STUDY GUIDE FOR MODULE NO. 1

CHAPTER 1: EMERGING TECHNOLOGIES

MODULE OVERVIEW

As we embark on this new semester and a new normal of classroom set-up, let us embrace this as an opportunity to pursue academic excellence amidst pandemic and learn as one.

The term emerging technology has a considerable growing interest in the area of research in the industry, market, and academe. Emerging technology has different definitions for different people. Some consider emerging technology as new technologies, while some define them as technologies of the future. There are also people who consider them as continuous innovation of previous technologies.

In this chapter, we will discuss what emerging technology is and examine the characteristics of an emerging technology to consider how technology emerged in our world. I will introduce some emerging technologies that are considered to reshape our daily lifestyle and industry in the near future.

MODULE LEARNING OBJECTIVES

At the end of this topic session, the students should be able to:
1. Define emerging technologies.
2. Understand the characteristics of emerging technologies and how they emerge.
3. Identify some emerging technologies and define their potential applications.
4. Explain how emerging technologies are transforming Business, Industries and our Lives.
5. Define what Industrial Revolution is, and identify its four (4) stages.

LEARNING CONTENTS (TOPIC 1: EMERGING TECHNOLOGIES)

WHAT IS EMERGING TECHNOLOGY?

There is no widely agreed-upon definition of "**Emerging Technologies (ETs)**." Very few articles provide a clear scope and complete definition for ET, and searching for an ET definition using a search engine does not return much information. Day and Schoemaker (2000) and Srinivasan (2008) state that ETs are science-based innovations with the potential to create a new industry or transform an existing one. Meanwhile, the Business Dictionary defines ET as "new technologies that are currently developing or will be developed over the next five to ten years, and which will substantially alter the business and social environment." This definition considers new technology as ET, which is not entirely accurate. This is one of the main misconceptions about ET. Technology can still be considered emerging in one context even though it has been considered established in another. The context here is related to place, domain, or application. For example, Radio Frequency Identification (RFID) is not considered emerging in developed countries, whereas it is described as an ET in other poor and developing countries in the world where the Internet and communication technology infrastructures are still poor.

Some people consider emerging technologies as innovations of existing technologies, which are used creatively for modernity. For example, artificial intelligence was first developed in the 1950s, but up to date this is still considered as an emerging technology because this development is still progressing and is embedded in various areas.

Therefore, Emerging Technologies are not necessarily new. Technology is labeled as emerging in a particular context (domain, place, or application) but can be established elsewhere. Technology is also considered emerging when it is not widespread in a particular context. ET has no limited or fixed life. Technology is defined as emerging when it causes a radical change to business, industry, or society.

LEARNING CONTENTS (TOPIC 2: CHARACTERISTICS OF EMERGING TECHNOLOGY)

Technology can also be labelled as an emerging technology through its characteristics. Table 1 shows the descriptions of emerging technology's five (5) main characteristics and how technologies emerge according to Rotolo et al. (2015).

CHARACTERISTICS	DESCRIPTION
1. Radical Novelty	Emerging technology may take the form of a progressing technology. Novelty or newness can also be generated by putting existing technology to a new use. For example, the applications of artificial intelligence are applied to different uses to achieve different results. Emerging technologies are radically novel. For example, they fulfil a given function by using a different basic principle as compared to what the previous technology used to achieve a similar purpose.
2. Relatively Fast Growth	Emerging technologies show relatively fast growth rates compared to non-emerging technologies. Growth may be observed across a number of dimensions, such as the number of actors involved, public and private funding, knowledge outputs produced, prototypes, products, and services. For example, users of Artificial Intelligence are growing (e.g., various companies, universities, and individuals)
3. Coherence	Emerging technology is convergence of preciously separated research streams and technologies that have already moved beyond the purely conceptual stage. Coherence refers to the internal characteristics of a group being united and logical interconnection. Coherence and its persistence over time distinguish technologies that have acquired a certain identity and momentum from those still in a state if flux and therefore not yet emerging. For example, cloud, artificial intelligence, data analytics, and robotics are grouped to achieve different use.
4. Prominent Impact	Emerging technology provides benefits for a wide range of sectors, transforms an industry, and exerts much enhanced economic influence. It applies a noticeable impact with narrow scope, as well as wide-ranging impact across domains and potentially the entire socio-economic system by changing the composition of actors, institutions, patterns of interactions among those, and the associated knowledge production processes. For example, artificial intelligence provides a prominent impact and enormous changes in different sectors such as businesses, academe, healthcare, and individuals around the world.
5. Uncertainty and Ambiguity	The prominent impact of emerging technologies lies somewhere in the future. Thus, uncertainty features in the emergence process. On the other hand, ambiguity arises because proposed applications are still malleable. Even the knowledge of the emergence's possible outcomes is incomplete. Uncertainty and ambiguity are key starting concepts for a wide variety of science

	and technology studies that focus on the role of the expectations in technological emergence. Emerging technologies are also characterized by uncertainty in their possible outcomes and uses, which may be unintended and undesirable, and by ambiguity in the meanings that different social groups associate with the given technology. For example, there are various applications or uses of artificial intelligence that some people can predict, but these applications may or may not be successfully developed.

Table 1. Characteristics of Emerging Technology

In conclusion, these characteristics define emerging technology as a radically novel and relatively fast growing technology through a certain degree of coherence persisting over time. These also have the potential to exert a considerable impact on the socio-economic domain(s) which is observed in terms of actors and institutions, as well as their patterns of interactions, along with the associated knowledge production processes. Its most prominent impact, however, lies in the future and so the emergence phase is still somewhat uncertain and ambiguous.

LEARNING ACTIVITY 1.1

LEARNING CONTENTS (TOPIC 2: EMERGING TECHNOLOGY AREAS AND THEIR POTENTIAL APPLICATIONS)

According to the World Economic Forum, the following areas of emerging technologies have the potential of altering deep-rooted practices of industries in the future:

1. ARITIFICIAL INTELLIGENCE (AI)

- AI is the simulation of human intelligence processes by machines. These processes include learning, reasoning, and self-correction.

Examples of AI Technology

AI is incorporated into a variety of different types of technology. Here are some examples:

- **Automation.** When paired with AI technologies, automation tools can expand the volume and types of tasks performed. An example is robotic process automation (RPA), a type of software that automates repetitive, rules-based data processing tasks traditionally done by humans. When combined with machine learning and emerging AI tools, RPA can automate bigger portions of enterprise jobs, enabling RPA's tactical bots to pass along intelligence from AI and respond to process changes.

- **Machine learning** is the application of AI that provides a machine the ability to learn from experience like humans. It is used in various applications such as healthcare, financial and marketing services, earth observation, and transportation. In healthcare, for example, machine learning algorithms will be applied to identify and develop new medicines at a rapid pace.

- **Robotics.** This field of engineering focuses on the design and manufacturing of robots. Robots are often used to perform tasks that are difficult for humans to perform or perform consistently. For example, robots are used in assembly lines for car production or by NASA to move large objects in space. Researchers are also using machine learning to build robots that can interact in social settings.

- **Self-driving cars.** Autonomous vehicles use a combination of computer vision, image recognition and deep learning to build automated skill at piloting a vehicle while staying in a given lane and avoiding unexpected obstructions, such as pedestrians.

Figure 1.1 Robotics and Self-Driving Car

2. QUANTUM COMPUTERS

- Computers that use quantum mechanics to perform calculations that can solve some problems far more efficiently than a conventional computer. Quantum computers use qubit as their basic unit of computation. Qubit is analogous to the standard bit (0 or 1), but it is in a quantum superposition between two (2) computational quantum states. It can be a 0 and a 1 at the same time. So far, the largest quantum computers that laboratories have demonstrated are from IBM, Google, Rigetti Computing and IonQ.

Researchers and a growing number of academics are developing programs and quantum computing software. Once refined, powerful quantum computers in the future could simulate nature itself, such as atoms, molecules, and could help in designing materials.

3. AUGMENTED REALITY (AR)

- AR is the technology that overlays computer-generated display, sound, text, and effects on a user's view of the real world. It combines real and computer-based scenes and images to deliver a unified but enhanced view of the world. There are various applications of AR, such as an in-car display with guides to

help the driver drive and reverse park safely, games such as Pokemon Go, and applications that help shopper's view how a piece of furniture will look in their living room before buying it.

The figures below show some examples of Augmented Reality:

Figure 1.2 Example of Augmented Reality (Games & Business)

4. INTERNET OF THINGS (IoT)

- IoT is a computing concept that describes the idea of everyday physical objects being connected to the Internet and being able to communicate and interact with other devices. This may include sensor and wireless technologies. IoT allows field devices to interact with one another and with more centralized controllers. It will also decentralize analytics and decision-making, thereby enabling real-time responses and results.

OTHER AREAS OF EMERGING TECHNOLOGIES:

5. CLOUD COMPUTING

- Cloud computing is a general term for anything that involves delivering hosted services over the internet. These services are divided into three main categories: infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS).

A cloud can be private or public. A public cloud sells services to anyone on the internet. A private cloud is a proprietary network or a data center that supplies hosted services to a limited number of people, with certain access and permissions settings. Private or public, the goal of cloud computing is to provide easy, scalable access to computing resources and IT services.

CLOUD COMPUTING vs. TRADITIONAL WEB HOSTING

A cloud service has three distinct characteristics that differentiate it from traditional web hosting:

- Users can access large amounts of computing power on demand. It is typically sold by the minute or the hour.
- It is elastic -- a user can have as much or as little of a service as they want at any given time.
- The service is fully managed by the provider (the consumer needs nothing but a personal computer and Internet access). Significant innovations in virtualization and distributed computing, as well as improved access to high-speed internet, have accelerated interest in cloud computing.

CLOUD COMPUTING EXAMPLES

Examples of cloud computing includes:

1. Google Docs, Microsoft Office 365: Users can access Google Docs and Microsoft Office 365 through the internet. Users can be more productive because they can access work presentations and spreadsheets stored in the cloud at anytime from anywhere on any device.

2. Email, Calendar, Skype, WhatsApp: Emails, calendars, Skype and WhatsApp take advantage of the cloud's ability to provide users with access to data remotely so they can access their personal data on any device, whenever and wherever they want.

3. Zoom: Zoom is a cloud-based software platform for video and audio conferencing that records meetings and saves them to the cloud, enabling users to access them anywhere and at any time.

LEARNING CONTENTS (TOPIC 3: THE FOURTH INDUSTRIAL REVOLUTION / INDUSTRY 4.0)

The technical advances change the way of production technology. The stages of production technology are called the “INDUSTRIAL REVOLOTION.” The **industrial revolution** is the systematic transformation of manufacturing through the integration of physical and digital systems to improve quality, lower costs, and increase efficiency. Because of this, production technologies fundamentally changed the working conditions and lifestyles of people. There are four (4) stages of industrial revolution:

- **FIRST INDUSTRIAL REVOLUTION, or Industry 1.0**, began in the 18th Century. This is the introduction of the mechanical production using hydroelectric and steam-powered equipment.
- **SECOND INDUSTRIAL REVOLUTION, or Industry 2.0**, began in the 19th century. New technological systems that use electricity were introduced during this revolution, which allowed for even greater production and more sophisticated machines.
- **THIRD INDUSTRIAL REVOLUTION, or Industry 3.0**, began with the first computer era. This industrial revolution evolved the use of electronics and information technology to automate a production process further. Manufacturing and automation advance considerably because of internet access, connectivity, and renewable energy.
- **FOURTH INDUSTRIAL REVOLUTION, or Industry 4.0**, is the current and developing environment. The disruptive and cutting-edge technologies, such as the Internet of Things (Iot), robotics, virtual reality (VR), AR, and AI, are changing the way we live and work. Industry 4.0 will lead to changes in traditional production relationships among suppliers, producers, customers, as well as between humans and machines.

Some of the technologies from the building blocks of industry 4.0 are the following:

- ✓ **Big Data Analytics**
- ✓ **Internet of Things (IoT)**
- ✓ **Cloud Computing**
- ✓ **Augmented Reality (AR)**

Figure 2.2 shows the First Four Main Revolutions in the Industrial World.

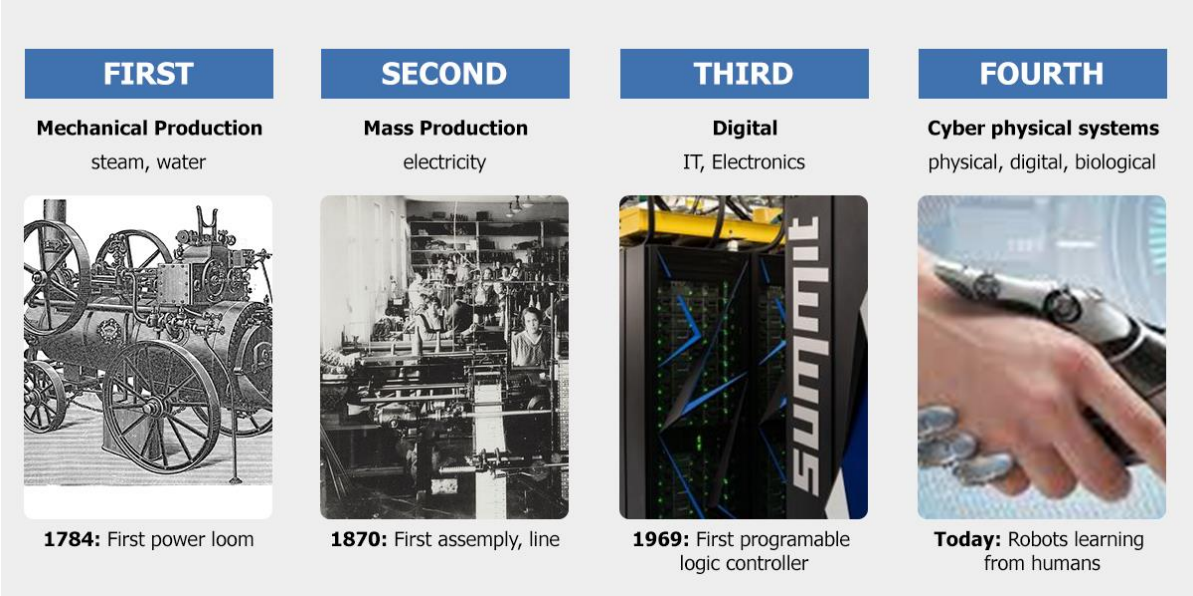

Figure 2.2 First Four main Revolution in the Industrial World

The emerging technologies driving the fourth industrial revolution include, among others artificial intelligence and robotics, neuro-technologies, biotechnologies, virtual and augmented reality and so on that are advanced within the last decade.

SUMMARY / KEY LEARNINGS

- Ideas and innovations being developed today will become the technologies used daily in our future society. As a BSIT student, you should know the current trends and acquire more knowledge to explore the impact and applicability of emerging technologies on business and industry, academe, society, and individual.
- There are four stages of industrial revolution, from Industry 1.0 to 4.0. It is the era when **power-driven machinery** was developed.