The promises and perils of the Fourth Industrial Revolution.

More than five decades ago, American singer-songwriter Bob Dylan wrote *The Times They Are A-Changin’*, a poignant, if somewhat melancholic anthem that is eerily prophetic about the state of the world today. With lines like ‘admit that the waters around you have grown’ and ‘your old road is rapidly ageing’, Dylan alludes to transition—revolution even—and suggests that those who resist change do so in vain. Indeed, the pace of change is more rapid now than ever before, much of it driven by technology. Artificial Intelligence (AI) is weaving itself into business processes and consumer devices, the Internet of Things (IoT) is helping to track and trace everything from logistics to personal health, and advances in additive manufacturing or 3D printing are modifying the way goods are being created.

With these innovations and more, humankind is now experiencing what is being called the Fourth Industrial Revolution, or Industry 4.0.
Unlike the industrial revolutions of the past which enabled mechanisation, mass production and mass communication, Industry 4.0 is altering not only what we do and how we do things, but also forcing us to confront questions about the nature of work and what it means to be human.

“The convergence of the physical, digital and biological worlds is occurring at an unprecedented pace, leaving great societal change in its wake and bringing forth new challenges as well as opportunities,” said NTU President Professor Subra Suresh at the inaugural Singapore panel session at the World Economic Forum in Davos, Switzerland, themed ‘Globalisation 4.0: Technology & Innovation for Humanity’. "Innovation, technology, skills and economic development will be critical to the advancement of Industry 4.0,” Prof Suresh said.

“Take China as an example. It manufactures 70 percent of all personal computers and 90 percent of all cell phones but is 75 percent less productive than similar manufacturing environments in the West,” said Professor Guido Gianasso, Professor (Practice) in Global Leadership and Associate Dean (Corporate Engagement and Relations) at NTU’s College of Business. By developing or adopting digital tools and advanced manufacturing methods, China could ramp up its mass production output and capture an even larger share of global markets, he said.

But more than just improve productivity, Industry 4.0 technologies also create opportunities for greater personalisation of products and services, explained Professor Louis Phee, Dean of NTU’s College of Engineering. In the past, most companies took a one-size-fits-all approach to designing and fabricating goods. Now, with technologies such as 3D printing, factories can churn out highly-customised goods in an efficient and economical manner, ultimately translating to more diverse choices and optimised outputs for consumers.

Importantly, a bespoke product no longer has to be designed and built in one place. Rather, companies can leverage cloud-based platforms on the internet to remotely coordinate their production processes across multiple geographies. So as much as Industry 4.0 technologies are a boon for the factory of the world (Asia), they help establish a global factory where factors of production can move freely before being assembled into a final form for the market.

But new jobs could be created in:

- Technology
- Healthcare
- Energy

Adapted from McKinsey Global Institute’s, ‘Jobs lost, jobs gained: Workforce transitions in a time of automation’ report, 2017

Facts and figures of Industry 4.0

50% of current work activities could be automated at existing levels of technology

Work activities most likely to be automated:

- Data collection
- Data processing
- Predictable physical labour

By 2030, 15% of work could be displaced by automation → 400 million jobs lost

3% of the workforce could need to change occupations → 75 million workers need to be retrained

How fast automation takes over depends on:

- Technical feasibility
- Cost of developing and deploying solutions
- Labour market dynamics
- Economic benefits
- Regulatory and social acceptance

But new jobs could be created in:

- Healthcare: 130 million
- Technology: 50 million
- Energy: 20 million

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“New jobs will be created, as has happened with previous Industrial Revolutions—we just don’t know what kind of jobs they are.”

~ Professor Guido Gianasso
24 hours a day to provide such services. This could change with robotic caregivers. Nonetheless, Prof Thalmann thinks that much more work needs to be done to take robots and AI out of factories and hospitals and into people’s homes. “What is complex is the relationship between humans and robots, because in professional settings, the service quality provided by robots has to be on par with that of humans,” she noted. Seeking to overcome this barrier, Prof Thalmann has built Nadine, a robot that recognises people, simulates emotions and can hold conversations in six different languages. Deployed in professional contexts, such as in the role of a receptionist, Nadine is revealing the shortcomings of human-robot relations and may eventually help intelligent machines better integrate with society.

Whither the new jobs?

Amidst the optimism surrounding Industry 4.0, many have raised concerns about the availability of jobs in a modern economy that values automation. A McKinsey report estimated that 50 percent of existing work activities can be automated, which means that layoffs are inevitable. Yet, new jobs will be created, as has happened with previous Industrial Revolutions—we just don’t know what kind of jobs they are, said Prof Gianasso. The question, then, is how do we prepare the workforce for the future?

Plugging gaps with automation

Going beyond manufacturing, Industry 4.0 technologies such as robotics and AI are also expected to have a profound influence on medicine. A mechanical engineer by training, Prof Phee builds surgical robots and can envision a future where the convergence of Big Data, machine learning and advanced robotics will allow doctors to provide more consistent, high-quality treatments to a larger number of patients. More crucially, Prof Phee highlighted that these technological developments will help society cope with a rapidly ageing population—a silver tsunami for which society is not adequately prepared for.

Professor Nadia Thalmann, Director of the Institute for Media Innovation at NTU, shares this view, adding that maintaining a good quality of life for seniors—especially those with physical disabilities or dementia—involves more than “just feeding and washing them”. Social interaction and mental stimulation are just as necessary in elder care, but it simply costs too much to have someone on standby all day.

“You need to know how robots and computers work, deeply enough that you don’t make judgements about these technologies based on hype.”

– Professor Nadia Thalmann
“My advice would be to go deep into one core area of competency, but then also have a superficial understanding of adjacent fields.”

– Professor Louis Phee

In Prof Thalmann’s opinion, a digital skillset is essential for thriving in the Fourth Industrial Revolution. “You may be an economist or a social scientist, but you need to know how robots and computers work, deeply enough that you don’t make judgements about these technologies based on hype,” she said. This is especially important if society wants leaders who can steer innovation in a positive direction. Today, technology is running ahead of regulations and policies, and surprisingly, it is the innovators who are nudging policy makers to draw up rules governing things like AI and autonomous vehicles, added Prof Phee.

Academia also has a role to play in helping society better understand emerging technologies and their implications, so the education system needs to produce individuals that are strong technically. Prof Thalmann thus suggested that “at least one-quarter to one-third of the courses in any curriculum should touch on computer science and data science”.

Softening the blow of disruption

On the other hand, universities should not neglect equipping their graduates with soft skills. Ironically, these come at a premium in an age of technology, precisely because they cannot be easily replicated by automation. “While having a digital skillset is important, we must also train our graduates to operate across geographical and cultural boundaries, to be able to build relationships and work in a team, and to be agile in their learning,” said Prof Gianasso.

Prof Gianasso said, emphasising that the ability to cope with rapidly changing scenarios, paradoxes and conflicting agendas will grant job seekers a competitive edge in the global workforce.

The private sector can also help workers stay relevant in Industry 4.0, Prof Gianasso added. “The most important change is in the mindset of the senior management teams. They need to understand that the money that goes into training is a high return investment,” he said.

But at the end of the day, the onus is on the individual to never stop learning. Those who are content with the knowledge and skills they already have run the risk of becoming obsolete as new technologies emerge, said Prof Phee.

“We all have to be like the Transformers and change with the times. My advice would be to go deep into one area of competency, but then also have a superficial understanding of adjacent fields,” he concluded.

“Previously, we would purchase products that are mass manufactured and standardised. In the future, we may be able to enjoy products that are customised for each of us.”

– Mr Hendri Zhang (EEE/2007)

“The internet has commoditised information, and success belongs to those who can react to information quickly and effectively. Embracing the tools provided by Industry 4.0 would therefore prevent one from falling behind.”

– Mr Rodrick Chia (EEE/1998)

“Many companies pursue data relentlessly in the hopes of winning the race in the marketplace. But it is the extent to which companies leverage data meaningfully that gives them a competitive edge over others. Today’s managers must equip themselves with data-intelligence transformation skills to compete effectively using actionable insights.”

– Dr Joan Gan Chui Goh (EEE/1990)

“Industry 4.0 brings exciting opportunities as it takes human potential to the next level by leveraging data, smart analytics and digital automation. But with greater digital interconnectivity, we also need to pay attention to areas like cybersecurity. Another aspect to think about is regulation, which would play a huge role in enabling newer ways of working while keeping societal interests in check.”

– Mr Abhimanyu Bhola (NBS/2005)