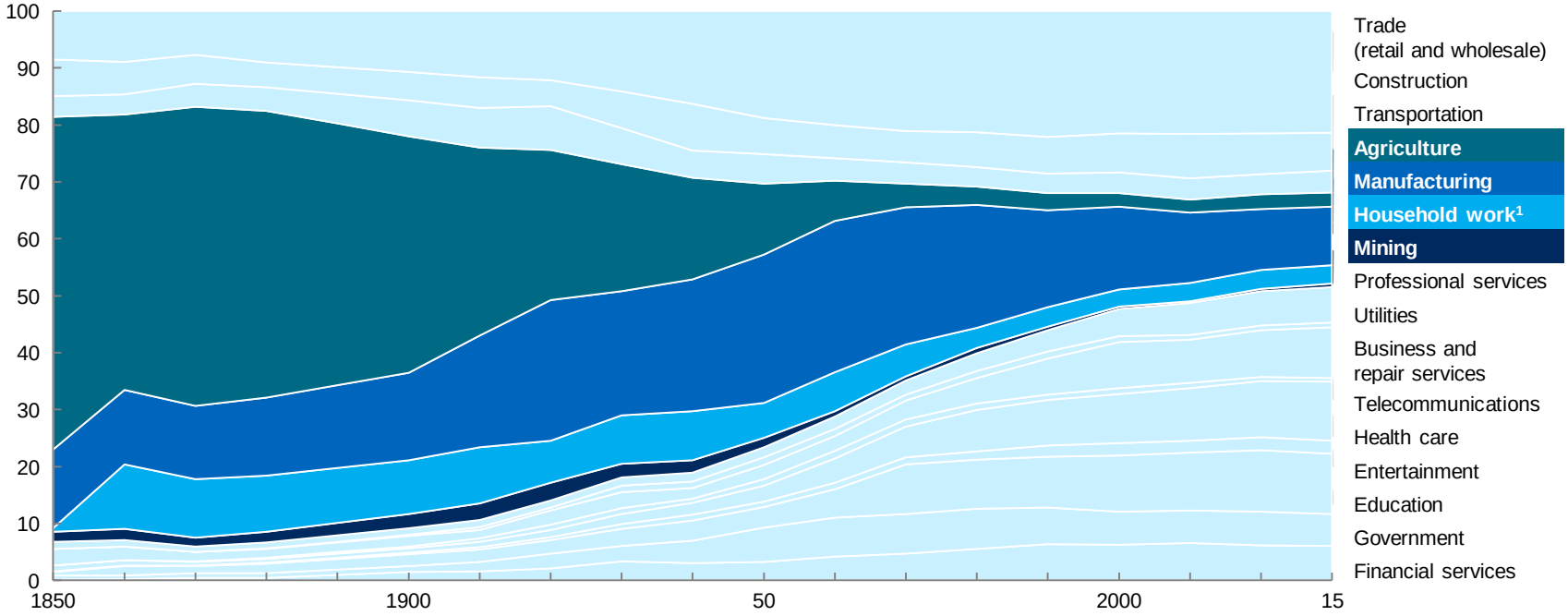


SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

History shows that technology has created large employment and sector shifts, but also creates new jobs

Large-scale sector employment declines have been countered by growth of other sectors that have absorbed workers

Share of total employment by sector in the United States, 1850–2015



1 Increase from 1850 to 1860 in employment share of household work primarily due to changes in how unpaid labor (slavery) was tracked.
NOTE: Numbers may not sum due to rounding.

SOURCE: IPUMS USA 2017; US Bureau of Labor Statistics; Groningen Growth and Development Centre 10-Sector Database; Moody's; IMPLAN; US Bureau of Labor Statistics; FRED; McKinsey Global Institute analysis

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Skills that will be in demand are changing – we have 5 defined categories



Physical and manual skills

- General **equipment operation** and navigation



Basic cognitive skills

- Basic **literacy, numeracy**, and communication



Higher cognitive skills

- **Advanced literacy** and writing
- **Critical thinking** and decision making



Social and emotional skills

- **Advanced communication** and negotiation skills
- Interpersonal skills and empathy



Technological skills

- Basic **digital skills**
- **Advanced data** analysis and mathematical skills

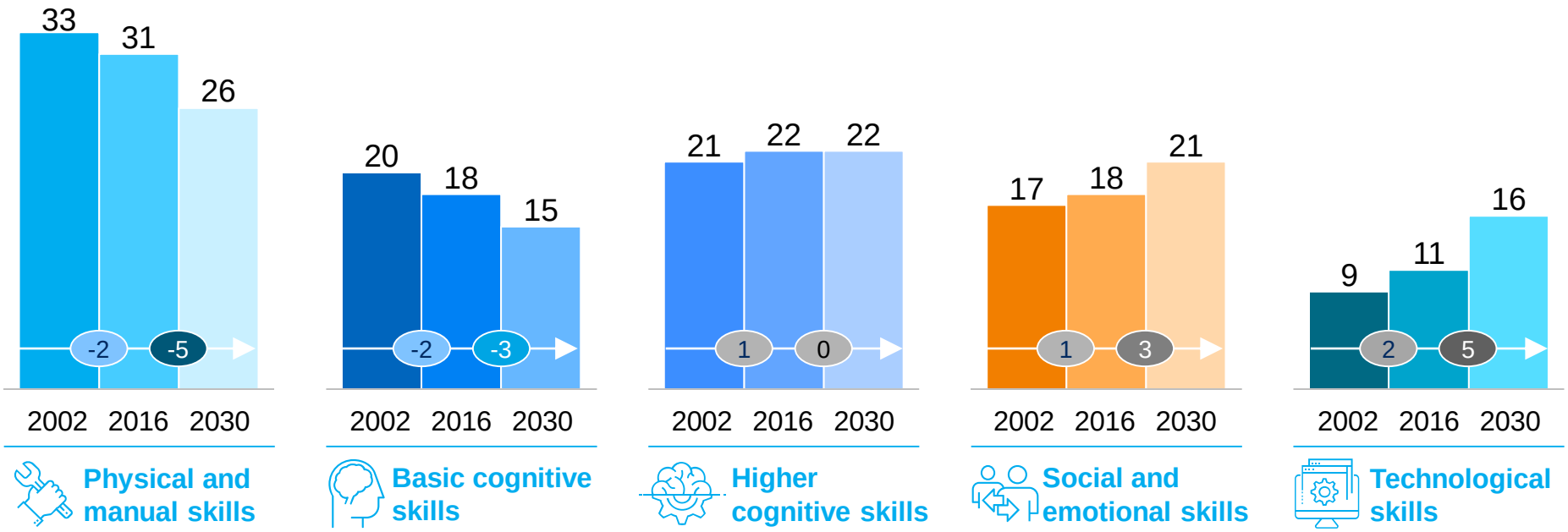
Skill shifts are accelerating due to automation and AI

United States, 2002-30

xx Percentage point change in share of total hours

Hours worked in skill categories

% of time distribution

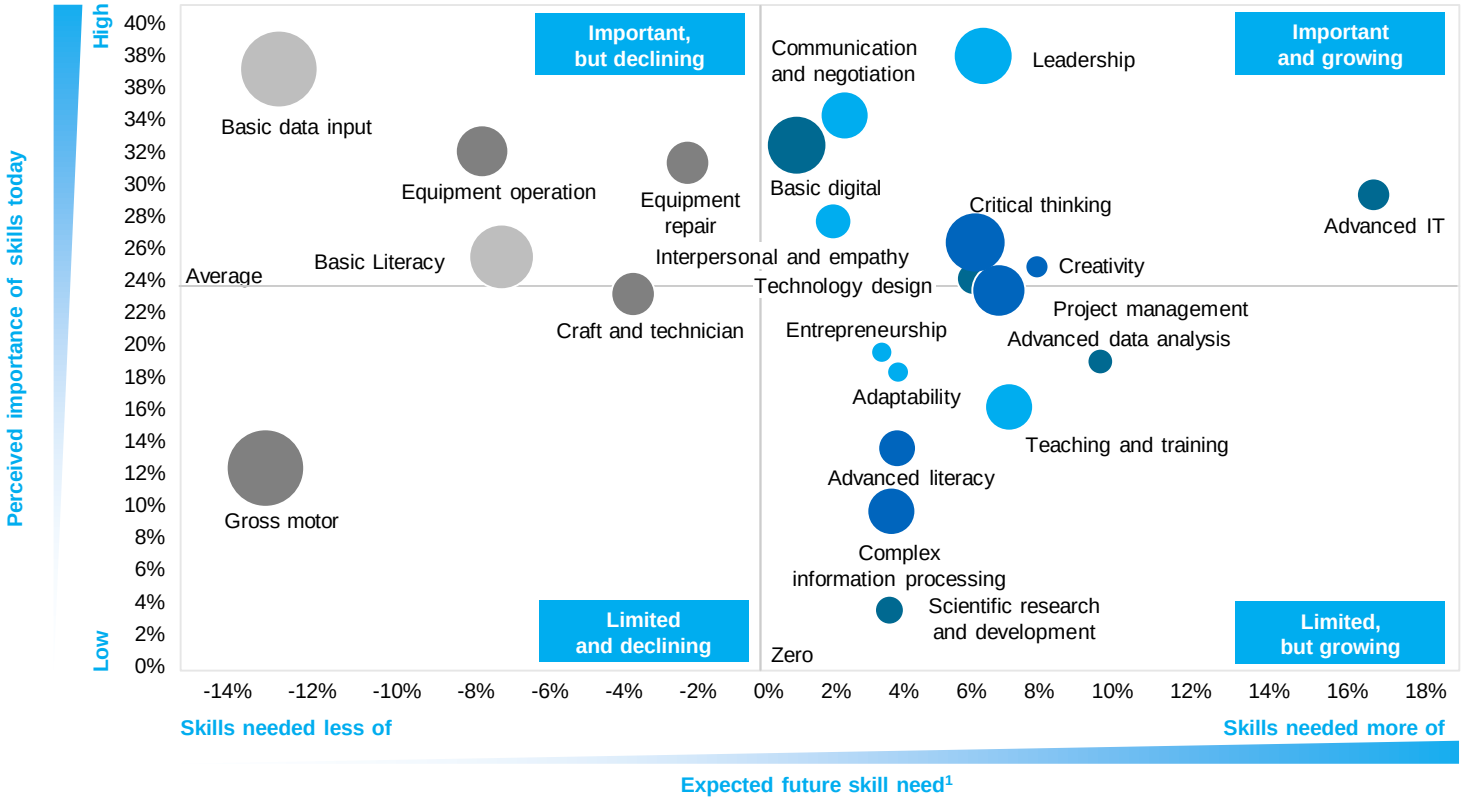


NOTE: Based on difference between hours worked per skill in 2016

SOURCE: U.S. Bureau of Labor statistics; McKinsey Global Institute analysis

Technological, socio-emotional, and higher cognitive skills are the "skills of the future"

Based on McKinsey Global Institute workforce skills executive survey, 2018



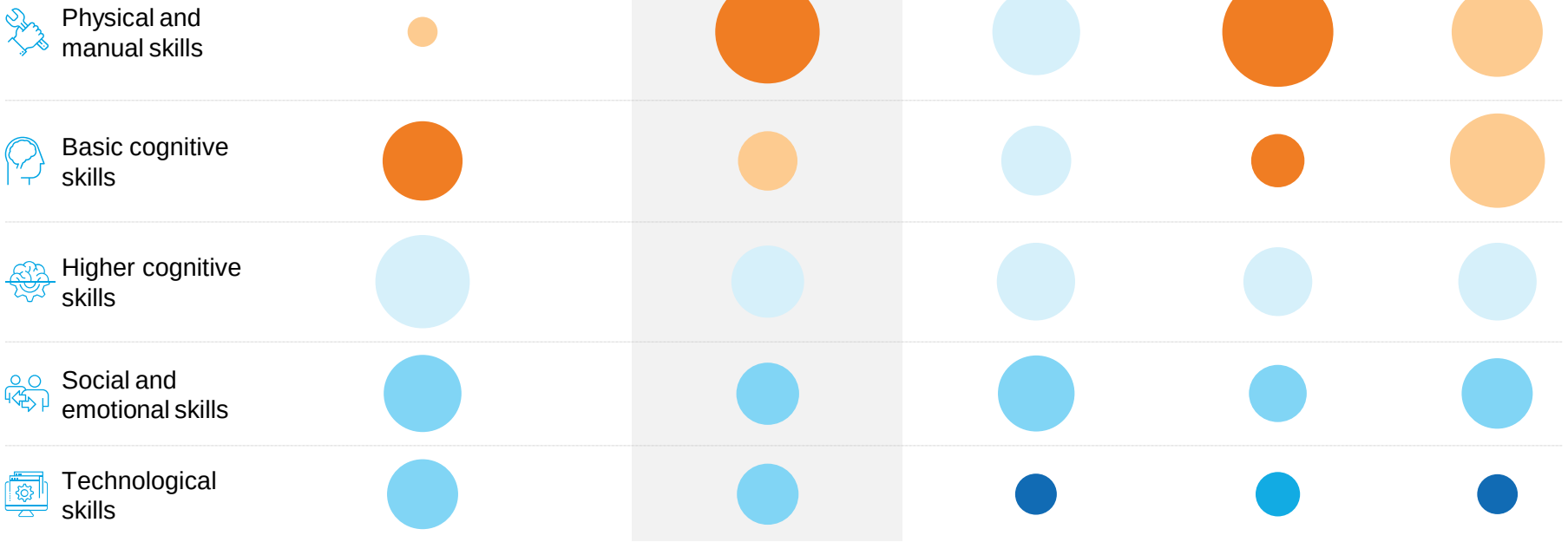
SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

Energy and mining will see a particularly steep decline in demand for physical and manual skills

-40% less 80% more

Number of hours worked

United States and Western Europe, Percent change in time spent using skill



SOURCE: McKinsey Global Institute analysis

Overview

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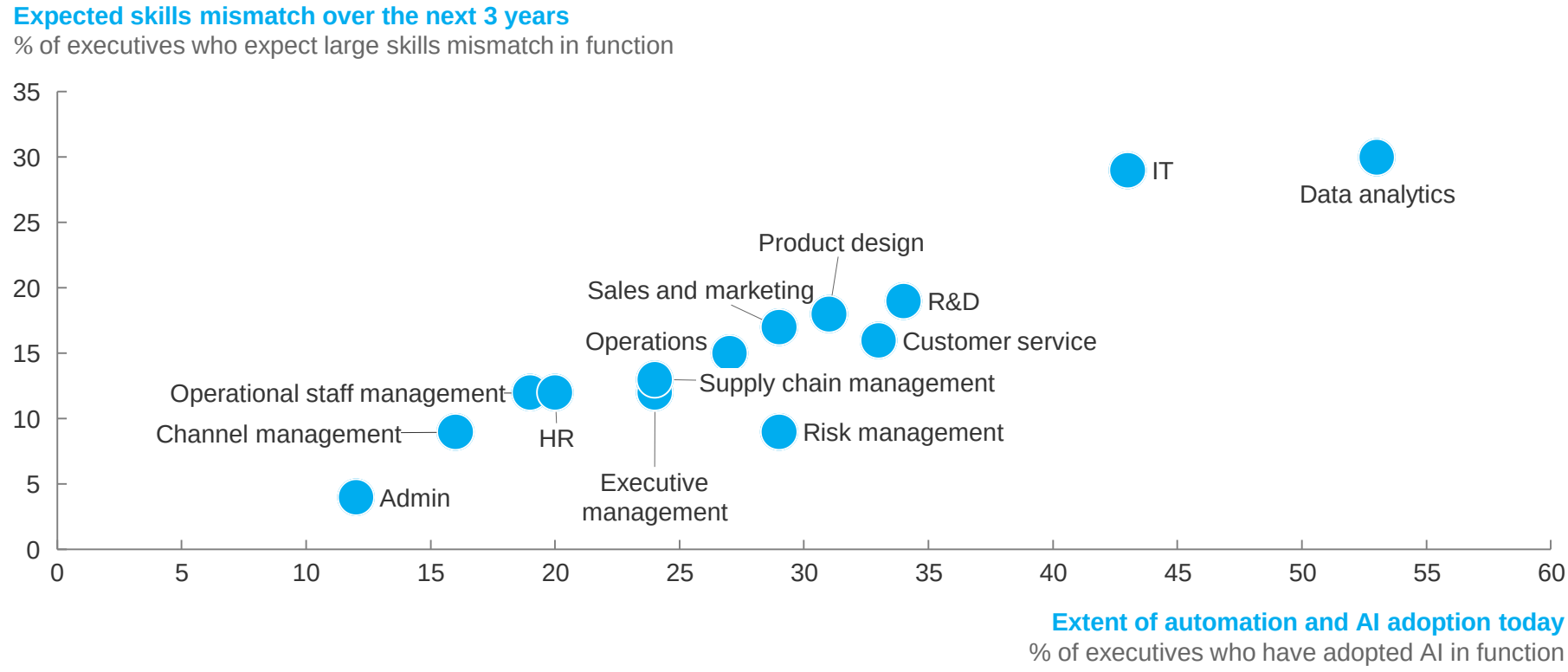
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Skill gaps are already emerging: companies say that functions that are the most automated today have the largest skill mismatches



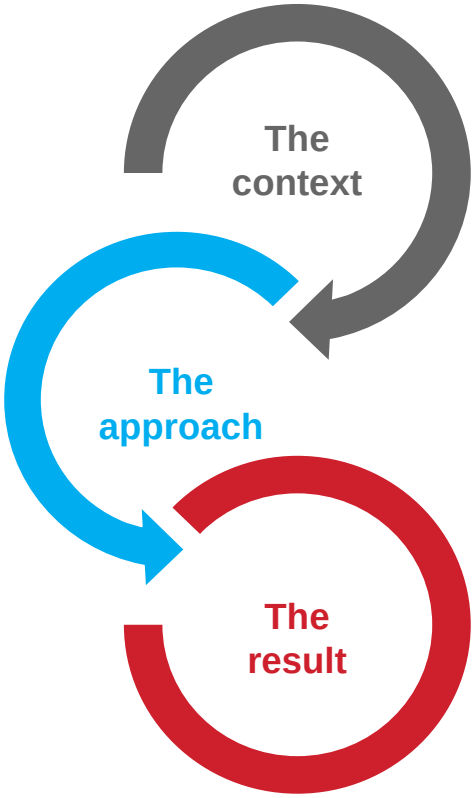
NOTE: Based on results of March 2018 study of more than 3,000 business leaders in 7 countries (Canada, France, Germany, Italy, Spain, United Kingdom, and the United States) and 14 sectors. Chart based on % of business leaders. Skills descriptions were shortened. Chart based on questions "When you think about how automation and AI will change your workforce skill needs, in which functions do you think skills mismatches will be largest over the next 3 years? (Select up to 3)" and "Which of your organization's functions have adopted automation and AI technologies to date? (Select all that apply)"

SOURCE: McKinsey Global Institute workforce skills executive survey, McKinsey Global Institute analysis

75% of global senior executives say reskilling is at least half of the solution to the skills gap



A well-known example of an employer-led reskilling program at scale is AT&T's "Workforce 2020" project



1

- Goal to reskill 100K+ employees by 2020

2

- Streamlined 2,000+ job titles
- Partnered with universities to offer learning options
- Aligned incentives to encourage skill building

3

- Spent $250 million on employee education and development
- Retrained employees to fill half of new technology-related job openings
- Reduced product-development cycle time by 40% and accelerated time to revenue by 32% (2016)

SOURCE: McKinsey Research, AT&T website, Harvard Business Review

New government entities are being set up around the globe with mandates to address the need for reskilling

Country/ entity	Mandate
FutureSkills Lab	To be a **laboratory for skills development and measurement** in Canada that informs skills and training program funding decisions of multiple players
Education & Skills Funding Agency	To provide **world-class education** and **care** that allows every child and young person to **reach his or her potential**, regardless of background
SkillsFuture SG	A nation of **lifelong learners**: a society that values **skills mastery**
Lifelong Learning Program (LLP)	Enable individuals at all stages of their lives to **pursue stimulating learning opportunities** across Europe
Skilling Australians Fund	To have a **lasting positive impact on skilling Australian workers** into the future
SENAI	To provide Brazilian industry with a **highly capable workforce** and **competent technical assistance**
N.S.D.C National Skill Development Corporation	To fulfill the growing need in India for **skilled manpower** across sectors and **narrow the gap** between the **demand** and **supply for skills**

Key insights

- Rising **awareness of need for reskilling support** for current workers (not just un-employed)
- Investment in **future skills,** not just current industry needs
- New markets by **providing incentives** to employers, employees, and training institutions

Singapore launched initiatives to upskill its citizens and harmonize the skills framework

SKILLSFuture SG

Internships

Enhanced internships

65%

Courses offer experience in real work environments

Young talent program

500+

Students received funding to participate in overseas programs

Upskilling

Mid-career enhanced subsidy

90%
Subsidies

~9,000
Courses offered

69,000
Singaporeans impacted

Credit

126,000
Singaporeans registers

18,000+
Approved courses available

Skills framework

Skills Framework Guide for enterprises and Singaporeans **on skills required for emerging jobs**

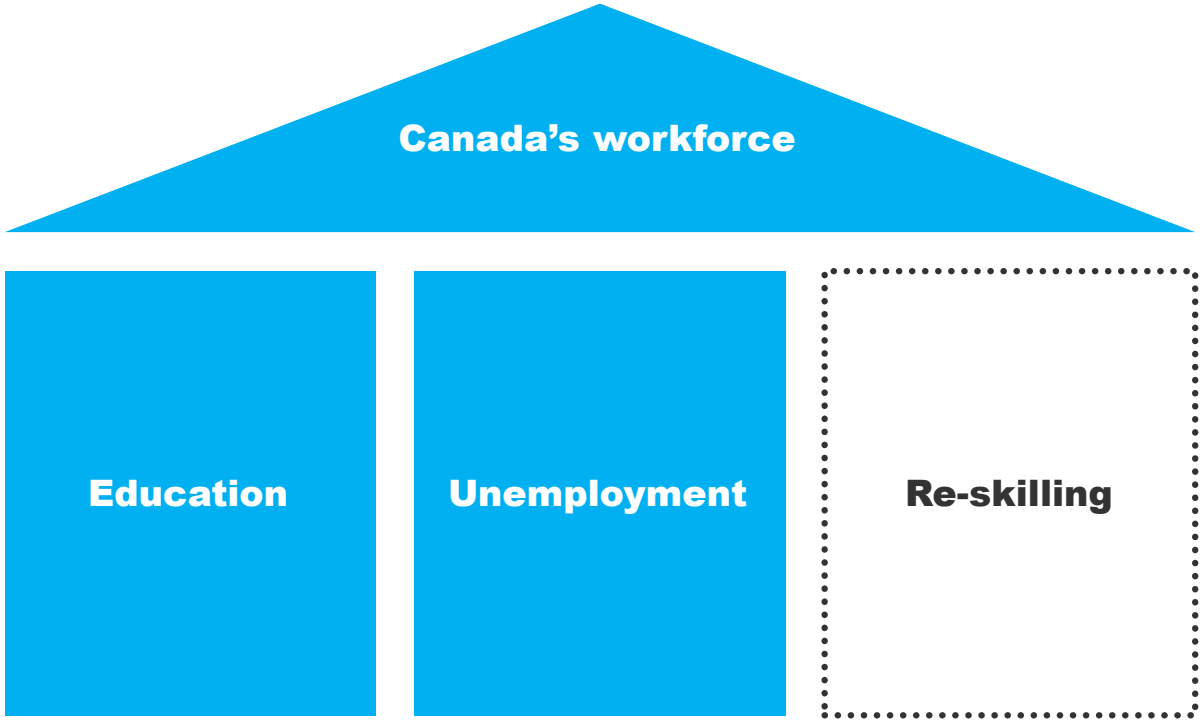
3 Framework launched

- Early childhood care and education
- Hotel and accommodation services
- Precision engineering

NEW

7 Frameworks in the pipeline

Canada needs a third pillar to support its workforce in the face of unprecedented technological change



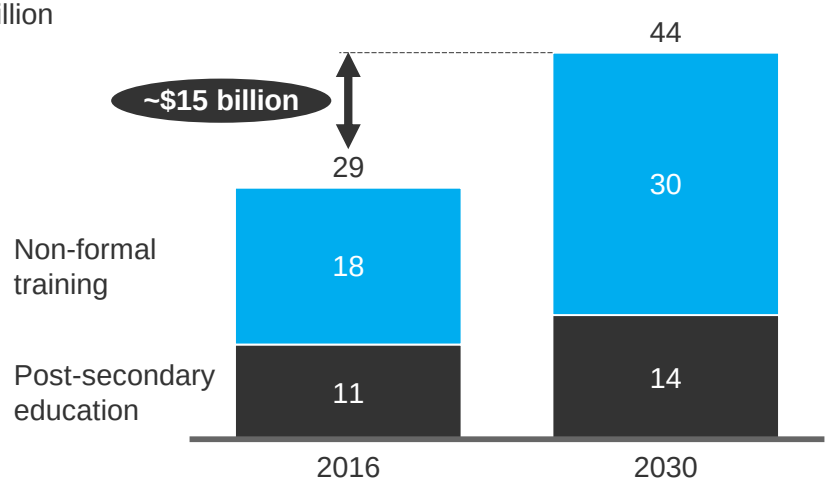
This resulted in the Growth Council's recommendations on lifelong learning...

Background

31% Of Canadians **would like to engage in training** but cannot due to various barriers

Projected annual adult reskilling cost

$ billion



Recommendations

- Formulate a comprehensive **Skills Plan for Working Canadians**

1. New, federally governed **Canada Lifelong Learning Fund** that helps reduce the financial barriers to continuing training

2. **Transformation of the government's employment centres** into hubs of hands-on career and training guidance for unemployed and working adults

...resulting in the creation of the FutureSkills Lab to develop, test and measure new approaches to skills development



- Examine major trends that will have an **impact on national and regional economies and workers**
- Identify **emerging skills** that are in demand now and into the future
- Develop, test and evaluate **new approaches to skills development**
- **Share results and best practices** across public, private and not-for-profit sectors to support broader use of innovative approaches across Canada

Overview

1. **We're in the midst of a massive economic and social transition with automation and AI at the core**

2. **Automation and AI are changing the nature of work. However, employment is likely to increase with automation and AI**

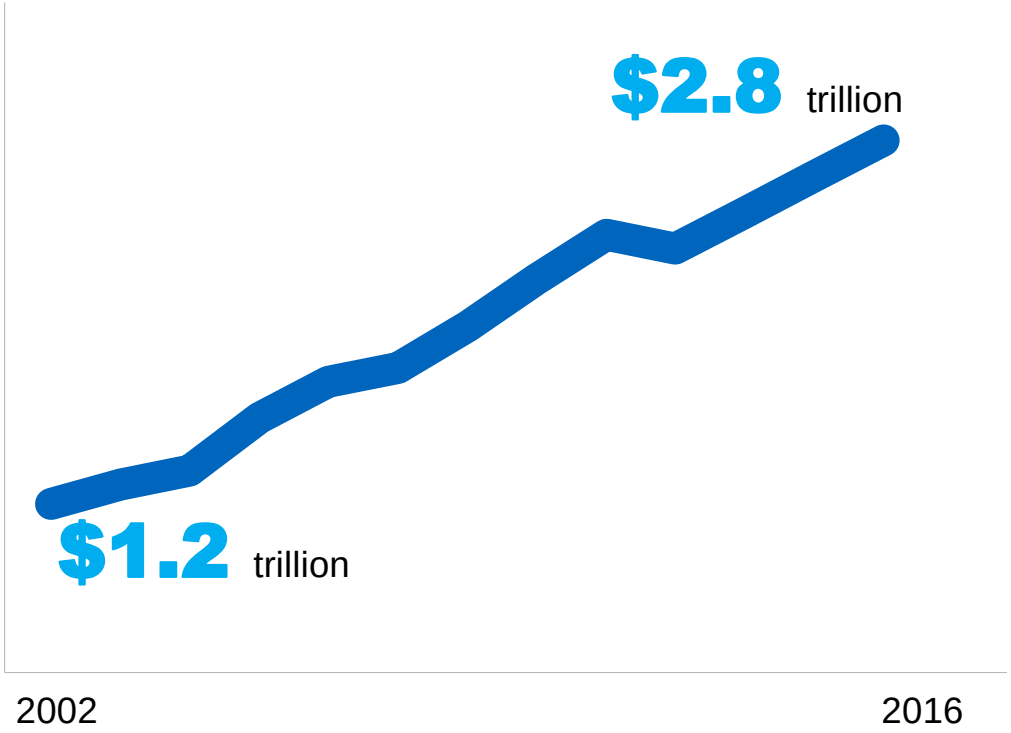
3. **Education is the Gamechanger**

   - **Technological, socio-emotional, and higher cognitive skills** are the "skills of the future"
   - We need to reskill people in a way we've never done before. **Lifelong learning has never been more important**
   - **We need to take a hard look at K-12** – what we teach and how we teach



Despite increased spending on primary education, we are failing across the globe to provide a great education to every child

Global K-12 education spending continues to rise



70 million
primary-school -age children still have no access to schools

340 million
secondary-school-age students are out of school

50% of those children lucky enough to attend school are failed by underperforming systems

SOURCE: World Bank EdStats, UNESCO school totals, sizes and averages; OECD, SACMEQ, UNESCO and ACER;
Results are a weighted average of the 96 countries for which enrolment, total number of students, and test data were available

Alberta's education system is building from a position of strength.

Alberta has...

Low variation in student performance across the socioeconomic spectrum

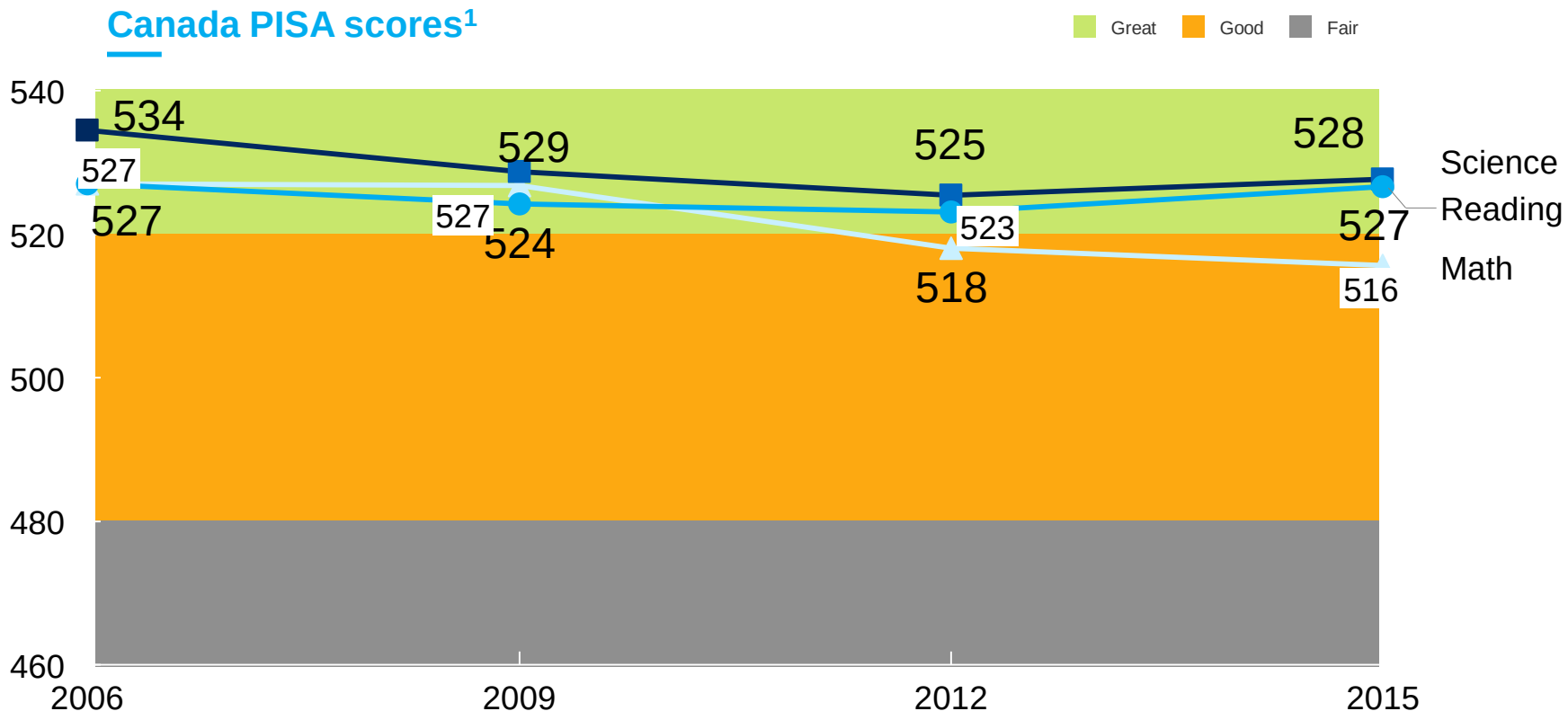
Highly trained teachers with a culture of collaborative practice

A decentralized model that pushes pedagogical decisions to schools and teachers

A plethora of technologies available in its schools

63

..but across Canada, PISA scores are flat or declining



1 We used the numerical cut-offs from our 2010 report to define poor, fair, good, great, and excellent school systems. Each category represents approximately one school-year equivalent, or 40 PISA points.
Excellent: >560 points Great: 520-560 points Good: 480-520 points Fair: 440-480 points Poor: <440 points

Advanced analytics applied to the OECD PISA dataset point to 3 noteworthy drivers of student performance

Input data –
over 100M data points

72 Countries	3 Subjects
18,000 Schools	~270 School variables
140,000 Parents	~150 Parent variables
110,000 Teachers	~250 Teacher variables
540,000 Students	~770 Student variables

Three insights for school systems

1. **Student Mindsets** – Account for ~30% of the factors that predict their achievement

2. **Teaching practices** – A combination of teacher-led and inquiry-based methods works best compared to exclusively one or the other

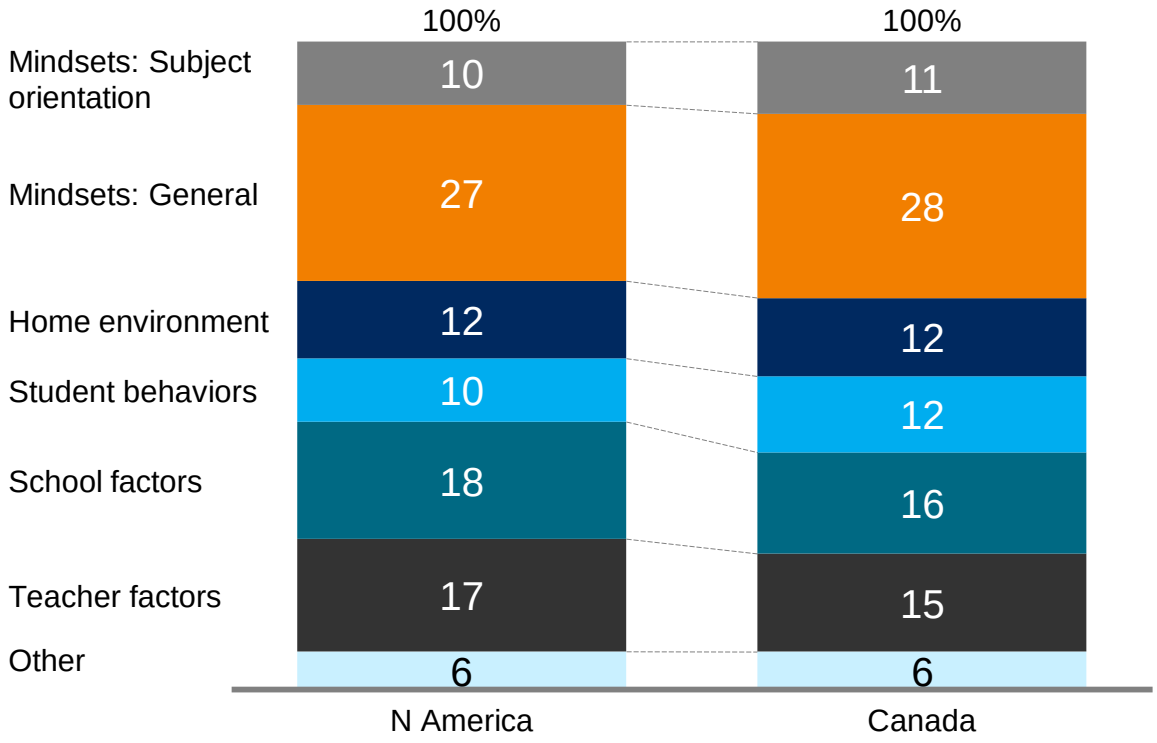
3. **Education technology** – Should be directed towards helping teachers teach

SOURCE: OECD PISA, McKinsey analysis

1 Mindsets eclipse even home environment in predicting student achievement

Factors driving Canadian student OECD PISA science performance, 2015

% of predictive power by category of variable for Canada



Examples of subject orientation mindsets

"I have fun learning science"

"I am interested in the universe and its history"

Examples of general mindsets

"I see myself as an ambitious person"

"What I learn in school will help get me a job"

"I feel like I belong at school"

"If I put in enough effort, I can succeed"

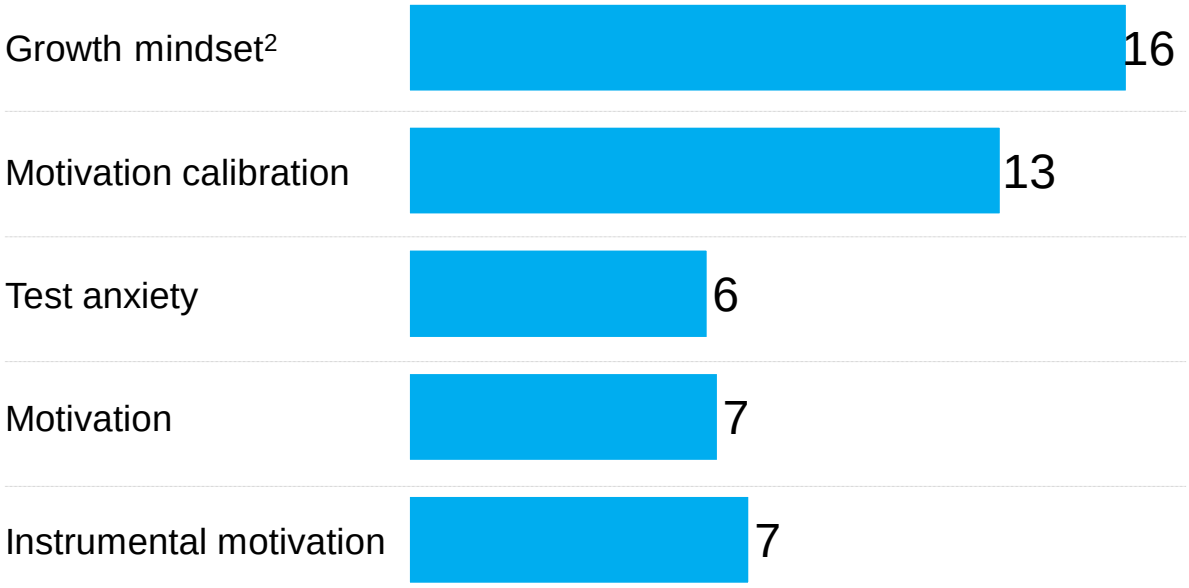
SOURCE: OECD PISA 2015

What mindsets matter most?

1

Score improvement for select general mindset measures[1]

% increase in Canadian PISA science score



Belief that abilities can be developed through dedication and hard work

Ability to identify what motivation looks like in day-to-day life

School-work and test-related anxiety

Self-identified desire to succeed

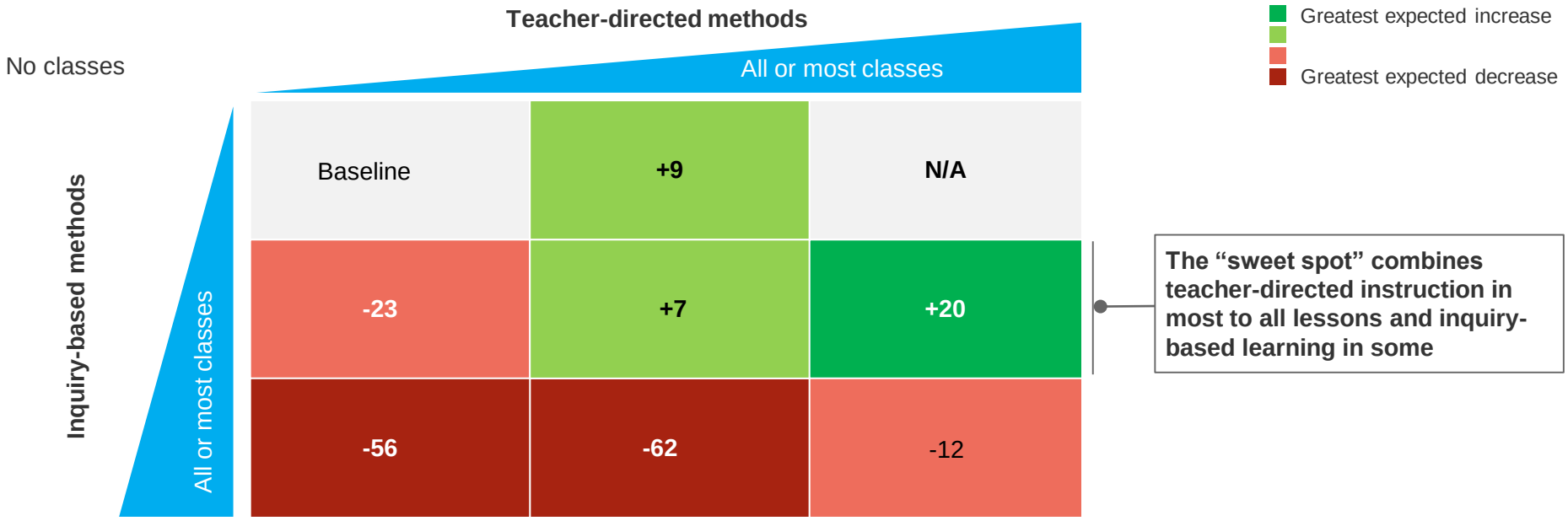
Belief that success in school will lead to better career opportunities

1 Statistically significant in regressions controlling for student socioeconomic status, school type, and school location
2 Growth mindset from 2012 data as questions not asked in 2015; % increase in PISA math score as focus of 2012 assessment was math

SOURCE: OECD PISA 2012, 2015; McKinsey analysis

2 The best student outcomes combine both teacher-directed and inquiry-based education methods

Average point increase in PISA science score relative to baseline[1]



Teacher-directed instructions examples

- Teacher explains scientific ideas
- Teacher discusses our questions
- Teacher demonstrates an idea

Inquiry-based methods examples

- Students are given opportunities to explain ideas
- Students can design their own experiments
- There is a class debate about investigations

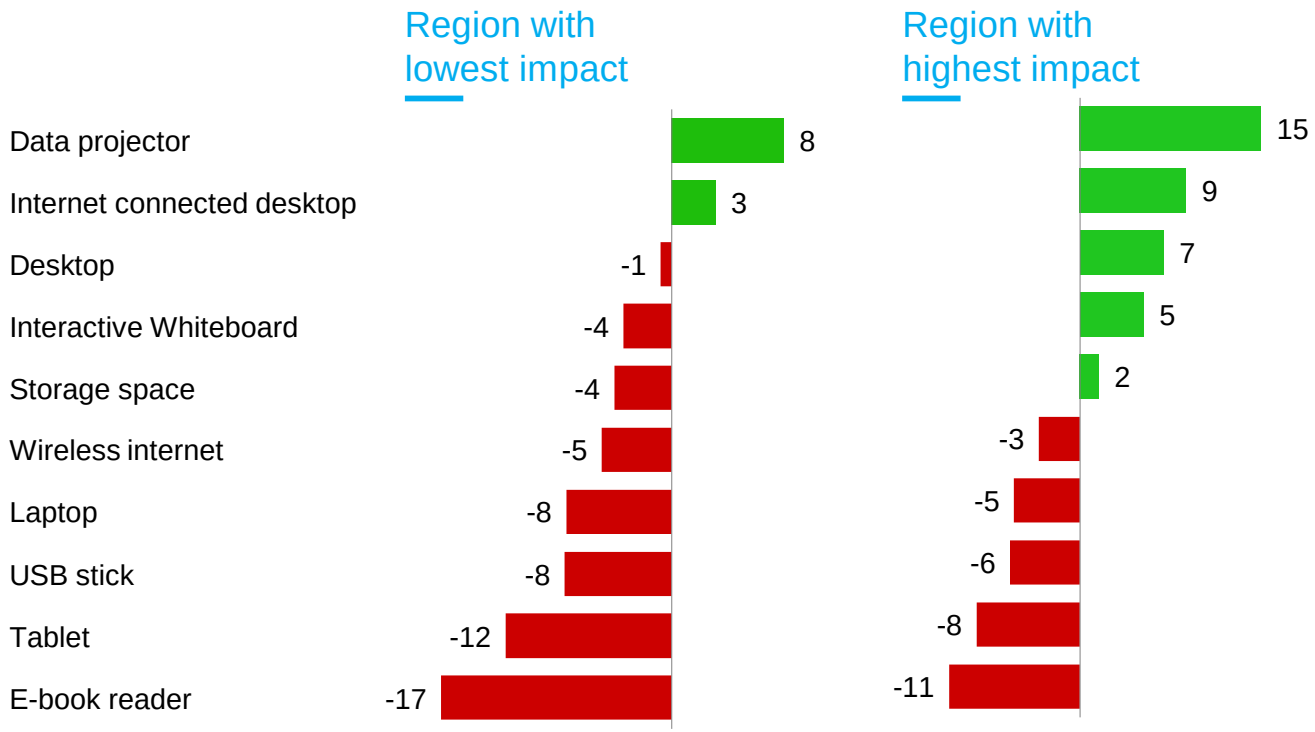
1 Expected change in score in a regression controlling for student socioeconomic status, school type and location.
Statistically significant at 95% except for teacher-directed in most-to-all classes and inquiry-based in most-to-all classes (-2).

SOURCE: OECD PISA 2015, McKinsey analysis

3 Technology directed to teachers is the most effective at improving learning

Impact of student use of technologies at school[1]

Percent change in PISA science score between "No" and "Yes and Use"



Comments

- Data projector, technology directed to teachers, improves PISA science score by >10 pts
- Technologies directed to students (e.g., tablet computer, e-book reader) can lower PISA science score by >10 pts

1 Range of statistically significant scores across regions in a regression controlling for ESCS, public/private, and urban/rural school types

SOURCE: OECD PISA 2015

Implications for school systems

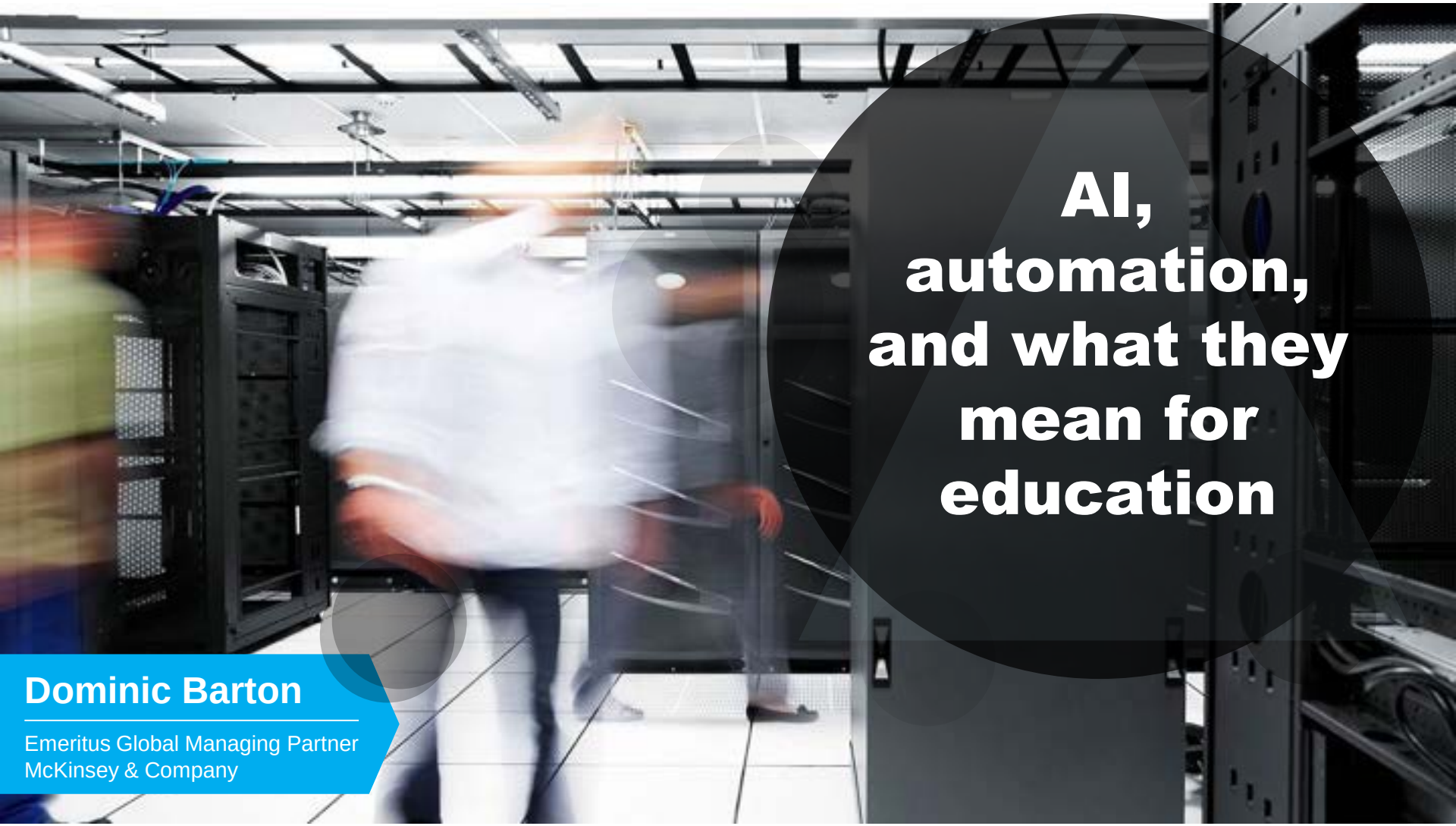
Student mindsets have double to triple the effect of socioeconomic background on outcomes

Students who receive a **blend of inquiry-based and teacher-directed instruction** have the best outcomes

School-based **technology** yields the best results when placed **in the hands of teachers**



70



AI, automation, and what they mean for education

Dominic Barton

Emeritus Global Managing Partner
McKinsey & Company



Discussion

~Question & Answer~

Thank You

The Alberta Teachers' Association

