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First Edition: 2021

Published by : Mrs. Meena Pandey for **Himalaya Publishing House Pvt. Ltd.**,
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Printed at : M/s. Aditya Offset Process (I) Pvt. Ltd., Hyderabad. On behalf of HPH.

Preface

It gives us immense pleasure to introduce the first edition book on “**Emerging Exponential Technologies – A Management Perspective**”. The term **Emerging technologies** are the technologies that are currently developing, or that are expected to be available within the next five to ten years, responsible in creating, or are expected to create, significant social or economic effects. Harnessing the power of **emerging technology** can allow us to drive economic growth and gain valuable insight into how to make our world a safer, healthier, and more efficient place. Emerging technologies are characterized by: (i) radical novelty, (ii) relatively fast growth, (iii) coherence, (iv) prominent impact, and (v) uncertainty and ambiguity. **Emerging technologies** include a variety of technologies such as educational technology, information technology, nanotechnology, biotechnology, cognitive science, robotics, and artificial intelligence to name a few.

It is imperative that such technologies be known to the Management students across the globe. Engineers innovate and produce a product or service, and good managers know how and where to apply the technology. It is a wonderful and proactive step taken by the Visvesvaraya Technological University, Belagavi, Karnataka and the Board of Studies of MBA to have introduced this subject for the MBA course from 2020.

We have extensively researched and presented this book to suit the management students. The whole content is focused on day-to-day applications of technology that the learner can easily verify. We have included a practical component that will help teachers and students deep dive into the learning. The aim is not to write how technology is made or coding is done but how the emerging technology concepts are applied in various sectors. There could be a little repetition here and there due to the context of the subject since there is a blurring line of difference between some technologies and their application.

We thank all the people who have been giving valuable inputs by way of blogs, open source and videos. We acknowledge the photos to Pixabay. We thank all the members of the KLE Society, Belagavi; Vice Chancellor of KLE Technological University, Dr. Ashok Shettar; Principal of KLE Dr. M.S. Sheshgiri College of Engineering and Technology Dr. Basavaraj Katageri; BOS and BOE members of MBA for their support.

We acknowledge the wonderful outcome of this publication to Himalaya Publishing House Pvt. Ltd. We thank Mr. Niraj Pandey, Mr. Vijay Pandey and Mr. H.C Pant for initiating the publication of this unique book. We thank the wonderful efforts by the type setters, reviewers and editors for the DTP, printing and editing of the book.

Bengaluru
September, 2021

Dr. Deepak G. Kulkarni
Dr. Prayag P. Gokhale

Syllabus

Course Outcomes

By the end of this course, the student will be able to:

- Identify different emerging technologies
- Differentiate different emerging technologies
- Select appropriate technology and tools for a given task
- Identify necessary inputs for application of emerging technologies

Unit 1: Introduction to Emerging Technologies

Evolution of Technologies, Introduction to Industrial Revolution, Historical Background of the Industrial Revolution, Introduction to Fourth Industrial Revolution (IR 4.0), Role of Data for Emerging Technologies, Enabling Devices and Networks for Emerging Technologies (Programmable Devices), Human to Machine Interaction, Future Trends in Emerging Technologies.

Unit 2: Introduction to Data Science

Overview for Data Science, Definition of Data and Information, Data Types and Representation, Data Value Chain, Data Acquisition, Data Analysis, Data Curating, Data Storage, Data Usage, Basic Concepts of Big Data.

Unit 3: Artificial Intelligence

Introduction to AI, What is AI?, History of AI, Levels of AI, Types of AI, Applications of AI in Agriculture, Health, Business (Emerging Market), Education, AI Tools and Platforms (e.g., Scratch/Object Tracking).

Unit 4: Internet of Things (IoT)

Overview of IoT, What is IoT?, History of IoT, Advantages of IoT, Challenges of IoT, How IoT Works? Architecture of IoT, Devices and Network, Applications of IoT at Smart Home, Smart Grid, Smart City, Wearable Devices, Smart Farming, IoT Tools and Platforms, Sample application with Hands-on Activity.

Unit 5: Augmented Reality (AR)

Introduction to AR, Virtual Reality (VR), Augmented Reality (AR) vs. Mixed Reality (MR), Architecture of AR systems. Application of AR Systems (Education, Medical, Assistance, Entertainment) Workshop-oriented Hands-on Demo.

Unit 6: Ethics and Professionalism of Emerging Technologies and Other Emerging Technologies

Ethics and Professionalism: Technology and Ethics, Digital Privacy, Accountability and Trust, Treats and Challenges. **Other Technologies:** Nanotechnology, Biotechnology, Blockchain Technology, Cloud and Quantum Computing, Autonomic Computing, Computer Vision, Embed Systems, Cyber Security, Additive Manufacturing (3D Printing).



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INTRODUCTION TO EMERGING EXPONENTIAL TECHNOLOGIES

Emerging technologies include a variety of technologies such as educational technology, information technology, nanotechnology, biotechnology, cognitive science, psychotechnology, robotics and artificial intelligence. These technologies have changed the face of the world and also led to the changes in the way the management is looking at these exponential technologies for effective decision-making. Let us look at how the world has changed and will change in future too with these emerging technologies.

1.1 INTRODUCTION TO EMERGING TECHNOLOGIES

The world that we see is changing drastically and in thoughtful ways. An extraordinary union of emerging technologies, driven by worldwide connectivity and developments like artificial intelligence (AI), are expected to complement collectively to transform the way we live, play, relate and work.

Now, we stand at a point of inflection in the advancement of technology, and that we have to comprehend that this is an exponential transformation that will make our world completely different than it seems to look now. But, it has to also understand the roles and responsibilities that the developers will have to shoulder and facilitate the approaching surge of innovation. A lot of ethical and principled choices are laid ahead for all of us, and coping with this will be a challenge for future generations.

1.2 UNDERSTANDING EXPONENTIAL TECHNOLOGIES

To appreciate the approaching technological insurgence, it is indispensable to comprehend the notion of exponential technology. To identify exponential trends prematurely, when the growth still looks linear, one needs to recognize the significant technological developments that push it. In many cases, the driver of exponential technologies is digitization like digital photography. Digitization is narrowly linked with exponential technology as it inclines towards “zero” cost. As the number of digital photos that one takes, the lesser will be the cost per photo and it will further reduce to almost “zero” cost. Even in the case of digital storage which is not

very far from a “zero” cost item. There are several cloud service providers providing data storage space that is nigh to free.

Democratization is one more vital specific of exponential technologies that makes the technology universal. In photography, this transpired for the reason of the parallel adoption of mobile phones.

1.3 INDUSTRIAL REVOLUTION OR THE INFLECTION POINT

Traditionally, industrial revolutions are regarded by alterations in the way the labourer works. For instance, the First Industrial Revolution was centralized on steam and mechanization, the Second Industrial Revolution focused on electric power and bulk production, or the Third Industrial Revolution which was grounded on digitization and information technology have brought in a drastic alteration in ways a labour work.

At present, the employment news is sent out with anxieties around AI and autonomous robots, and the replacement of the current workforce with these technologies. Research carried out by the “McKinsey Global Institute” forecasts that around 45% of existing works may perhaps be automated and suggests that around 1/3rd of the jobs in existing jobs can be accomplished by computers. These are forewarnings of terrible unemployment. Though related predictions have occurred with all the previous three industrial revolutions, all these predictions were proved to be inaccurate with time. Though work was drastically impacted in all the above cases, especially when there was a democratization of technology, the technology that was elicited in each industrial revolution usually facilitated people to progress on to better jobs. In a nutshell, labour improved.

1.4 IS TODAY’S TECHNOLOGY ANY DIFFERENT?

Today’s technology revolution does offer some significant modifications from the past cycles. Considering the fusion of exponential technologies, they have potentially amplified each other, e.g., energy storage augments, drones technology, etc.

The exponentially growing acceptance of cyber-physical devices connected to the Internet, e.g., home automation devices.

The exponential rapidity of transformation, e.g., the unbelievably rapid acceptance and pervasive adoption of smartphones.

Actually, we are witnessing a transformative transformation in the entire system and industries like travel, transportation and purchasing. Moreover, these major shifts are altering us together as nations, as communities and as individuals. Smartphones, e.g., have by now transformed individual communication and relationships.

1.5 PROVOKING QUESTIONS ON EMERGING TECHNOLOGIES

Whether we categorize the present era as the Fourth Industrial Revolution, or merely an inflection point in the digital revolution, there are important questions that we have to confront.

Firstly, there are evident ethical enquiries about various innovations in the offing—genetic engineering is an easy example. While it is surprising and concerning that how few organizations are employing ethicists on their teams, the fact is any employee can fill that role merely by raising ethical demands, and in recent years, there are incidences of employee protests that reveal this commitment.

Secondly, innovation cannot happen without bearing in mind the issue of governance. Regulation of exponential technologies, whether it is good or bad, is the biggest question? Facial recognition can be used to tag personal photographs as easily as the governments can use it to track the populations. Likewise, drones can be employed to transport medicines to the sick, on the other hand, the drones can be effectively used as weapons.

Virtually, any technology can do good or evil, but the challenge is to identify potential consequences. Whether companies self-regulate or the law provides boundaries, either approach will struggle to keep pace with rapid change. Autonomous driving, social media propaganda, and ethnic/gender bias in machine learning have already emerged as immediate challenges.

Finally, one should consider what motivates innovation. The core driver of the industrial revolutions of the past was capitalism and it generated reflective advancement. On the other hand, it also created concerning inequities. At present, as we step into a world that is remodeled by exponential technologies, there are numerous opportunities to develop humanity and to guarantee social and economic benefits to all.

1.6 NEXT STEPS

The time in which we are living is changing at a very fast pace and the speed and the breadth as which the technology is never like before. Whether one involved with exponential technologies in the area of physical sciences like energy storage, medicine, bioengineering or in the area of computer sciences like cloud, AI, blockchain, Big Data, etc., there are prospects to have an impact, and for those not yet leveraging these technologies, they should be urged to the organizations to catch up. For organizations that fail to engage exponential technologies early in the curve alongside their competitors, there is a risk of being left behind exponentially.

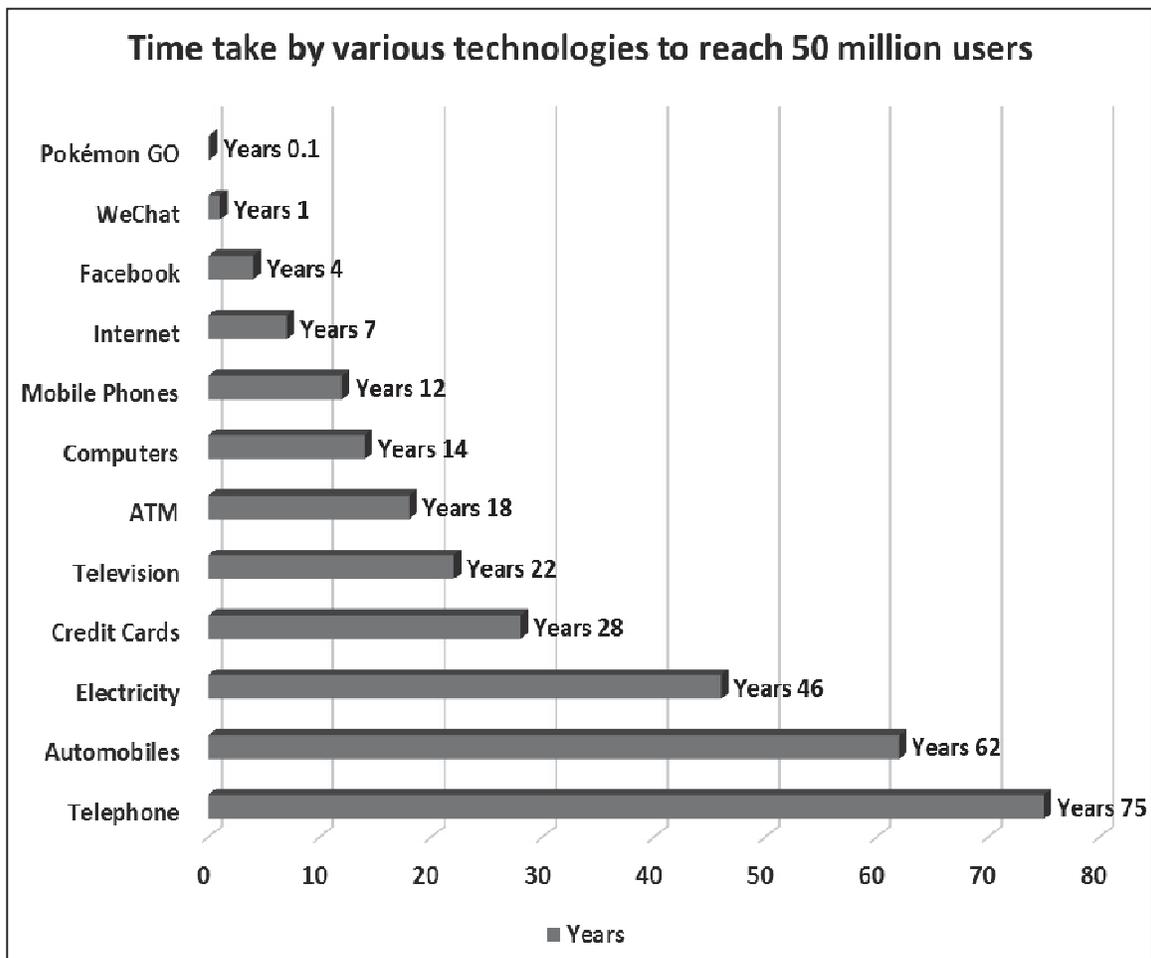
Lastly, don't be scared to think big. Look further than leveraging prevailing technologies and plan time to ideate the next product or service. For instance, instead of Uber replacing taxi drivers, we have to think of autonomous driving that will replace drivers completely.

To summarize, one has to capture the potential of today's exponential technology and focus on how one can leverage or even surpass it to make the world a better place.

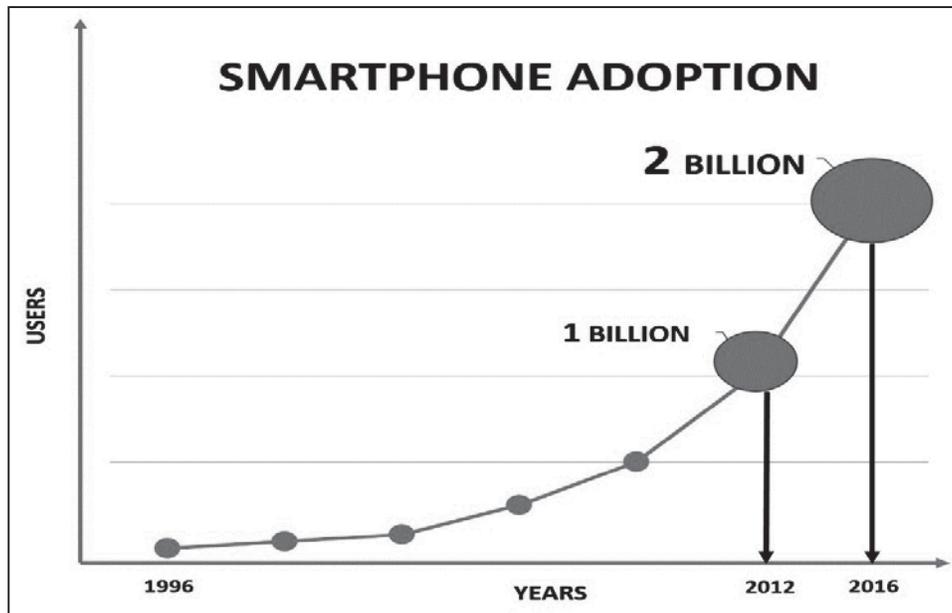
1.7 EXPONENTIAL TECHNOLOGY TRENDS THAT WILL DEFINE THE FUTURE

One of the most fascinating facts of this decade is the quantum of changes that have occurred in a very short time. An incredible amount of activities have been witnessed based on exponential technologies, including IoT, AI, 3D printing and blockchain. These rapid changes suggest the pace at which technological advancements have happened and it is expected to change more rapidly in the coming decades – the reason being that the industry is attaining global acceptance at an exceptional rate.

Consider the invention of the telephone, a game-changing technology of its time. But, it took about 70 years for landline phones to reach 50 million users (see below) as compared to mobile phones, which took hardly 10 years to reach the 50 million whereas Pokémon GO reached 50 million users in just 19 days. This was possible only because the game was developed using exponential technologies like computer processing power, mobile phones, the internet and augmented reality.



Now, let's contemplate the progression of the smartphone, considered as another breakthrough technology. These devices provide a significant cue for the innovators. A key reason why exponential technologies are adopted so quickly is that they are built on the foundation that is provided by earlier exponential technologies. For example, smartphones have facilitated as a growth platform for many of today's industry-leading companies, including Apple, Uber, Amazon, Swiggy and Zomato.



Now, it has become possible for new technologies to reach 1 billion users instantly. For instance, in the year 2017, Google introduced “Smart Reply” technology. This technology was a machine-learning-powered feature that would suggest three likely replies to an e-mail. Smart Reply was made available to a limited number of Gmail users but the next day, with just a flip of the switch, more than a billion users witnessed “Smart Reply’s” capability.

In this age of speedily accelerating transformation, all types of organizations must rapidly develop their ability to innovate. It is turning into a challenge for many organizations to create an innovation-friendly work environment and a continuous learning environment which is essential for survival. No doubt, it is difficult to adopt changes so quickly, but the leaders at present have to accept this challenge of learning the fundamentals of these exponential technologies and also to assess the opportunities and threats that these technologies pose to their organizations.

1.8 MAJOR EXPONENTIAL TECHNOLOGICAL DRIFTS

Some of the major exponential technological drifts are stated below:

1.8.1 Artificial Intelligence (AI)

It refers to a technique where machines are programmed to think like humans and mimic their actions and also simulate human intelligence. Some companies have hyped AI for several

years to such an extent that some leaders have stopped giving attention. However, AI is improving exponentially, is getting economical and easier to obtain and use.

1.8.2 Augmented Reality/Virtual Reality (AR/VR)

AR is a technology that adds digital elements to a live view with the use of a digital camera often on a smartphone and VR is a technology that involves a thorough immersion experience that shuts out the physical world. These technologies have been misjudged as toys for amusement and gaming. Though, these technologies are developing quickly and are finding their uses in the field of architecture, construction, medicine, aerospace, manufacturing and education. Shortly, it is expected that many physical events would be enveloped by AR.

1.8.3 Autonomous Vehicles

These are vehicles that can drive without any human assistance. Let's have a look at all the A-list brands which are contending in the space of autonomous vehicles – Toyota, Ford, GM, Tesla, Volkswagen and Google. This suggests the potential of a large market. The global market is estimated to reach around \$65.3 billion in the coming decade.

1.8.4 Block Chain

It is a “database that stores encrypted blocks of data and then chains them together to form a chronological single-source-of-truth for the data”. The elimination of third parties from transactions is driving the global market for this technology and it is expected to grow at a rate of around 60% till the first half of the next decade.

1.8.5 Data Science

Data will continue to be a key driver of the global economy. It is believed that data is the new oil in today's digital economy. The outlook is also good for the future of work, as LinkedIn recently identified Data Scientist as one of the fastest-growing jobs in the world.

1.9 NEED FOR EXPONENTIAL LEADERS TO HARNESS THE BENEFITS OF EXPONENTIAL TECHNOLOGY

One thing that is common among these exponential technologies is the buzz and hype that is created by the media and which is aiding to large adoption of these technologies.

The leaders of today should understand the significance of these exponential technologies from the perspective of their organization. Further, the leaders should also invest in these innovative processes that will fuel quantifiable growth and progress, and this is how the traditional leaders will transform into future exponential leaders.

It is time that the enterprises are transforming into exponential enterprises to ensure that they are ahead of the pace of change. These organizations have started building a future-focused strategy and are developing exponential leaders, and are in turn producing the products for the future.

1.10 REVIEW QUESTIONS

1. What does research carried out by “McKinsey Global Institute” forecasts?
2. Name some of the major exponential technological drifts.
3. Define “Smart Reply” technology introduced by Google.
4. Explain ‘Data Science’.
5. What do today’s leaders must understand?
6. What is Democratization?
7. Give a key reason why exponential technologies are adopted so quickly with example.
8. “AR and VR technologies are improving rapidly and finding use in many cases.” Explain.
9. What does Artificial Intelligence (AI) refers to?
10. What is Digitization?

1.11 MULTIPLE CHOICE QUESTIONS

1. A tape recorder is considered to be _____.
(a) Emerging Technology (b) Current Technology
(c) Obsolete Technology (d) Crazy Technology
2. IoT stands for _____.
(a) Industrial Internet of Things (b) Internet of Things
(c) Intelligence Internet of Things (d) Internal Internet of Things
3. What does design provide?
(a) Technology (b) Ecosystem
(c) Technology and ecosystem (d) Digital revolution
4. Several instructions execute simultaneously in _____.
(a) Processing (b) Parallel Processing
(c) Serial Processing (d) Multitasking
5. Wi-Fi stands for _____.
(a) Wireless Fidelity (b) Wireless Flexibility
(c) Wide Fidelity (d) WAN Flexibility
6. RFID stands for _____.
(a) Random Frequency Identification (b) Radio Frequency Identification
(c) Random Frequency Information (d) Radio Frequency Information

7. _____ computers are lower to mainframe computers in terms of speed and storage capacity.
- (a) Mini (b) Super
(c) Mainframes (d) Hybrid
8. PDA stands for _____.
- (a) Personal Digital Applications (b) Private Digital Applications
(c) Personal Digital Assistants (d) Private Digital Assistants
9. SaaS stands for _____.
- (a) Software as a Service (b) System Software and Services
(c) Software as a System (d) System as a Service
10. _____ is an emerging branch in computer science, which interprets means and method of making computers think like human beings.
- (a) Block chain (b) VR
(c) AI (d) Cloud computing

Answers:

1. (c); 2. (b); 3. (c); 4. (b); 5. (a);
6. (b); 7. (a); 8. (b); 9. (a); 10. (c).