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**CENTER FOR  
CURRICULUM  
REDESIGN**

# **Hype vs. Reality:**

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**A Roundtable Discussion on the  
Impact of Technology and Artificial  
Intelligence on Employment**

**October 21, 2014**

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## Introduction

There is nothing new about technology causing the elimination of some jobs; it has been happening since the dawn of civilization.

In the past, new technology has eventually contributed to creating jobs -- jobs requiring higher levels of skill, education and training. Up until now, machines have been most effective at performing repetitive and mechanical tasks – jobs that are “dirty, dull and dangerous.” Those jobs requiring human judgment, knowledge or interaction were considered to be largely immune to either mechanization or computerization.

Recent advancements in computer data analytics and robotic technologies, however, have led some to speculate that this time could be different; that occupations involving cognitive, creative and socially interactive skills could also now be at risk.

These concerns have received a great deal of attention in the media lately, in part, as a result of a September, 2013 Oxford University paper titled *The Future of Employment: How Susceptible are Jobs to Computerisation?*, by Carl Benedikt Frey and Michael A. Osborne.<sup>1</sup> Frey and Osborne examine 702 occupations and predicted, which were most, least, and somewhat at risk of being taken over by computers or computer-driven robots within the next two decades.

“According to our estimate,” Frey and Osborne write in their report, “47 percent of total U.S. employment is in the high risk category,” including such occupations as taxi drivers, fast-food counter clerks, paralegals, tax preparers and insurance underwriters, among many others.

The 47 percent estimate and the large number of professional and semi-professional jobs on the list have prompted headlines in the media like “How to Keep Your Job When Your Boss Is a Robot” (*Bloomberg*, March 18, 2014) and “The Future of Jobs: The Onrushing Wave” (the *Economist*, January 18, 2014). The cover of the *Economist* featuring the article showed tornados ripping into a white-collar office workspace.

Fueling this anxiety, some media pundits claim that education is no longer the sure fix it has historically been to the elimination of jobs by technology – that computers and other machines are on the cusp of becoming so powerful and capable they will completely replace humans in the workplace.

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<sup>1</sup> Carl Frey: Oxford Martin School, Programme on the Impacts of Future Technology, University of Oxford, Oxford, OX1 1PT, United Kingdom, [carl.frey@philosophy.ox.ac.uk](mailto:carl.frey@philosophy.ox.ac.uk). And Michael Osborne: Department of Engineering Science, University of Oxford, Oxford, OX1 3PJ, United Kingdom, [mosb@robots.ox.ac.uk](mailto:mosb@robots.ox.ac.uk).

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At the Center for Curriculum Design (CCR), we believe concerns about technology replacing human workers are serious, but over-stated. Technology and education have been in a race for centuries; it always takes a while for education to catch up. If technology is pulling further ahead of education today, it is because our *system* of education is not remaking itself fast enough.

Education remains the key to employment success in this century, just as it has in the past.

Even the most enthusiastic futurists admit there are obstacles -- what the Oxford paper calls “bottlenecks” – structural impediments to how far and how fast A.I, “Big Data” analytics, and robotic technologies can advance enough to actually replace humans.

We do not want to add to the hyperbolic tone this subject is garnering in the media, but we do want to promote a serious discussion that we hope will encourage a long-term positive effect on education and career training policy. As the January *Economist* article correctly points out, “Adaption to past waves of progress rested on political and policy responses.”

That is one reason why we – with the generous support of the McGraw-Hill Financial Global Institute, the U.S. Council for International Business (USCIB) and the Hewlett Foundation – recently held our third colloquium on the topic of technology and employment last March: “Hype vs. Reality: A.I./Robotics and the Impact on Employability.”

The colloquium gathered together several leading economists and technology experts from both academia and business, as well as academics in psychology and sociology, to attempt a more comprehensive, less heated, and more reasoned discussion on the potential impact of technology on employment and education in the near future.

(A full list of participants appears at the end of this report.)

### **Our Consensus, In Brief**

CCR agrees with the Oxford report that technology will continue to advance, that new discoveries will accelerate the pace of innovation, and that those jobs that can be done faster and cheaper by machines will be – including, perhaps, some facets of innovative, creative activities.

But CCR also believes it is just as likely that truly creative intelligence tasks, social intelligence tasks, and those mechanical tasks involving sophisticated perception and manipulation will still require – at the very least – human oversight, if not substantial human involvement. In other words, just as it has in the past, technology will eliminate some jobs for human beings while creating the conditions for the emergence of others.

Taking advantage of these new jobs will require a very different kind of educational system than the one currently in place. We will need to replace the old education standards still in general use with an educational framework that combines the acquisition of traditional knowledge with the 21<sup>st</sup> century

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skills<sup>2</sup> of creativity, critical thinking, communication, and collaboration. We will need to teach both skills and character, in addition to knowledge, with a focus on “metacognition,” which includes “learning how to learn.” Precisely because we cannot predict what technologies will be ascendant in the future, we have to teach ourselves and our children to be versatile.

### **A Brief History of Technology and Jobs**

In 1412, the city council of Cologne prohibited the manufacture of a spinning wheel for fear it would put hand spindle craftsmen out of work. These fears were not groundless; one worker at a spinning wheel could produce the same amount of yarn in the time it took 200 workers using hand spindles.

In the 19<sup>th</sup> century, the advent of steam power, assembly line manufacturing, and the factory system that developed combined to replace single artisans with droves of assembly line workers. In effect, it was a movement towards “de-skilling,” opening up employment to many more less-skilled workers. When electricity replaced steam in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, it led to a demand for more skilled workers to operate and service the electrified machines on the assembly line.

From the 1920s onward, it was “The Race Between Education and Technology,” the title of a book by Harvard economists Lawrence Katz and Claudia Goldin. Until recently, it was a race where education managed to more or less keep pace.

As noted above, some experts believe the next few decades could be different – that even service jobs and – to a lesser extent – occupations requiring cognitive skills could be vulnerable to computerization, but many computer scientists, economists and others disagree.

According to a June 12, 2013, MIT Technology Review article, “Many of the traditional problems in robotics—such as how to teach a machine to recognize an object as, say, a chair—remain largely intractable and are especially difficult to solve when the robots are free to move about a relatively unstructured environment like a factory or office.”

The article quoted John Leonard, a professor of engineering at MIT and a member the school’s Computer Science and Artificial Intelligence Laboratory (CSAIL), who noted that many difficulties to having complete artificial intelligence remain.

And in a response that appeared in Slate soon after the Oxford report was released (“Researchers claim many jobs at risk for automation, here is what they missed,” 9/27/2013), author Miles Brundbage took issue with Frey and Osborne’s claim that artificial intelligence technology is on the verge of being able to replace humans.

Still, Brundbage acknowledged that Frey and Osborne are “pointing toward a quite urgent and important issue: how we can best structure our education system and ensure ready access to retraining services so that everyone has a fair shot at thriving in the labor market of the future.”

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<sup>2</sup> “21<sup>st</sup> Century Skills” by Bernie Trilling and Charles Fadel (Wiley 2009)

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John McDermott of the Financial Times (“Is your job safe in the second machine age?” 2/10/13) also made the point that education is key and emphasized the importance of social and creative intelligence skills.

The Economist article also said that education that embodies critical thinking is vital to meeting the employment challenge of technology, noting that high school was implemented to educate workers in the wake of the industrial revolution, and that now “those schools themselves need to be changed, to foster the creativity that humans will need to set them apart from computers. There should be less rote-learning and more critical thinking.”

### **What CCR Panelists Believe**

After an introductory presentation by moderator Charles Fadel, founder of CCR, who discussed the global and societal context behind the issues involved, each of the colloquium’s 10 panelists made a short presentation expressing their take on how new technology is likely to affect employability in the near future.

**Henrik I. Christensen**, a robotics expert from the Georgia Institute of Technology, noted that in the past, technology involved highly structured jobs with limited personal contact. These were jobs that were “dirty, dull and dangerous,” and where the cost/benefit ratio made sense. Now, he said, the decision to automate will be made based almost exclusively on the underlying economic factors. Unskilled labor is rare and will become even rarer, said Christensen, who believes being skilled will become the new norm with life-long learning a necessity.

**Ernest Davis**, a computer scientist at New York University, expressed two primary opinions. The first was that there will be no significant impact on employability from artificial intelligence or automation for 25 years. The second was that all of the current trends must be taken into account when discussing the future of the job market: globalization, shifting demographics, and weather – not just technology.

**Michael J. Handel**, a professor of sociology from Northeastern University, noted that “hype always focuses on the most novel trends.” He said there is an overestimation of the rate of future change in technology and that general trends are steady. Like Davis, he said there are other factors beyond technology that affect job and wage dynamics and that this makes predicting difficult. “There are more cashiers now,” he noted, despite the fact that automatic check-out is common for reasons unknown.

**Frank Levy**, a current MIT urban studies and former economics professor, said that machines and computers make errors, just as humans do, and that there is a cost involved when different tasks are done incorrectly. The relative risk of errors in different professions will have a strong impact on which jobs are taken over by technology. “Automatic check-out at Home Depot? An error is no big deal and does not incur a huge cost,” Levy said. “But if an automatic, self-driving vehicle makes an error? Big cost.”

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**Gary Marcus**, a professor of psychology at New York University asked the question: What would it take to build machines that have the flexibility of humans? His answer: “A lot.” So, should we be worried? “Yes,” he said, but not for at least 20 years.

**Luke Muehlhauser**, executive director of the Machine Intelligence Research Institute, said the exponential growth of computing power based on Moore’s Law – that computer processing power doubles every 18 months – no longer applies. “Moore’s Law hit a ceiling at the beginning of the millennium,” Muehlhauser said. So what is exponential and what isn’t now? The most important exponential trend at the moment, he said, is computations per dollar. “And that trend is fragile, not guaranteed.”

**Susan Puglia**, of IBM’s Academy of Technology, discussed IBM’s big data computer and Jeopardy winner, Watson, and talked about the vital importance of the neurosynaptic chips developed under IBM’s SyNAPSE program. These chips can make computers more intuitive and better at analyzing massive data sets. Humans will still be needed to interpret computer-driven analysis, Puglia believes, but more skills will be needed by workers to take advantage of this technology.

**John M. Smart**, technology consultant, educator and president of the Acceleration Studies Foundation, spoke about the social, economic and political impacts new technology is sure to have over the next five to 15 years, but said, “We won’t get to advanced AI without: massively parallel computational devices communicating seamlessly with the Internet of things, and a better understanding of the human brain and its evolutionary development.”

## **Consensus**

At the end of the day, the panel found six primary predictions and opinions with which they could all agree:

- Routine tasks will remain the most automatable, for the foreseeable future, but some facets of innovative and creative activities might become automatable;
- The full-fledged adoption of technologies generally takes much longer than initially anticipated, yet often strikes deeper over time than first assumed;
- Robust occupations will be those that are full of challenges, with new discoveries to be made, new performances to be obtained, new things to be learned and shared with others;
- Occupations that will see an increase in demand are so-called T-shaped (requiring both depth and breadth) with deep expertise and complex communications skills;
- Further progress on predictability would require a deep, sector-by-sector analysis and cannot be achieved by a top-down review; and
- The ultimate challenge in predictability is due to parameters being numerous and variable, with wide “error bars” that interact temporarily with each other.

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## **Revolutionizing Education**

One of the factors inherent in predicting how new technology will affect society is that predictions are made based on experience, which is always from the past. As a result, people tend to think, at first, that new technology will just help them do what they've always done – only better. But in fact, new technology often changes the landscape so thoroughly, over time, that it also changes fundamentally what we do, not just how we do it.

Technology and education are still in a race, and technology is winning. That's no surprise; technology is always in the lead in this race, but it should not be allowed to get so far ahead it disappears over the horizon.

Just as the world of the 21st century bears little resemblance to that of the 19<sup>th</sup> century, today's education curriculum must undergo a major redesign to be relevant to the century in which we currently live and take into account all the dimensions of knowledge, skills, character, and metacognition.

Advances in robotics, big data analytics and artificial intelligence do not in the least diminish the importance of education, but they do increase, dramatically, the need to create and implement an innovative global curriculum adapted to the needs of the 21<sup>st</sup> century.

### **Alphabetical List of Participants and Their Affiliations:**

- Henrik Christensen – Georgia Institute of Technology
- Ernest Davis - New York University
- Charles Fadel - Center for Curriculum Redesign (moderator, sponsor)
- Michael Handel - Northeastern University
- Gary Marcus - New York University
- Frank Levy - Massachusetts Institute of Technology
- Luke Muehlhauser - Machine Intelligence Research Institute
- Susan Puglia - IBM
- Juergen Schmidhuber - The Swiss AI Lab IDSIA (USI & SUPSI)
- John Smart - Acceleration Studies Foundation
- Lynn Andrea Stein - Olin College

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## About the Author

**Charles Fadel** is a global education thought leader, expert and inventor; founder and chairman of the [Center for Curriculum Redesign](#); visiting scholar at Harvard GSE; Chair of the education committee at BIAC/OECD; co-author of best-selling book “[21<sup>st</sup> Century Skills](#)”; founder and president of the [Fondation Helvetica Educatio](#) (Geneva, Switzerland); senior fellow, human capital at The Conference Board; senior fellow at P21.org. He has worked with education systems and institutions in more than thirty countries. He was formerly Global Education Lead at Cisco Systems, visiting scholar at MIT ESG and UPenn CLO, and angel investor with Beacon Angels. He holds a BSEE, an MBA, and five patents.

Full Bio at: <http://curriculumredesign.org/about/team/#charles>

