

The Digital Transformation of Industries

by Madeline Patton

Presentation for the NSF ATE, Preparing Technicians for the Future of Work

December 12, 2018

Mehran Gul, Lead for Digital Transformation Initiative

World Economic Forum, Geneva, Switzerland

At the inaugural meeting of the Preparing Technicians for the Future of Work project, Ann-Claire Anderson, principal investigator of the Advanced Technological Education initiative funded by the National Science Foundation, noted that “technicians are at the center of technological disruption,” but have so far not been the focus of the many scientists and consultancies looking at workplace changes.

To provide a global context for the ATE Leadership Caucus and the project’s 10-member industry advisory board, Mehran Gul, lead of the Digital Transformation Initiative at the World Economic Forum in Switzerland, gave a 30-minute presentation about the digital transformation of industries on December 12 in Alexandria, VA. He also answered questions from the audience for 30 minutes afterward.

Historic Predictions vs. Reality

Gul began by sharing headlines from the past 100 years that predicted dire job impacts from machines. Given that those predictions did not match the realities that unfolded, he is skeptical about current predictions of automation eliminating jobs. Instead he expects “augmentation of human capabilities rather than substitution.” Referring to data on total employment growth since 1939 as evidence of “unequivocally upward progress,” he said the number of people employed and productivity have increased with the introduction of more sophisticated machinery in workplaces.

Sharing a new twist on the necessity being the mother of innovation adage, Gul said, “Invention is the mother of necessity. The more that we develop technologically, the more that creates needs that create more jobs that create more needs that create more jobs.”

He observed that it’s easy to think about jobs that will be eliminated but difficult to think about what new jobs will be created by new technologies. It’s harder still to predict where the jobs will be. Historic data, however, indicate there will be more jobs from technological innovations.

“If you look at the past half century or so jobs have not become obsolete as a result of technology. And if you really think about it, the entire point of technological progress is to eliminate jobs that we find uncomfortable or undesirable for most people, and to really elevate humanity to do things that we actually like to do,” he said.

The “reallocation” of people to different parts of the economy in response to technological changes can be quite positive. For instance, he noted, in 1900 48% of the U.S. population worked in agriculture. Now just 2% of the U.S. population works in agriculture but produces more food than in 1900.

As an example of the unpredictable nature of automation’s impact, he reminded the audience that ATMs were expected to replace bank tellers when they were introduced in the 1980s. The cash dispensing machines did drive down operating costs, and contributed to banks’ expansion in more places. Fewer tellers staff each location, but there are thousands more tellers than before; their jobs

involve forging relationships with customers and doing less routine tasks. Rather than the workforce shrinking, “people got redeployed in jobs they actually wanted to do,” he said.

Gul’s Analysis of Data

While the overall number of jobs has grown, Gul’s presentation slides of data illustrated the polarization in the labor force at low and high incomes. The middle income segment has been “hollowed out” during the past 70 years.

Computer advances mean that routine jobs can be automated and fit into algorithms. But jobs that require manual dexterity, creativity, strategizing, and abstract thinking have not. So far the jobs of plumbers, hairdressers, and cooks have continued while the jobs of payroll clerks and law clerks have not. And while machines carry out routine tasks very quickly, they are not yet capable of non-routine tasks that require interpersonal interactions, adaptability, and common sense. For example robots currently install windshields on new cars in controlled factory environments, but it still takes a human to replace a broken windshield out in the world. So far computers are not as good as humans at operating in changing environments and doing unpredictable tasks like cleaning up shards of glass around the frame for it seal properly.

The reality that humans know more than they can describe and program into a computer, which is known as Polanyi’s Paradox, is a big issue in artificial intelligence. If scientists can overcome this paradox, and figure out how to teach computers tacit knowledge, Gul predicts a wider swath of jobs will be automated.

In the next 10 to 15 years he expects that impact of automation will be more evenly spread through the workforce and will affect the high- and low-wage workers more than middle-income workers who have been disproportionately affected so far.

Rather than eliminate jobs he anticipates that automation will bring more high-skilled tasks down to level of people who may not have high skills. He suggests that one way of dealing with this will be the use modular training of three or six months in duration to teach specific skills. One source he cited predicts that people will need an extra 101 days of learning by 2022.

“A foundation in literacy and numeracy is really what the education system ought to be focusing on,” he said. He suggested that educators focus on creativity, problem-solving, and judgment because tasks that require them will likely continue to be done by humans not machines.

O-Rings and Educators

“Tasks cannot be substituted by automation; they are generally complemented by it,” Gul said, pointing out that few current jobs do not involve computers in some way, but rarely do computers operate without human interaction.

He used the Challenger explosion, which was caused by the failure of a booster rocket O-ring that ossified in the cold temperatures the night before the launch in 1986, to illustrate that “any big system is only as strong as its weakest link.”

Conversely, he said, “improvements in the reliability of any given link, improve the value of improvements in every other. In the future, humans are going to be the O-ring of any job or of any

workplace,” he said, noting that society can’t afford for “the vital human link to be the weakest link in the system.”

Therefore, the introduction of technology in any workplace means that more attention must be paid to the training of humans who use it and will likely be more important in the future.

During the question and answer session, Gul said he did not think the investment in education technologies like MOOCs had yielded valuable results. “The teacher is still the O-ring, right? A great MOOC in the hands of a bad teacher is still a bad MOOC. So we need to solve the teacher problem, which is a 20th century problem not a 21st century problem.”

He likened the challenge of educating the future technical workforce to the dilemma encountered by a physician who created an elegant microbiome as a dietary intervention. The problem is that it does not work as anticipated because it depends on people sticking with it every day.

“Education has the same problem, it’s not about the right curriculum, it’s not about the right MOOC, it’s who is there to make sure you are there [and] stick with it every single day—and that is the teacher’s job.”

Sparking a Love of Learning

In a brief interview after his speech, Gul expanded on what U.S. educators should do to prepare people to use emerging technologies now and respond to workplace changes in the future.

“The job of a teacher is to make the student want to learn rather than make them learn that specific thing,” he said, describing the creation of the desire to learn like a toy that once wound up “goes by itself.”

He asked rhetorically, “How do you make teachers more like coaches that spark that desire and that love of learning?”

One issue he identified is the insertion of metrics to determine how well an individual is performing, but the emphasis on measurements obscuring “the bigger picture.”

“That might be what happening in U.S. system now. We focus too much on what’s being measured but not enough on why we are measuring it and what is the bigger goal. The job of the teacher is really to spark the love of learning rather than to make you learn one specific thing.”

For those thinking about the Future of Work, Mehran Gul recommends reading

- *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies* by Erik Brynjolfsson and Andrew McAfee; and
- *What Technology Wants* by Kevin Kelly.