Article

Exponential Technology, Industry 4.0 and Future of Jobs in India

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Abstract

Advance in technology leads to economic growth, and in turn to creation of new jobs, while making some old jobs obsolete. However, the rise of exponential technologies such as mobile internet, internet of things, big data analytics, artificial intelligence, etc. is disrupting this cycle dramatically, affecting jobs that used brawn as well as brain. This article analyses the impact of this shift in the Indian context and suggests several policy measures for government, industry and also institutions to prepare for the future of jobs in India, so that we do not face the grim prospect of jobless Indian growth.

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Jobs Disappear, Work Does Not

Brian Arthur, in his thought provoking article 'where is technology taking the economy' mentions his recent experience (Arthur, 2013). He says,

> I visited a fintech (financial technology) company in China, which had developed a phone app for borrowing money on the fly while shopping. The app senses your voice and passes it to online algorithms for identity recognition; other

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> algorithms fan out and query your bank accounts, credit history, and social-media profile; further intelligent algorithms weigh all these and a suitable credit offer appears on your phone. All within seconds. This isn't quite the adoption of external intelligence; it is the combining of sense-making algorithms, data-lookup algorithms, and natural-language algorithms to fulfill a task once done by human.

'Once done by human' as Brian says. And now? It is done by machines. Why? Because what took humans several days, takes only seconds!

Technology-led Cycles of Job Creation and Destruction

The challenge of technology-led destruction and creation of jobs is the most debated topic today. Among many others, Mashelkar (2016) has written about the challenges of technology-led jobless growth. Automation destroys jobs but it increases productivity. This, in turn, leads to economic growth and creates new jobs.

New technology also creates new jobs. Technology obsoletes itself at an increasingly accelerated pace. Therefore, we need more people, who will create new technology. Further, people are required to maintain any new emerging technology, such as Internet of things (IoT) or advanced robotics or automation of knowledge work or three-dimensional printing. Further, people are also required to assist other people in using new technology. Finally, new technology requires new labour forms and sometimes, in plenty.

In a given category of a job, one technology can be a creator and another can be a destroyer. Uber has created the demand for drivers—who, with the aid of a smartphone and a smart app, can now serve greater number of customers than they might have when they were working for a conventional taxi service. On the other hand, autonomous vehicles will not only destroy the jobs for the drivers but also a range of other jobs in ancillary industries, such as in automotive finance market, parking industry and the automotive aftermarket.

Exponential Technologies

Exponential technologies are those whose performance improves by double or triple digit every year on the same cost basis. Currently, the

following technologies have been classified as the top 10 most disruptive exponential technologies:

1. Internet of things (IOT)
2. Artificial Intelligence (AI) (Machine Learning)
3. Robotics Process Automation (RPA)
4. Virtual/Augmented/Mixed Reality
5. Sensors
6. 3D Printing
7. 3D Visualisation
8. Mobile Internet and Cloud
9. Big Data Analytics/Open Data
10. Blockchain

In what way are they exponential? The best example of such 'exponential' behaviour is computing technology. During 1971–2011, computing technology followed Moore's Law, whereby for every dollar cost, the computing power doubled every 2 years, making computing very cheap leading to disruption of number of industries. However, now there are other exponential technologies too with their own laws, for example, data storage (Kryder's Law), digital imaging (Hendy's Law), Network Capacity (Butler's Law) and DNA sequencing (Carlson's Law).

Another exponential can be seen in sensors as Janusz Bryzek (2015) has shown. During the years 2007–2014, sensors underwent 1000× change. How? The cost, power consumption and physical size of sensors went down by 1000×, whereas the number of transistors per sensor increased by 1000×, just as the total number of sensors increased by 1000×.

This exponential also extends *P* exponential growth of organisations using exponential technologies (Bryzek, 2015). To reach $1 billion revenue, it took 4 years for Dropbox, 3 years for Uber and AirBnB and just 2 years for Instagram!

Rise of Exponential Technologies

For the need of space, we will not be able to give a full narrative of the impact of each of these 10 exponential technologies. We will illustrate by just taking one example. And that is of AI/Machine Learning, which is increasingly allowing automated processes to self-adjust, improve and offer data-driven accurate decision-making at extraordinary speeds.

With exponential growth in computing power, there is a superlative increase in AI. Thus, Google Translate is displacing translators, investment advice algorithms are displacing investment advisors and automated landing systems are replacing airplane piloting skills.

Advances in software are already giving computers the ability to draw conclusions from patterns they discern within huge data sets. Computers with machine-learning capabilities are no longer relying only on fixed algorithms and rules. They are modifying and adjusting their own algorithms based on analyses of data, enabling them to 'see' relationships or links that a human mind might overlook. Moreover, these machines are 'learning' more and getting smarter day by day.

Go, an ancient board game, has been always viewed as one of the greatest challenges for AI. In late March 2016, AlphaGo took on and defeated legendary Go player, Lee Sedol, who has won 18 world titles (Lee et al., 2016). What is really remarkable is that AlphaGo played many unprecedented and creative moves. Apparently, according to experts, AlphaGo's move 37 in Game 2 had a one in 10,000 chances being played by a human!

AlphaGo Zero is the latest incarnation of its Go-playing automation (Silver et al., 2017). One would think that it would be hard to top the AlphaGo version that vanquished the human world champion in Go. AlphaGo Zero, however, not only beats the previous system but does validates a revolutionary approach. To be more specific, AlphaGo Zero learnt to perform the task from scratch, without learning from previous human knowledge. World champion level Go playing expertise was acquired in just 3 days of training with considerably less training data.

Power of Convergence

When we get a convergence of several of these exponential technologies, dramatic transformations take place. The convergence of AI, robotic process automation (RPA), machine learning and cognitive platforms is potentially so disruptive that Klaus Schwab, founder of the World Economic Forum, calls it the 'Fourth Industrial Revolution' (Schwab, 2016). Let's explain.

The first industrial revolution was spurred by use of steam-powered machinery, the second replaced steam and water with electricity, and the third was the information technology revolution. Today however, we are at a tipping point—the beginning of a fourth Industrial revolution—Industry

4.0, as some may call, involves the confluence, at speed, of previously disparate technologies, as mentioned previously. This is going to lead to a big disruption in the job market around the world.

Future of Jobs

There have been several scholarly studies and reports on the future of jobs. Let's consider some of them.

Brynjolfsson and McAfee (2014) showed, in an interesting graph, separate lines representing productivity and total employment in the USA. For years after World War II, the two lines closely tracked each other, with increases in jobs corresponding to increases in productivity. These authors very interestingly showed that beginning in 2000, the lines diverged; productivity continued to rise robustly, but employment suddenly started dropping. By 2011, a significant gap appeared between the two lines, showing growth in economy but no growth in jobs! Brynjolfsson and McAfee call it the 'great decoupling'. And they felt that technology was behind both the healthy growth in productivity and the weak growth in jobs.

The 2016 follow-up report ('Technology At Work v2.0') by Martin school (Global Perspectives & Solutions, 2016) suggests that the technology impact on jobs will be far greater in the developing world than in the developed world. For instance, the report concludes that 69 per cent of jobs in India and 77 per cent jobs in China are at 'high risk' of automation as against 47 per cent jobs in the USA and 57 per cent jobs across the OECD. In the rest of the essay, we will examine the role of exponential technology in job distraction and job creation in India.

McKinsey Global Institute Report predicts that between now and 2025, up to two-thirds of the US$9 trillion knowledge worker marketplace may be affected (McKensie Global Institute, 2013).

The Bank of England estimates that robotic automation will eliminate 15 million jobs from the UK economy in the next 20 years (*The Guardian*, 2015).

Specific Jobs That Will Be Affected

These are predictions about the extent of loss of jobs, but the question is, which specific jobs will be most affected and how.

Bernard Marr, who is rated as one of the globally respected experts in digital transformation, has highlighted 10 professional jobs that are threatened by advances in exponential technologies (Marr, 2016).

Health Care

Surgeons already use automated robotic systems with less invasive procedures. IBM's Watson can diagnose lung cancer from analysing MRI scans far more reliably. The UCSF Medical Centre recently launched an automated, robotics-controlled pharmacy at two UCSF hospitals that automatically dispense prescriptions based on barcodes scanned by nurses. Johnson & Johnson has an FDA-approved device that can deliver low levels of anaesthesia automatically, thus making the job of anaesthesiologists obsolete. And several such examples are emerging.

Insurance

Much of what insurance brokers and insurance underwriters do today can be done by computers using big data and machine learning. Formulae have been used for decades to determine how much insurance a person is qualified for and at what rate, but new tools will automate the decision-making speeds to seconds.

Architects

Programmes already exist to help individuals design their own homes, making architectural skill and even design and colour choices more automated. For now, most people are using the software mostly as a visualisation tool but as the sophistication of the programmes improves, the need for human architects and designers diminishes.

Journalists

Much of what journalists do can now be automated using machine-learning tools such as narrative science that creates natural language news stories by analysing data. These programmes will be increasingly

used in financial and sports reporting, which rely heavily on data and numbers, but other fields are not far behind.

Financial Industry

Algorithms can now analyse financial data and prepare accounts (as well as do tax returns) without the need for accountants. Bank tellers have already been partially replaced by ATMs, but soon even high-level bankers, including loan officers, will be easily replaced by automated systems. Governments are now using big data and machine learning to check tax returns and identify potential fraud in tax matters. Computers are already being used to make stock trades faster than humans ever could and they are even used to predict how the market will react and make recommendations on whether you should buy or sell.

Teachers

The job of teachers will definitely change with digitisation. Studies have already shown that algorithms used to customise leaning to individual pupils based on their progress and understanding that can be more effective than a human teacher. Teacher's role will now move from an instructor to an orchestrator and a facilitator.

Human Resources

Human resources, headhunting and hiring is already being affected by data mining as algorithms take on the job of sorting through resumes to find the perfect candidates.

Marketing and Advertising

Marketing is human skills of persuasion and manipulation. But even that is being successfully outsourced to computers. Companies are also experimenting with automated ad buying: instead of having people choose which magazines to place ads in and on which pages, the computers will take care of it, using billions of data points for reference.

Lawyers and Paralegals

In the discovery phase of a lawsuit, lawyers and paralegals can be required to sift through thousands of documents. Now, sophisticated databases can use big data techniques including syntactic analysis and keyword recognition to accomplish the same tasks in much less time. Watson-style machine-learning system would be legally 'trained' to review precedent and case history and even draft legal briefs—which has traditionally been the job of lower level law firm associates. A statistical model created by researchers at Michigan State University and South Texas College of Law was able to predict the outcome of almost 71 per cent of US Supreme Court cases.

Law Enforcement

Predictive policing might at first sight appear as an infringement of civil liberties, but it brings huge benefits. In 2003, the same sorts of algorithms retailers like WalMart, which is used to predict demand for products, was used to predict demand for police presence in New York City on New Year's Eve, and the results were striking: 47 per cent fewer random gunfire incidents and a $15,000 savings in personnel costs during the 8-hour period. Better risk prediction could decrease the number of officers needed at any given time.

Predictions on Future of Jobs in India

Having focused on global trends, let's focus on India now.

Currently, half of India's population is under the age of 25 and two-third is younger than 35. It is estimated that by 2027, India will have the world's largest workforce of people in the 15–64 age group. At present, only 18 per cent of the country's workforce is formally skilled.

Skill development and employability remain as a key challenge especially with the advent of exponential technologies.

The question is how different sectors of the Indian economy be impacted by exponential technology—agriculture, services, manufacturing? Given relatively low levels of technology adoption, will some sectors have a longer gestation period? With demographic shifts and an ageing population across key markets, can India be the skill partner for the

world. What would be the key skills in demand and what are the reskilling imperatives? How will the skill set requirements for technology jobs change? How will supply pools adapt to changing demand?

> FICCI, NASSCOM and EY produced a comprehensive report *Future of Jobs in India—A 2022 Perspective* (FICCI, NASSCOM, & EY, 2017). This report highlights the impact that various primary forces such as globalization, demographics, and Industry 4.0/exponential technologies, are expected to have on the key sectors of the economy.

According to this report, the future of jobs in India in 2022 would be determined by the country's response to 12 megatrends, which includes increasing nationalism, rapid adoption of exponential technologies, increasing/shrinking overseas job market for Indian workforce and level of FDI flows. During adoption of exponential technologies by Indian companies, what will receive priority will be evolution of products/services into smart connected products and services, acceleration of the optimisation of industry value chains, business innovation, demand for a resourceful planet and sustainability and new work arrangements. Under demographic changes, rising size of the middle-class, high proportion of young population including millennials and increasing urbanisation will be important.

As businesses and governments seek to streamline processes and reduce operating costs, cognitive technologies will be rapidly creating a new class of digital labour. Many jobs will be reconfigured and redesigned, causing job dislocations and requiring employees to learn new skills.

Man versus Machine or Man with Machine?

Humans bring three dimensions to the job market: physical, cognitive and emotional. Machines have surpassed us in both the physical dimension (less and less manual work is necessary) and the cognitive dimension (AI is increasingly able to surpass humans in tasks such as chess and medical diagnosis). This leaves the emotional domain, where humans still have the upper hand. As more and more jobs are automated, the nature of the value that humans will add will evolve to focus around creativity, connectivity with others and self-fulfilment.

Computers are increasingly performing tasks that are typically considered as 'human'—such as complex analyses, subtle judgments and creative problem solving. We will be able to interact with a machine in

the way that one would with a co-worker. Instant access to information and substantial enhancement in the quality and pace of decision-making, and consequently, the performance, will be the benefit.

Jobs that require emotional and relational work, creativity, synthesising, problem-solving and intelligent interpretation will still continue to require human intervention, but the extent of this will be reducing.

India would continue to be a favourable manufacturing offshoring hub for some time but this may get affected by the increasing adoption of exponential technologies in the developed markets and new business process offshoring opportunities in North America/European markets are expected to drop significantly.

Indian Jobs Shifts

In the automotive sector, the jobs that will disappear over a period of time will be a welding technician, painting technician, press machine operator, inspection assistants and in-plant handlers. But new job functions will be created in this sector. There will be a need for automobile analytics engineer, 3D printing technician, machine learning–based vehicle cyber security expert and sustainability inspection expert.

India's automotive industry showcases usage of increased automation. While the plant-level automation at most OEMs remains at 30 per cent, its level in the body shop is beyond 95 per cent. Auto companies are increasingly deploying smart robots with AI capabilities that are able to adapt, communicate and interact with each other and with humans.

In the retail sector, the jobs that will be threatened will be cashier, inventory assistants, sales representatives and stock boy. The new job roles in this sector will be retail data analyst, digital imaging leader, IT process moulder, digital marketing specialist and customer experience leader. Further, there will be changing job roles in this retail sector. There will be, for instance, sales associate to fashion consultant, store assistant to product facilitator, warehouse coordinator to inventory management and logistics specialist, package sorter to package sorting machine operator.

In the banking, financial services and insurance sector, the threatened jobs will be data entry operator, teller, cashier, underwriter and data verification personnel. The new jobs roles will be cyber security specialist, credit analyst, robot programmer, block chain architect and process modular expert. One can give more examples from other sectors.

It is important to take note of the persuasive articulation of why India must embrace the new era of AI, block chain and robots that has been put together by Amitabh Kant (2018) recently, while discerning the future of jobs in India.

Technology-led Offshoring/Reshoring of Jobs

IT Services Sector

Economists Otto Kassi and Villi Lehdonvirta of the Oxford University (Kassi & Lehdonvirta, 2016) have created an Online Labour Index (OLI), which measures the utilisation of online labour across countries and occupations by tracking the number of projects and tasks posted on platforms in near real time. India is the leading country, with a 24 per cent share of the online labour market.

India is emerging as the third largest online labour market. OLI survey 2016 shows that India-based employers represented 5.9 per cent of all projects/tasks posting for online labour of which 45 per cent were for software development and technology projects. This trend suggests the changing nature of employment in the IT-BPM sector. New ways of working such as freelancing is an important megatrend shaping the industry.

There will be employment opportunities to Indian software developers, creative and multimedia professionals, online sales and marketing professionals, writers, translators and data entry operators.

As per the report, in the organised IT/BPM sector, 60–65 per cent of the workforce would be deployed in jobs that have radically changed skill sets (projected for 2020) and some examples of the future job roles in the IT/BPM sector includes VFX Artist, Computer Vision Engineer, Wireless Network Specialist, Embedded System Programmer, Data Scientist, Data Architect, AI Research Scientist, etc.

It is predicted that India's IT services industry is set to lose 6.4 lakh low-skilled positions to automation by 2021, according to US-based HfS Research. Large number of non-customer facing roles at the low-skill level in India, with a significant amount of 'back office' processing and IT support work, will be automated and consolidated. In India, though there were large IT players, certain types of coding jobs were specially developed towards software testing or heavily around small, added features such as upgrading. These are the jobs that are going to be replaced by automated processes.

The era of digitisation and automation will create newer career choices for IT professionals. The new job roles that will dominate the IT workforce are within digital domains, such as big data, AI, IoT, cloud computing and cybersecurity.

The NASSCOM-FICCI-EY Report (FICCI et al., 2017) gives a brilliant depiction of skill set requirements vis-à-vis new job roles. This is shown in Table 1.

Table 1. Skill Set Requirement: New Job Roles

	Key Skills	Cognitive abilities	Physical abilities	Content skills	Process skills	Complex problem-solving skills	Resource management skills	Social skills	System thinking	IT/Hardware skills	Environment Conscious thinking
New Jobs	VFX artist	√		√				√		√	
	Computer vision engineer	√							√	√	
	Wireless network specialist	√			√				√	√	
	Embedded system programmer	√			√	√				√	
	Data scientist	√			√	√			√	√	
	Data architect	√			√	√			√	√	
	AI research scientist	√		√	√	√			√	√	
	Language processing specialist	√		√				√		√	
	RPA developer	√		√			√	√		√	
	Deployment engineer	√					√	√		√	
	3D modelling engineer	√	√							√	√
	3D designer	√								√	√
	Cloud architect	√			√	√	√		√	√	
	Migration engineer	√							√	√	
	Android/iOS App developer	√		√		√		√	√	√	
	Digital marketing	√		√				√		√	√

Source: FICCI, NASSCOM and EY (2017).

The emergence of smart, connected products will have a significant impact on the Indian labour market. The skill sets required to create a smart, connected product are new and multi-disciplinary—knowledge of systems engineering, software development, electronics and mechatronics in addition to basic mechanical and electrical engineering is necessary. The current workforce would need to embrace the new technologies to keep up with the pace of changing job roles. At the same time, new job roles might emerge to support further integration of connected technology into products/services.

Start-ups and Jobs

Start-up India movement is expected to create an aspiration in the young to move from a 'job seeker' to 'job provider'. Over 5,000 tech start-ups set-up in the last 5 years are giving rise to new innovative business models, changing the structure of the economy (from unorganised to organised) and creating additional jobs.

Every year over, 1,500 tech start-ups are emerging in the market place that have business models based on personalisation, asset sharing, usage-based pricing, collaborative ecosystem and agility.

In the context of India, these business models have stimulated the overall growth of the economy. Business innovation backed by technology has not only led to growth in the retail and logistic sector, created employment opportunities but is also proving to be an important force in moving the economy towards the organised sector—for example, for e-commerce and taxi aggregators (Uber/Ola).

The 'Uber' model of technology aggregation of services has also been taken up by other entrepreneurs in building maintenance, health care and other home services. Some of them are beginning to gain size and scale.

E-commerce companies have developed a job ecosystem around them. It includes logistics firms, freelance web scriptwriters, web photographers, etc., which support the entrepreneurs. There are also entrepreneurs who support local artisans in the design, manufacture and marketing of fashion and lifestyle products on the Internet. Some of the entrepreneurs are on-boarding artisans onto B2B and B2C platforms. Such platforms, once developed, will make it possible to service an e-commerce company such as Amazon and Flipkart.

We are also seeing the emergence of technology-enabled knowledge service provision in development sectors—agriculture, health, financial services and education. In such models, a less-educated worker (such as

an ASHA worker in the health care space, a business correspondent in the financial services space, a para teacher in the education and skills space and a rural-technician in agriculture and allied spaces) is supported through technology tools such as information tablets connected to the cloud and diagnostic tools to deliver the much-needed developmental services in distant areas. This combination of a trained human being in collaboration with a technology tool is emerging as a gainful employment opportunity in rural areas in the country.

The rise of millennials is also redefining the workplace culture. A majority of millennials view innovation and flexibility as the key purpose of business and just as important as profitability.

Mobile payments and digital wallets have witnessed an exponential growth in the past year. During FY16, total mobile payment transaction volume in India reached $2.9 billion. One of the industry bodies expects mobile payments to reach around ₹460 billion by 2022 at a CAGR of 13.2 per cent. Government-backed 'Digital India' has further aided the prospects of payment FinTechs in India.

As these FinTechs are witnessing an exponential growth, they are on a hiring spree. As the sector evolves, industry experts anticipate at least a 15 per cent increase in hiring due to e-wallets and payment banks. Also, the sector is seeing an increased demand for talented IT professionals with understanding of finance. Similarly, the sector is also witnessing an increase in the hiring in other business operations too.

Supply chain optimisation through exponential technologies such as chatbots and block chain is transforming the Indian BFSI sector. Indian Banks are looking to bring in robotics into their branches as digital assistants to interact with and assist customers in day-to-day activities. These robots will have an impact on the POS and retail industry.

Policy Recommendations

Government

The government should avoid bringing in any formal regulations to curb the advance of exponential technologies in India just for the purpose of saving jobs. This will have unintended consequence of eventual loss of jobs. Why? Because such regulations will make Indian industry increasingly non-competitive and its closure will lead to exactly the opposite effect of loss of jobs. The policies must be such that industry stays competitive by adopting rather than regressing exponential technology.

The large size of the Indian consumer market is the greatest competitive advantage that India has. This should be leveraged fully to gain access to the latest technologies through insistence on technology transfer during the approval of FDI deals. Government should make technology transfer as a precondition for granting Indian market access to global firms, who should be persuaded to become not just business partners but knowledge partners, besides being job creators. China has a policy that mandates foreign firms to transfer technology to China in return for access to its markets. A modified Indian version of that policy, not obtrusive but developmental, should be implemented.

Industry must become an active partner in skilling as also in research in exponential technologies. This will help in mobilisation of the much-needed funds, infrastructure and technology knowhow. Suitably incentivised public–private partnerships for this purpose should be created. A good example is IITB-Monash Research Academy[1] where a large number of private sector industry partners participate, many of them exploring research in exponential technology. Government of India, through its Department of Science & Technology and Department of Biotechnology, supports it with grant of fellowships. This academy model can be multiplied many times over in India.

The MSME sector must be skilled on latest exponential technologies. The current effort by MSME Ministry to set up new high-tech technology tool rooms and upgrading existing ones under the World Bank–funded project in some of the key industrial clusters needs to be expanded across the country (McKensie Global Institute, 2013). This will enable the MSME sector to adopt exponential technologies. Large industrial enterprises that use MSME as vendors/suppliers must also become knowledge partners in exponential technology with them.

Indian youth is aspirational. We can have job-led growth only when the youth understand the nature of the jobs that they will get into their future. We must set-up high-quality career counselling centres that enlighten the students (as also their parents!) about the emerging dynamic job market.

It is important to set-up centres of excellence (CoEs) in emerging exponential technologies. It is heartening to note (FICCI et al., 2017) that FICCI along with Samsung under the aegis of the Ministry of Labour & Employment, Government of India, is setting up India's first CoE on career counselling. The CoE will use technology tools to develop standards and conduct counselling of youths on emerging jobs of future and changing workplace readiness for informed decisions. Similarly, NASSCOM, along with the Ministry of Electronics & Information Technology (MeiTY), Government of India, Government of Karnataka and ERNET,

has set-up the CoE of IoT in Bengaluru. The CoE–IoT is an IoT start-up accelerator that is attempting to build an IoT ecosystem, connecting various entities, such as start-ups, enterprises, venture capitalists, government and academia. Centres like CoE-IoT will enable start-ups in areas of IoT, big data, AR/VR, AI and robotics.

India must have the aspiration of not only leading in the applications of the 'current' exponential technologies but also to create 'future' exponential technologies. The CSIR's New Millennium Indian Technology Leadership Initiative (NMITLI) was set up as a unique public–private partnership to precisely achieve this. Mashelkar (2015) describes the way this initiative worked, its success stories and the lesson learnt. Similarly, perhaps as a part of the Atal Innovation Mission, we could set up 'Atal Exponential Technology Leadership Initiative'. This initiative could be run by using the well-proven public–private partnership model of NMITLI.

Central Government has been championing and promoting start-up India movement by bringing in several policy changes. Start-ups using exponential technologies need to be given a special preference. The start-up policy announced by the Maharashtra Government recently has gone an extra mile to give such a preference to exponential technology led start-ups, changing the tendering process for the start-ups and also mandating the public sector to have minimum 10 per cent of their public procurement from start-ups. Such policies can be adopted in every state. That will give a big filling to exponential technology led start-ups rather than routine incremental innovation-based clones of the Western world start-ups, as is the case in many of the e-commerce-based start-ups today.

AgriTech start-ups can play a major role in bringing advanced but affordable technological solutions to boost farm productivity in India. AgriTech start-ups can help in increasing crop nutritional values, reducing the cost of farming, driving efficiency of agri supply chains through technology intervention, reducing storage wastes, developing smart warehousing solutions, deploying customised farm mechanisation and enabling farm-market connectivity. In India, we have start-ups that use some of the exponential technologies, such as AI, big data analytics, Blockchain and sensors (through drones). Examples are Aibano, vDrone, INtelloLabs, Aarav Unmanned Systems, Flybird Innovations, etc. Deployment of these technologies would radically change the skill sets required by farmers and fuel the requirement for a new age farming outreach workforce.

Exponential technology will impact several sectors. Government should play a crucial role as a technology promoter, strategic partner,

first buyer of new exponential technology application through innovative public–private partnerships, etc. The recent news about government planning to develop an advanced IT infrastructure with Aadhar like model for the mega National Health Protection Scheme (NHPS), which will benefit 100 million Indians with the help of leading experts is welcomed. What is done in health should be done in other sectors such as education, tourism, hospitality, etc.

Industry

Exponential technologies will affect every sector, every industry. The IT/BPM sector will be most affected by exponential technologies. There is a great drive and action within the sector for adoption of these technologies and revamping business models. Other sectors should follow suit. Industry associations should take this agenda upon an urgent basis, since the window left for adjustments is just 2–3 years.

This period of adjustment/transition has to be managed very carefully. As industry deploys exponential technologies, there will be an impact on hiring, leading even to layoffs in some cases. Every affected or likely to be affected company must set up counselling, mentoring and reskilling mechanisms to support the laid off workforce. For the existing workforce, there needs to be large-scale re-skilling on exponential technologies and their potential applications.

Industry associations and individual companies can work towards creating a collaborative learning ecosystem in their respective sectors to skill workforce/students on the next generation of technologies. For example, NASSCOM is working with IT/BPM companies (such as TCS, Infosys and Accenture) and academia to create a NASSCOM-branded learning platform to reskill/skill 1.5–2 million people on next-gen technologies within 4–5 years (FICCI et al., 2017). Similarly, FICCI has developed a technology platform Resource Integration of Sustainable Employment (RISE) to strengthen the process mechanism of the skill development ecosystem using big data analytics, which will help policymakers and industry to strategise for the future requirements of skilled manpower.

Companies should create the necessary platforms/tools to embrace the new ways of working and reach out to this workforce of tomorrow. For instance, EY, to source, match and engage contractors, has built an innovative platform, namely, GigNow. The platform not only allows engagement teams to tap into more sources of talent pools, quickens

the process to deploy and lower the indirect costs but also provides the gig workforce to view the various contractual employment opportunities at EY.

Indian industry must seek global collaborations to move into the era of exponential technology and industry 4.0. The World Economic Forum Centre for the Fourth Industrial Revolution in San Francisco has been already set up. As a Sister Centre, World Economic Forum Centre for the Fourth Industrial Revolution in India (C4IR) is also proposed to be set up. The C4IR will allow policymakers and leaders in India to stay ahead of the curve through unique insights into new forms of governance and new technology applications, and connection with cutting-edge technology innovators globally. The C4IR should also have focused studies on the dynamics of creation and destruction of jobs and allied issues on skilling, etc.

Educational Institutions

Immediate nationwide audit of all the higher educational technological institution should be undertaken to understand the current level of preparedness in terms of exponential technologies, industry 4.0 and future jobs.

There is few consensuses that the new skills in the era of industry 4.0 will be the ability of the students with complexity, critical thinking, emotional intelligence, cognitive flexibility, creativity, etc. Considering creativity, India's education system has given more importance to logical thinking and reasoning capabilities, but now, with Al, the new jobs will be more focused on creative thinking. The matrix shown as Table 1 in section 'Technology led Offshoring/Restoring of Jobs' could be used for the new design.

Universities of the future need to transition towards a learner-centred education model where learning and work go hand in hand. Customised learning modules coupled with adaptive, dynamic and agile life-long learning should be the focus of the universities to create workforce with long-term sustainability.

Indian academia must lead to open disruptions such as open knowledge (Udacity, Courser, a Kahn), open source development/collaboration (GitHub), open innovation (Quirky) and open research (Materials project, OSDD). Let's take a specific example of open source platform.

> With the objective of making AI accessible to everyone, Tech Mahindra, along with AT&T and the Linux Foundation, has launched a user-centric,

> open source platform called Acumos. Idea is to make this available to universities and colleges and even to school students and create a whole library of AI solutions that people can use. If AI can be made simple—in a way that even people in small towns and villages can create businesses using AI as they are doing today with the mobile phone.

What is urgently needed is a deep analysis for each sector to assess the future needs and launch a new skill and competency development programmes. India will have to move from 'right to education' to 'right education' to 'right way of education' in view of the great disruption that exponential technology is going to create. Further, new exponential technology will be high technology. It will be based on a solid foundation of high science. India must continuously raise its investments in high science, so that India's high science base remains strong and globally competitive.

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Note

1. See www.iitbmonash.org

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