

Higher Education 4.0 Drivers and Framework

Expert Group Meeting on “Artificial Intelligence and Local Industrial
Development”

UN-House, Beirut July 1-2, 2019

Pierrette Zouein

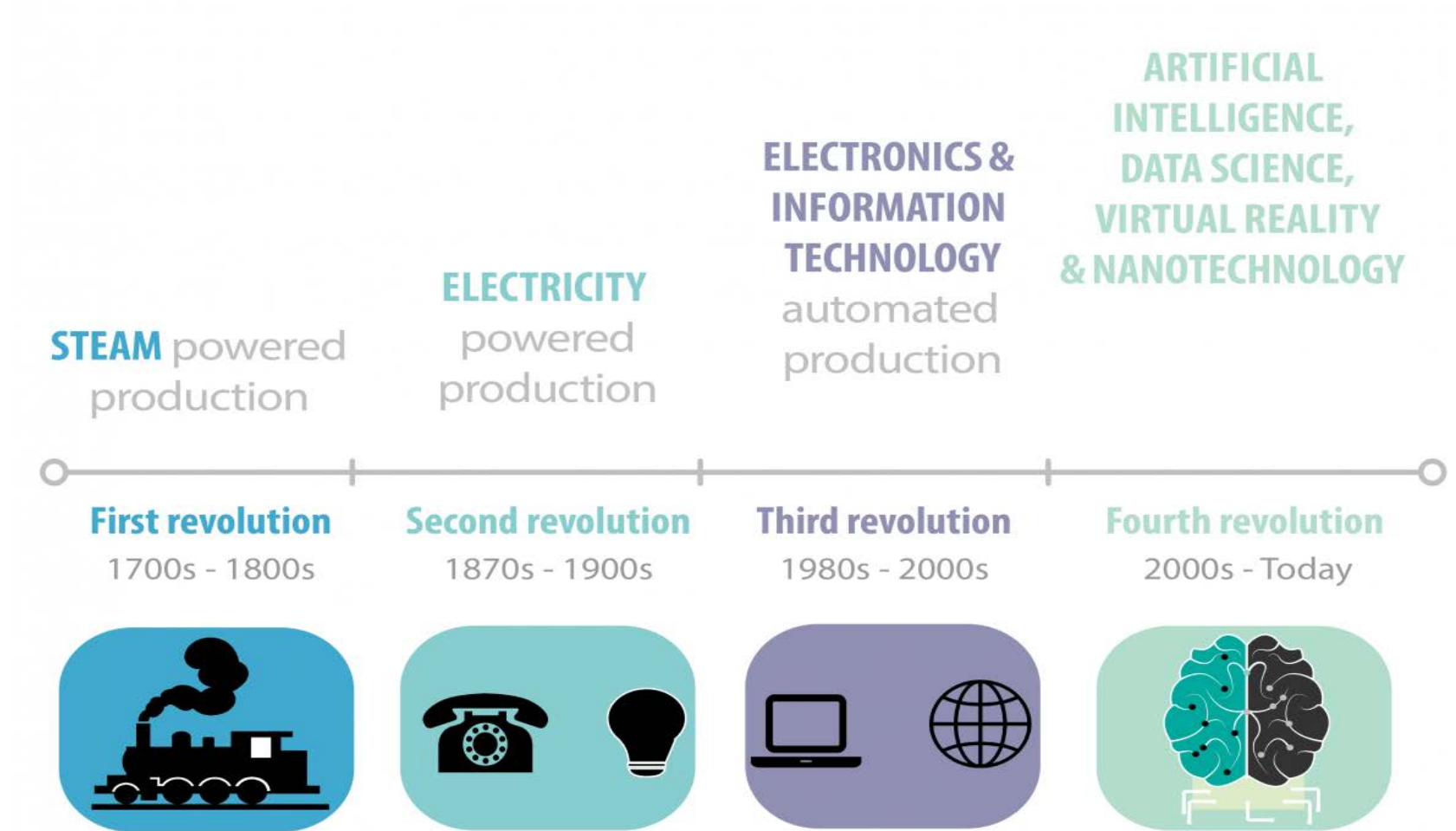
Associate Professor of Industrial Engineering

Lebanese American University

Overview

- The Global economy is being transformed with jobs outsourced to developing nations and AI
- The digital revolution is happening much faster than anticipated across large areas of a complex, interconnected economy that has very tight built in feedback loops
- In that context, this presentation will shed light on
 - ✓ The impact of Frontier technologies on future employment
 - ✓ Skills needed by workers for jobs of the future
 - ✓ “How to prepare **Balanced Global Citizens** with a heart for **Servant Leadership** in an increasingly **secular, internationalized, technology driven fast changing world?**”

The Four Industrial Revolutions



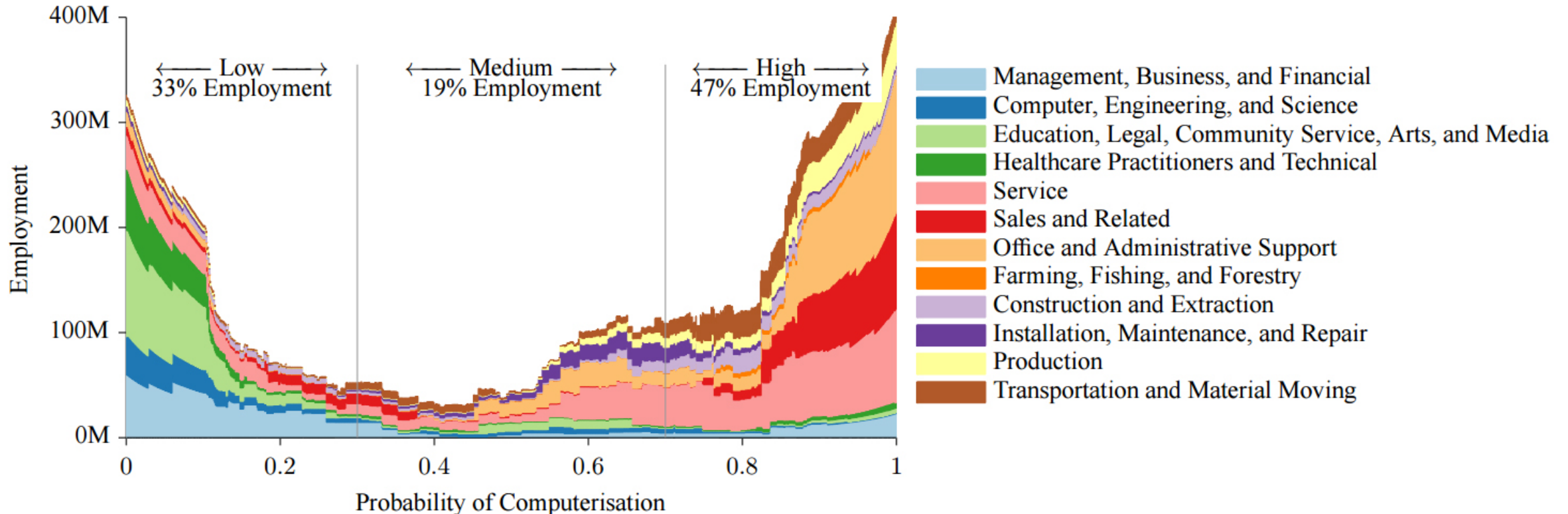
The Fourth Industrial Revolution

- The 4th industrial revolution is marked by frontier technologies namely
 - ✓ physical technologies (e.g., intelligent robots, autonomous drones, driverless cars, 3D printing, and smart sensors)
 - ✓ Digital technologies (e.g., the internet of things, services, data and even people)
 - ✓ Biological technologies (e.g., synthetic biology, individual genetic make-up, and bio-printing) technologies

Impact of 4IR on Job Market Need

- The rippling effects of the 3rd IR upon society, politics, economics and education are still being felt and we are reacting to them
- The exact impacts of FTs on society and the planet are still unknown—but the fact that they will bring profound and rapid change seems all but certain
- The pace of change is compounded and multiplied as a result of the integration and compounding effects of multiple “exponential” frontier technologies and the exponential increase in computer power
- The potential for irreversible loss of control over networks of powerful AI agents with increasing autonomy within financial sectors and within urban infrastructure can be scary
- There are serious concerns that the 4IR brings a permanent reduction in the need for human labor with blue-collar jobs being replaced by robots and IoT and white-collar jobs by AI
- A 2013 Oxford Martin School study estimated that 47% of US jobs could be replaced by automated processes within two decades

Susceptibility of jobs to computerization from AI and robotics



Source: Frey, C.B. and M.A. Osborne, "The Future of Employment: How Susceptible Are Jobs to Computerisation?", 17 September 2013

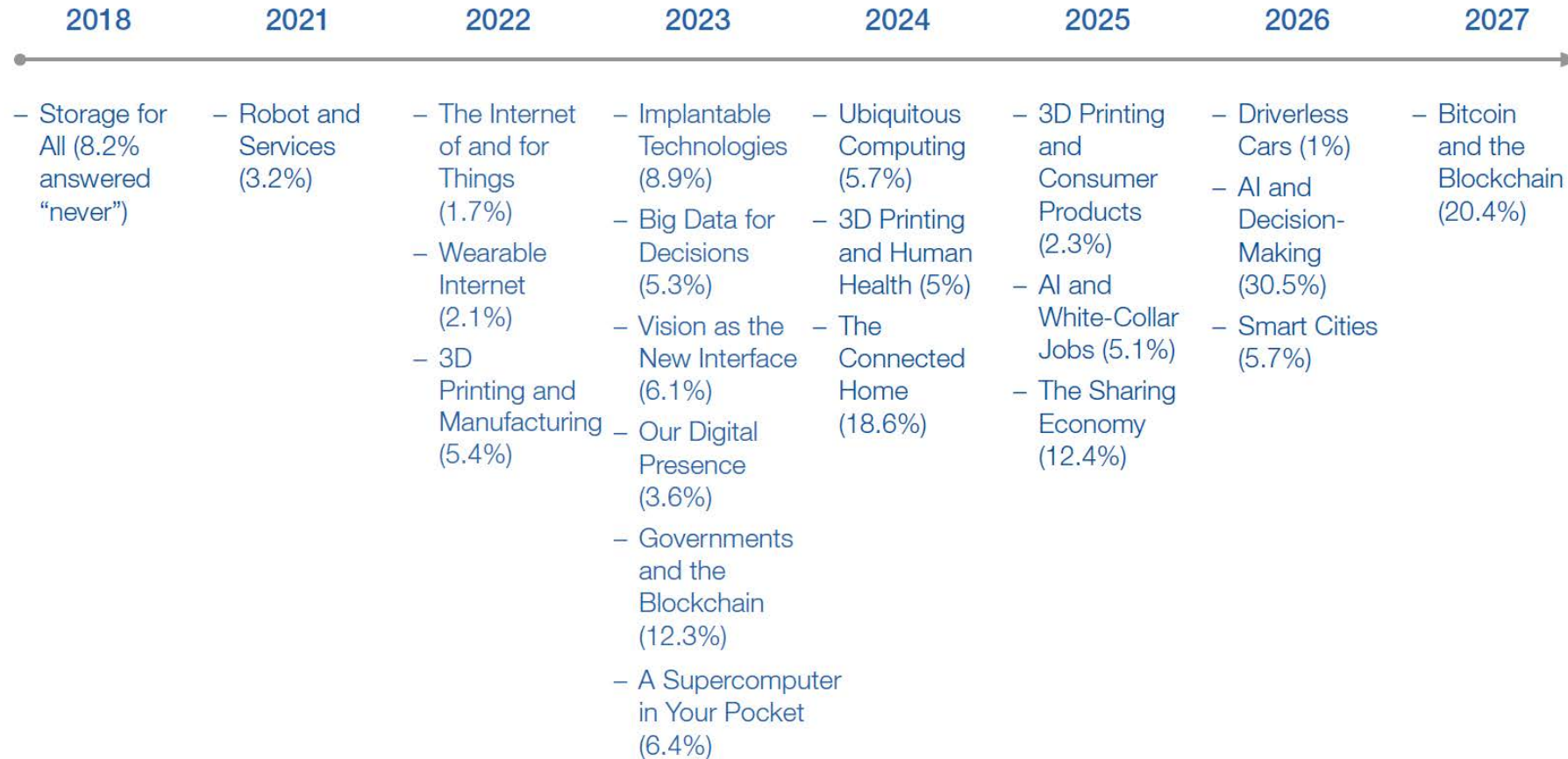
Global Job markets affected by Frontier Technology

- Mobile internet and cloud technology are already impacting the way we work
- Those working in sales and manufacturing will need new skills, such as technological literacy
- Global media and entertainment has already seen a great deal of change in the past five years
- Financial services and investment sector has yet to be radically transformed
- AI, 3D printing and advanced materials are still in their early stages of use, but the pace of change will be fast
- Change won't wait for us: As educators we need to be proactive in up-skilling people so everyone can benefit from the 4th IR

WEF GAC15 Technological Tipping Points

- A survey done by the *World Economic Forum's Global Agenda Council* on the ***Future of Software and Society in 2015*** defined a set of tipping points at which technologies of the 4IR will become widespread enough to create massive societal change and would require shifts in employment and education
- A survey of 800 high-tech experts and executives determined a series of dates by which tipping points would be reached
 - ✓ implantable cell phones by 2025
 - ✓ 80% of people with a digital presence by 2023,
 - ✓ 10% of reading glasses connected to the internet by 2023
 - ✓ 10% of people wearing internet-connected clothes by 2022
 - ✓ 90% of the world population with access to the internet by 2024
 - ✓ 90% of the population using smartphones by 2023
 - ✓ 1 trillion sensors connected to the internet by 2022
 - ✓ over 50% of internet traffic directed to homes and appliances by 2024
 - ✓ Driverless cars comprising 10% of all cars in the United States by 2026.

WEF GAC15 Technological Tipping Points



Source: WEF GAC15 Technological Tipping Points report 2015

Impacts of the 4th IR on Education

- Higher education should respond to the need for “preparing **Balanced Global Citizens** with a heart for **Servant Leadership** in an increasingly **secular, internationalized, technology driven fast changing world?**”
- A disparity exists in the skills required for the old and new jobs – can’t turn an assembly-plant worker into a data scientist overnight, if at all
- How should we tailor education now to enable youth to capture economic opportunities and drive sustainable development?

Rippling effect of First Two IR on Education

- The first 2 shaped University graduate education as we know it or at least as my generation has experienced it
- One of the most important rippling effect of the first 2 IR is in the amount of funding that was invested in research and mostly in STEM programs that groomed the 3rd and 4th IR
- NSF, created in 1950, shifted the incentive structures and curriculum within US higher education for decades to come
- In the US only, higher education counted 3600 US universities and colleges, enrolling more than 19 million students annually with 3 million degrees granted, and an employment of more than 3.6 million people including 2.6 million faculty in 2014
- The higher education system accounting more than \$380 billion of economic activity in the US in 2014 is an industry in itself

The education industry itself is perhaps in need of an “Industrial Revolution” – A Higher Education – HE 4.0

Rippling effect of the 3rd IR on Education

- One of the largest ripples from the 3rd IR is the move toward online education with Massive Online Open Courses in 2012 “Year of the **MOOC**”
- MOOC are expected to completely displace traditional in-person higher education and expand access to university education to millions of previously unserved students across the world
- MOOC among other movements will revolutionize the way we deliver education and Higher Education (HE)

Educational Responses to the 4th IR

New modalities of Instruction - Hybrid Environments

- Any educational plan for the 4IR must be built upon the results of the 3rd IR by leveraging on-line courses to strengthen residential education
- Current modalities integrate high quality **in-person learning** environments with **online technologies** to give more flexibility and modularity of courses
- Examples of blended environments are courses offered online with lab and project components delivered in-person
- MIT , Stanford, Harvard and many others are moving towards offering courses in Hybrid modes for residential students

Educational Responses to the 4th IR

New sequencing of Education – “Stackable credentials” (1)

- Online education companies like Coursera and EdX are partnering with larger universities to create newer and more interactive formats for their online courses
- As a result, dozens of new “Stackable Micro-Credentials” (SMC) are being developed
- SMCs link **multiple online courses with in-person consultations with faculty** and **opportunities for students to conduct significant original industry-related capstone projects**

Educational Responses to the 4th IR

New sequencing of Education –“ Stackable credentials” (2)

- SMCs could be the way to go in the future about building expertise and credential if employers are involved in defining the SMCs
 - ✓ They allow students to progress in their career with plenty of entry and exit points that result in credentials along the way with **labor market value**
 - ✓ They give flexibility of **tailoring credentials and expertise** in a dynamically changing job market
 - ✓ They cater to teaching and learning needs for an unknown future

Educational Responses to the 4th IR

Shift to Focus on High impact Pedagogies

- Free and immediate access to information shifted focus to new **learning pedagogies**
- New learning pedagogies are needed to adapt to the way new learners learn and to leverage the digital advances from the 3rd IR
 - ✓ Active learning
 - ✓ Adaptive learning
 - ✓ Just-in-time learning
 - ✓ Just-in-time teaching
 - ✓ Project-based learning

How to Develop the Needed Skill Set

Shift to Focus on High impact Pedagogies– Active Learning

- Active learning is a student centered approach in which the responsibility for learning is placed upon the student, working in collaboration with classmates and where teachers are facilitators only
- The goal of such pedagogies is to develop **higher order thinking skills** (e.g., analysis, synthesis, evaluation, critical thinking) in addition to content knowledge
- Active learning also places a premium on **collaboration** within **diverse teams in a project-based** and **peer learning environment** which are highly needed competencies to succeed in future job markets
- Shift focus from information delivery which is at the fingertips of learners to **deep learning** where students **retain, apply, and transfer what they learn**

Other High impact pedagogies

Collaborative and Project-Based Learning

- A relatively recent movement is the **flipped or inverted classroom** in which most of the content delivery happens outside of class—via readings, video lectures, simulations, and other instructional material—and class time focuses on applying and understanding the material
- **Project-based learning** is a project-centered approach where students are exposed to a real-life problem that calls on multi-disciplinary expertise to tackle and solve. Students of different backgrounds have to collaborate to solve the problem
- These approaches enhance **CREATIVITY, project and people management skills, communication skills, creative thinking, collaboration skills** and others that are needed to succeed in the next 4th industrial revolution

Educational Responses to the 4th IR

Re-Shaping Curricula in STEM

- Substantial changes to the science and technology curriculum is needed to develop capacity in the rapidly emerging areas of FTs such as

- ✓ Renewable energies
 - ✓ Science behind climate change
 - ✓ e-mobility and sustainable transportation
-
- ✓ Big Data science
 - ✓ Artificial intelligence
 - ✓ Robotics
 - ✓ Nanomaterials
 - ✓ Genomics

- New **interdisciplinary programs and interdisciplinary courses** are needed

Educational Responses to the 4th IR

Re-Shaping Curricula – New Interdisciplinary Programs

- **Bioengineering** is a major that trains students at the **interface of life sciences and engineering** and merges expertise and resources in the departments of medicine, biology and engineering.
- **Green chemistry** is another degree program at Stanford which blends **chemistry, biology and environmental science** to allow students to engage on real environmental problems such as synthetic fuels, bioplastics and toxicology, and to train students in techniques to reduce pollution
- Other interdisciplinary programs like mechatronics, systems engineering ...

Educational Responses to the 4th IR

Re-Shaping Curricula – New Interdisciplinary Courses

- Some examples of interdisciplinary courses at Stanford
 - ✓ A course in “**Problem Solving in Biology**” has students design experiments to develop cures to real-world pathogens such as Lyme disease and HIV, using authentic data from scientific literature
 - ✓ Another course in “**engineering biology**” that allows students to design their own life forms on computers and bioprint them to solve practical problems in medicine, public health and environmental management

Educational Responses to the 4th IR

Re-Shaping Curricula – Emphasis on Creativity

- A survey done by the World Economic Forum's Global Agenda Council on the Future of Software and Society (2015) showed
 - ✓ **CREATIVITY** and ability to innovate topped the list of skills workers need nowadays and will need in the future as machines, using masses of data, begab to make our decisions for us
 - ✓ workers need to be more creative in order to benefit from fast changes in new products, new technologies and new ways of working
 - ✓ Robots may help us get to where we want to be faster, but they can't be as creative as humans (yet?!)
 - ✓ Academic curricula should develop habits of mind and capacity for creativity within workers at all levels

Educational Responses to the 4th IR

Re-Shaping Curricula – Emphasis on Developing Technology Competencies

- **Technological literacy** is the ability to **use, manage, understand, and assess technology**
- The International Society for Technology in Education established the National Educational Technology Standards for Students (NETS-S) encompassing a full range of **technology competencies** that include
 - ✓ creativity and innovations
 - ✓ research and information fluency
 - ✓ critical thinking, problem solving, and decision-making
 - ✓ digital citizenship
 - ✓ technology operations and concepts
 - ✓ cognitive flexibility – self directed learning and thinking
 - ✓ knowledge production and management
 - ✓ communication and collaboration

Educational Responses to the 4th IR

Emphasis on Ethical Thinking

- The shelf life of any skill in the present-day environment has become very short, requiring future workers to continuously update their skills and teach themselves about new technologies and new industries that may not have existed while they were being trained for their initial degrees
- Education should put a premium on developing skills like **adaptability** and **self-directed learning** and **thinking**
- Education within 4IR should also include a strong overlay of **ethical thinking** and **intercultural awareness** to enable for thoughtful and informed application of the exponentially developing technologies

Educational Responses to the 4th IR

Emphasis on Digital Literacy and Citizenship

- Digital literacy and citizenship will be needed to **succeed** and **act ethically, responsibly, and productively** in **any work environment**
- Needed skills:
 - ✓ Coding
 - ✓ Collaboration in the online environment
 - ✓ Cloud Software for document management and computing
 - ✓ Personal Archiving for knowledge transfer
 - ✓ Information Literacy for Evaluation
 - ✓ Social Media Savvy

Educational Responses to the 4th IR

Emphasis on Interpersonal and Intercultural Skills

- Integration of 4IR technologies requires a simultaneous treatment of rapidly changing technical details and building capacity for **teamwork** and **collaboration** within students
- Employers and industries are projecting that **social skills** that include **persuasion, emotional intelligence** and **capacity for teaching others** will be at a premium
- **Entrepreneurship** and **people skills** are sought after by many large tech companies to help them develop new products and new marketing
- Interpersonal skills with deep **intercultural understanding** and an abiding respect for freedom and human rights will be a hallmark of the future 4IR workplace

Educational Responses to the 4th IR

Summary of Non-technical Skills

- Entrepreneurship
- People management and people skills
- Collaboration and teamwork
- Social skills including persuasion, negotiation, and emotional intelligence
- Adaptability
- Judgement
- Capacity to teach others

Concluding Remarks

Educational responses to the 4IR include but are not limited to:

- New modalities of instruction to leverage the proliferation of MOOC and strengthen residential education through hybrid online and in-person instruction
- Adoption and development of high impact pedagogies (active learning and project-based learning)
- Develop capacity in emerging technologies by creating and offering new interdisciplinary programs
- Allow new sequencing of education through the development of Stackable Micro-Credentials
- Reshape curricula to embed
 - Technological competencies
 - Digital literacy and citizenship
 - Ethical thinking
 - Interpersonal and intercultural skills