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SCHOOL OF COMPUTING

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

UNIT I

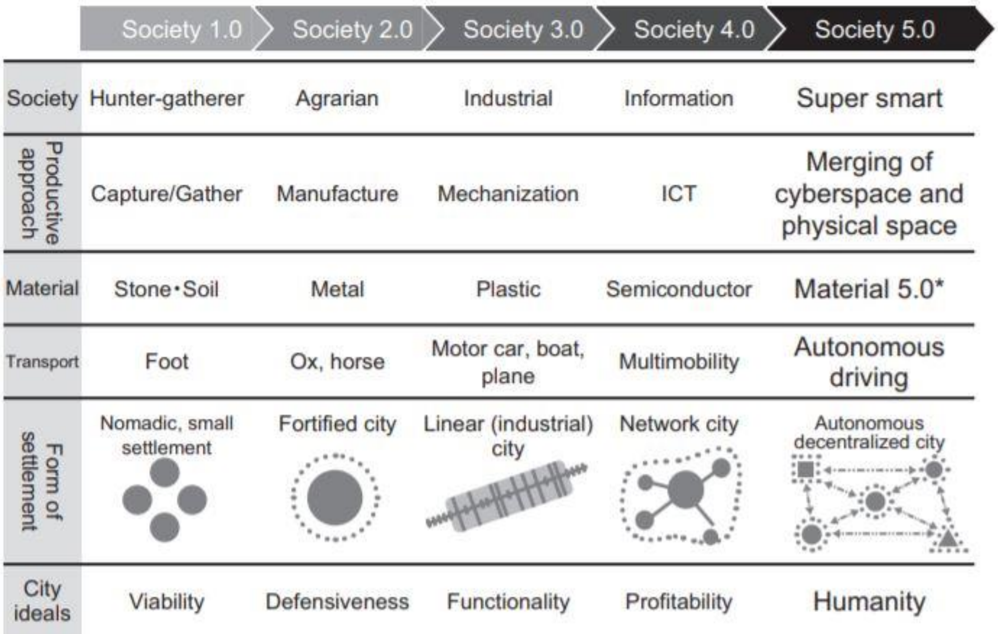
SOCIETY 5.0 – SAIC4002

INTRODUCTION TO SOCIETY 5.0 **9hrs**

Introduction –Schema of society 5.0-Characteristics of Society 5.0. Introduction to communication technologies: Artificial Intelligence – robotics - 3D Printing. People: Centric Society -Knowledge Sharing- Physical space Cyberspace – Humanity VS Society 5.0 – Elements of Society 5.0-Data Driven to Society- Modelling real world Issues.

INTRODUCTION

On January 22, 2016, the Government of Japan released the 5th Science and Technology Basic Plan (Cabinet Office 2016a). The plan proposes the idea of "Society 5.0," a vision of a future society guided by scientific and technological innovation. The intention behind this concept is described as follows: "Through an initiative merging the physical space (real world) and cyberspace by leveraging ICT to its fullest, we are proposing an ideal form of our future society: a 'super-smart society' that will bring wealth to the people. The series of initiatives geared toward realizing this ideal society are now being further deepened and intensively promoted as 'Society 5.0.'"1 An annotation explains the reasoning behind the term Society 5.0 as follows: "(Society 5.0 is) so called to indicate the new society created by transformations led by scientific and technological innovation, after hunter-gatherer society, agricultural society, industrial society, and information society"(see Fig. 1).



	Society 1.0	Society 2.0	Society 3.0	Society 4.0	Society 5.0
Society	Hunter-gatherer	Agrarian	Industrial	Information	Super smart
Productive approach	Capture/Gather	Manufacture	Mechanization	ICT	Merging of cyberspace and physical space
Material	Stone・Soil	Metal	Plastic	Semiconductor	Material 5.0*
Transport	Foot	Ox, horse	Motor car, boat, plane	Multimobility	Autonomous driving
Form of settlement	Nomadic, small settlement	Fortified city	Linear (industrial) city	Network city	Autonomous decentralized city
City ideals	Viability	Defensiveness	Functionality	Profitability	Humanity

Fig 1.1 Contextualizing Society 5.0. Categories created by the authors. Source: Produced by authors. *Research conducted by the University of Tokyo's Material Innovation Research Center

In other words, Society 5.0 is a model to communicate the government's vision of a future society to industry and the general public. This model was the culmination of numerous discussions among experts from various fields. It was also based on research into the history of technology and social development.

Schema of society 5.0

The basic schema of Society 5.0 is that data are collected from the "real world" and processed by computers, with the results being applied in the real world. This schema is not new in itself. To cite a familiar example, air-conditioning units automatically keep a room at the temperature programmed into the unit. An air conditioner regularly measures the room's temperature, and an internal microcomputer then compares the temperature reading with the registered temperature setting. Depending on the result, the airflow is activated or deactivated automatically, such that the room maintains the desired temperature. Many of the systems we rely on in society use this basic mechanism. It underlies the systems responsible for keeping our homes adequately supplied with electricity, and those that keep the trains running on time. This mechanism relies on computerized automated controls. When people use the term "information society," they mean a society in which each of these systems collects data, processes them, and then applies the results in a particular real-world environment. So what makes Society 5.0 different? Instead of having each system operating within a limited scope, such as keeping a room comfortable, supplying energy, or ensuring that the trains run on time, Society 5.0 will have systems that operate throughout society in an integrated fashion. To ensure happiness and comfort, it is not enough just to have comfortable room temperatures. We require comfort in all aspects of life, including in energy, transport, medical care, shopping, education, work, and leisure. To this end, systems must gather varied and voluminous realworld data. This data must then be processed by sophisticated IT systems such as AI, A. Deguchi et al. 3 as only these IT systems could handle such a vast array of data. The information yielded from such processing must then be applied in the real world so as to make our lives happier and more comfortable. But does this not happen already? The difference is that in Society 5.0, the resulting information will not just guide the operation of an air conditioner, generator, or railway; it will directly shape our actions and behavior. In summary, Society 5.0 will feature an iterative cycle in which data are gathered, analyzed, and then converted into meaningful information, which is then applied in the real world; moreover, this cycle operates at a society-wide level.

Characteristics of Society 5.0

Merging Cyberspace and Physical Space

Having clarified the basic schema, we now turn to the next question: what do we mean by "merging the physical space (real world) and cyberspace?" Cyberspace refers to a digital space in which real-world data are collected and analyzed to derive solutions. The term was coined to describe an imaginary or virtual area, where swathes of raw data are freely accessed and converted into useful information, which can then be shared with others. The infrastructure of this space is the vast array of computer networks. However, in the case of Society 5.0, cyberspace does not just mean a space for exchanging vast volumes of data. It also means a space created by computer networks for analyzing problems and modeling practical, real-world solutions. When the computer systems of Society 5.0 analyze raw real-world data, they must do so using a structure that mirrors the real, physical world. As complicated as this may sound, the principle is very simple. To use the air conditioner example again, the internal microcomputer runs a program to measure a variable that describes the room temperature (let us call this variable "T"). The program compares the T value against the registered temperature setting and then determines whether to activate or stop the airflow. Thus, such an air conditioner has a discrete cyber model that analyzes the room with a single parameter, T. Let us call this the "room model." Modern air-conditioning systems can also sense the positions of people in the room and customize the temperature accordingly. Such systems allow for a more complex cyber room model, one that uses a range of parameters—such as room size, temperatures of different parts of the room, and positions of the room's inhabitants. The more closely one wants to meet people's needs for happiness and comfort, the more granular (or closer to the real world) the cyber model must be (see Fig. 1.1). The ultimate objective of Society 5.0 is to incorporate real-world models into cyberspace such that they can deliver highly nuanced solutions to real-life problems. What, then, is physical space? Physical space refers to the real world, from which raw data are collected and into which solutions are applied. Some might interpret "real world" to mean everything that is real, including computer systems. Hence, the government literature adopted the descriptor "physical" to distinguish this space from cyberspace. This book uses the expression "physical space (real world)."

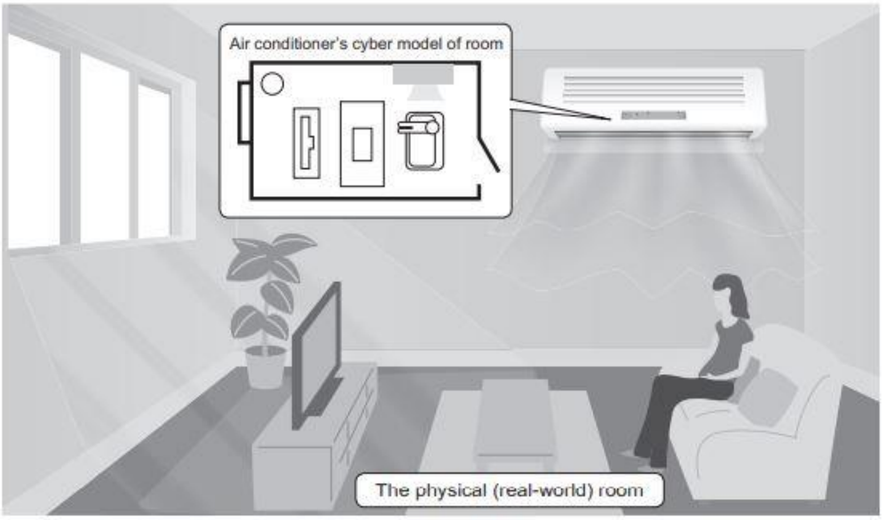


Fig1.2 Physical space (the room) and cyberspace (the air conditioner's model of the room)

As the next section explains, the idea of merging cyberspace with the physical space (real world) refers to a cycle in which data smoothly flow from the physical space (real world) into cyberspace and then flow back from cyberspace into the physical space (real world) in the form of meaningful information. Hitherto, we have relied on systems such as energy supply and rail transport systems, each of which governs some part of the physical world and is controlled separately. However, once all of these systems are interconnected through cyberspace, they will enable much more sophisticated services and produce much greater value in the real world.

Introduction to communication technologies:

The term Society 5.0 refers to the fifth step in the evolution of human civilization following the early hunter-gatherer society, then the agricultural society, the industrial society marked by mass-produced goods and our current information society. The aspirational goal involves recognizing that there is a limit to what people can do and that, instead of turning over all control to automation, humans can live better lives by wielding the latest technological tools.

In today's information age, we are sometimes overwhelmed by the sheer volume of data available to us. Sifting through mountains of information and analyzing it can stand in the way of reaching a solution. In Society 5.0, citizens will actively apply existing means such as the **Internet of Things (IoT), artificial intelligence (AI) and Big Data** to process all the inputs and avoid information overload. The projected result will be greater economic growth as well as improved quality of life.

Some of the aspects of tomorrow's super-smart society are already in play. For example, online shopping for goods and services is widespread. As cloud computing becomes even more pervasive, both consumers and proprietors will continue to reap benefits ranging from the greater ease and lower cost of conducting transactions virtually anywhere to the added security and protection from identity theft afforded by facial-recognition technology.

Along these same lines, integrating **AI** into home electronics is no longer a futuristic dream. Beginning meal preparations from remote locations and then arriving home to cozy conditions are possible today thanks to wi-fi-controlled kitchen appliances and smart HVAC systems.

With advanced driver-assistance systems (ADAS), autonomous vehicles are making it easier for us to get around outside our homes. Society can expect to realize safety, cost and time-optimizing advantages with the next generation of personal vehicles and public transportation options.

While self-driving cargo trucks are on the horizon, drones offer an airborne means of delivering goods, from pizzas to Amazon orders. But unmanned aircraft also are finding more vital applications in delivering relief supplies into hard-to-reach regions that have been hit by disasters, such as Puerto Rico following Hurricane Maria, and performing aerial reconnaissance of fleeing criminals and fast-spreading fires.

Robots have the potential to free society from the physical challenges and dangerous conditions encountered on some job sites. With GPS devices being smaller and more accurate than ever, AI-enabled automatons can be precisely controlled to perform intricate tasks that could not even be considered just a few years ago. Caring for people in need is one such application. Around the world, people are living longer lives. This is especially true in Japan, the world's fastest aging society. By 2050, an estimated third of the population will be 65 years of age or older. The country is taking a hard look at smart robotics as a means of providing enough 24/7 caregivers and unflagging physical assistance to assure independent lifestyles for its fast-growing senior population.

In addition to nursing care, the idea of a beneficial Society 5.0 extends to wearable health monitors and online medical examinations. The advent of telemedicine not only means fewer visits to clinics – and therefore less exposure to potentially infectious fellow patients in doctors' waiting rooms – but also reduces the time and transportation costs required to get medical attention. This could present invaluable benefits to seniors and people with mobility challenges.

The vision for the super-smart Society 5.0 is to free people from everyday burdensome tasks and serve the needs of every person while not ceding all control to machines. Japan is working to become the first nation to meet its challenges by implementing such a society. To me, that's advanced thinking.

Toward a People-Centric Society

It is through the mechanism described above that Society 5.0 will become a people-centric society. Originally, the purpose of an air conditioner was to keep a room at the desired temperature. The matter is simple enough if temperature control is our sole objective, but things start to get more complicated once our goal is a people-centric society. The government's 2017 comprehensive strategy describes a human-centered society as one that can "balance economic advancement with the resolution of social problems … to ensure that all citizens can lead high-quality lives full of comfort and vitality." The authors of the strategy described it as such because they understood how difficult it can be to balance economic development, resolution of social problems, and quality of life. Society 5.0 was thus proposed as a way to attempt this feat. Air conditioners play an invaluable role in society; many offices and factories would struggle to function if their premises were not comfortably air-conditioned. Air conditioner's cyber model of room The physical (real-world) room Fig. 1.1 Physical space (the room) and cyberspace (the air conditioner's model of the room) A. Deguchi et al. 5 Yet air conditioners also contribute to global warming: they often run on power derived from burning fossil fuels, which releases greenhouse gases. Thus, we cannot only consider the need to keep buildings comfortably air-conditioned; we must also consider the effects upon society as a whole, or indeed upon our entire ecosystem. As this example illustrates, balancing these two interests is no easy task. If we single-mindedly pursue economic growth, we may end up becoming a society of mass production and mass consumption, and harm the planet in the process. However, if we forgo our pleasures and restrict our energy consumption to the bare minimum, life becomes drab and uncomfortable. Moreover, if we all lived such a spartan existence, the economy would stall. Society 5.0 is an attempt to overcome this seemingly intractable dilemma. In this book, we outline the approach to this dilemma, an approach that we have termed "Habitat Innovation." We also examine the direction of the technological developments underlying Habitat Innovation. The task of solving social problems without sacrificing quality of life is difficult for another reason: it requires us to balance what is best for society with what is best for the individual. Suppose you live alone in a single-room apartment. Who decides on your air conditioner's temperature settings? Clearly, you are free to decide this for yourself. Suppose, however, that you are just one of the inhabitants. Each person may have their own temperature preferences. How do you ensure that you are all happy and comfortable? Should you take a poll of each person's preferred temperature and then calculate the mean? Should you hold a debate about the ideal temperature and then take a vote? Should someone in your group make a final decision? Not so simple anymore, is it? Yet this kind of scenario is at the easy end of the spectrum. Just imagine applying this to more complex social scenarios, in which you must consider the happiness of countless individuals, and do so using a dizzying array of scales and metrics. Could you reconcile or find an acceptable balance between the interests of the society and that of the individuals in it? This challenge is linked at a fundamental level to the question of what we mean by "high-quality lives full of comfort and vitality." There are many different definitions and measures of wellbeing. Well-being is not like the temperature of a room; you cannot quantify it in most cases. It will take us much more time until we can derive clear-cut solutions to this problem, but for the time being, humanities and social science researchers are delving into the peripheries of matter and considering how best we can approach the core. The vision of society that Society 5.0 describes requires us to think about two kinds of relationships: the relationship between technology and society and the technology-mediated relationship between individuals and society.

Introduction to Communication Technologies

In Society 5.0, the communication technologies used are Artificial Intelligence,Robotics, and 3D printing.

Artificial Intelligence

What is AI ?

Artificial Intelligence (AI) is a branch of Science which deals with helping machines

- Find solutions to complex problems in a more human-like fashion. This generally involves borrowing characteristics from human intelligence, and

- Applying them as algorithms in a computer friendly way. A more or less flexible or efficient approach can be taken depending on the

• Requirements established, which influences how artificial the intelligent behavior appears Artificial intelligence can be viewed from a variety of perspectives.

• From the perspective of intelligence artificial intelligence is making machines "intelligent" -- acting as we would expect people to act.

o The inability to distinguish computer responses from human responses is called the Turing test.

o Intelligence requires knowledge

Expert problem solving - restricting domain to allow including significant relevant knowledge

- From a business perspective AI is a set of very powerful tools, and methodologies for using those tools to solve business problems.
- From a programming perspective, AI includes the study of symbolic programming, problem solving, and search.

o Typically AI programs focus on symbols rather than numeric processing.

o Problem solving - achieve goals.

o Search - seldom access a solution directly. Search may include a variety of techniques.

o AI programming languages include:

– LISP, developed in the 1950s, is the early programming language strongly associated with AI. LISP is a functional programming language with procedural extensions. LISP (LISt Processor) was specifically designed for processing heterogeneous lists

-- Typically a list of symbols. Features of LISP are run- time type checking, higher order functions (functions that have other functions as parameters), automatic memory management (garbage collection) and an interactive environment.

– The second language strongly associated with AI is PROLOG. PROLOG was developed in the 1970s. PROLOG is based on first order logic. PROLOG is declarative in nature and has facilities for explicitly limiting the search space.

– Object-oriented languages are a class of languages more recently used for AI programming. Important features of object-oriented languages include: concepts of objects and messages, objects bundle data and methods for manipulating the data, sender specifies what is to be done receiver decides how to do it, inheritance (object hierarchy where objects inherit the attributes of the more general class of objects). Examples of object-oriented languages are Smalltalk, Objective C, C++. Object oriented extensions to LISP (CLOS - Common LISP Object System) and PROLOG (L&O - Logic & Objects) are also used.

Artificial Intelligence is a new electronic machine that stores large amount of information and process it at very high speed

The computer is interrogated by a human via a teletype It passes if the human cannot tell if there is a computer or human at the other end

The ability to solve problems

- It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence

Importance of AI

Game Playing

- You can buy machines that can play master level chess for a few hundred dollars. There is some AI in them, but they play well against people mainly through brute force computation--looking at hundreds of thousands of positions. To beat a world champion by brute force and known reliable heuristics requires being able to look at 200 million positions per second.

Speech Recognition

- In the 1990s, computer speech recognition reached a practical level for limited purposes. Thus United Airlines has replaced its keyboard tree for flight information by a system using speech recognition of flight numbers and city names. It is quite convenient. On the other hand, while it is possible to instruct some computers using speech, most users have gone back to the keyboard and the mouse as still more convenient.

Understanding Natural Language

- Just getting a sequence of words into a computer is not enough. Parsing sentences is not enough either. The computer has to be provided with an understanding of the domain the text is about, and this is presently possible only for very limited domains.

Computer Vision

• The world is composed of three-dimensional objects, but the inputs to the human eye and computers' TV cameras are two dimensional. Some useful programs can work solely in two dimensions, but full computer vision requires partial three-dimensional information that is not just a set of two-dimensional views. At present there are only limited ways of representing three-dimensional information directly, and they are not as good as what humans evidently use.

Expert Systems

• A ``knowledge engineer'' interviews experts in a certain domain and tries to embody their knowledge in a computer program for carrying out some task. How well this works depends on whether the intellectual mechanisms required for the task are within the present state of AI. When this turned out not to be so, there were many disappointing results. One of the first expert systems was MYCIN in 1974, which diagnosed bacterial infections of the blood and suggested treatments. It did better than medical students or practicing doctors, provided its limitations were observed. Namely, its ontology included bacteria, symptoms, and treatments and did not include patients, doctors, hospitals, death, recovery, and events occurring in time. Its interactions depended on a single patient being considered. Since the experts consulted by the knowledge engineers knew about patients, doctors, death, recovery, etc., it is clear that the knowledge engineers forced what the experts told them into a predetermined framework. The usefulness of current expert systems depends on their users having common sense.

Heuristic Classification

• One of the most feasible kinds of expert system given the present knowledge of AI is to put some information in one of a fixed set of categories using several sources of information. An example is advising whether to accept a proposed credit card purchase. Information is available about the owner of the credit card, his record of payment and also about the item he is buying and about the establishment from which he is buying it (e.g., about whether there have been previous credit card frauds at this establishment).

Applications of AI

Consumer Marketing

o Have you ever used any kind of credit/ATM/store card while shopping?

o if so, you have very likely been “input” to an AI algorithm o All of this information is recorded digitally o Companies like Nielsen gather this information weekly and search for patterns – general changes in consumer behavior – tracking responses to new products – identifying customer segments: targeted marketing, e.g., they find out that consumers with sports cars who buy textbooks respond well to offers of new credit cards.

o Algorithms ("data mining") search data for patterns based on mathematical theories of learning **Identification Technologies**

o ID cards e.g., ATM cards o can be a nuisance and security risk: cards can be lost, stolen, passwords forgotten, etc

o Biometric Identification, walk up to a locked door – Camera – Fingerprint device – Microphone – Computer uses biometric signature for identification – Face, eyes, fingerprints, voice pattern – This works by comparing data from person at door with stored library – Learning algorithms can learn the matching process by analyzing a large library database off-line, can improve its performance. **Intrusion Detection**

o Computer security - we each have specific patterns of computer use times of day, lengths of sessions, command used, sequence of commands, etc – would like to learn the "signature" of each authorized user – can identify non-authorized users o How can the program automatically identify users? – record user's commands and time intervals – characterize the patterns for each user – model the variability in these patterns – classify (online) any new user by similarity to stored patterns

Machine Translation

o Language problems in international business – e.g., at a meeting of Japanese, Korean, Vietnamese and Swedish investors, no common language – If you are shipping your software manuals to 127 countries, the solution is ; hire translators to translate – would be much cheaper if a machine could do this! o How hard is automated translation – very difficult! – e.g., English to Russian – not only must the words be translated, but their meaning also!

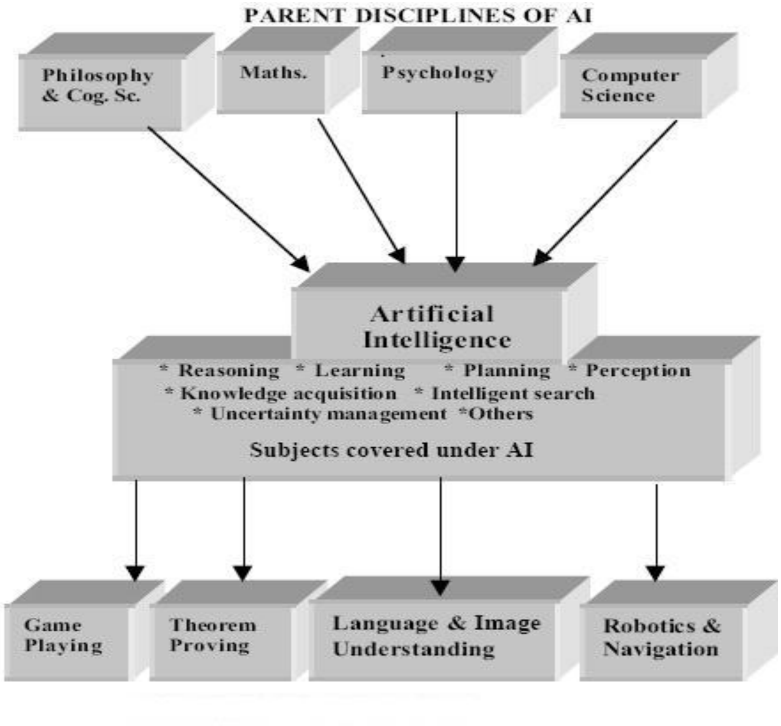


Fig 1.3 Applications of AI

ROBOTICS

- Robotics is an interdisciplinary sector of science and engineering dedicated to the design, construction and use of mechanical robots.
- Robots all consist of some sort of mechanical construction.
- Robots need electrical components that control and power the machinery.
- Robots contain at least some level of computer programming.

Pre-Programmed Robots:

- Pre-programmed robots operate in a controlled environment where they do simple, monotonous tasks.
- An example of a pre-programmed robot would be a mechanical arm on an automotive assembly line.

Humanoid Robots

- Humanoid robots are robots that look like and/or mimic human behavior.

- These robots usually perform human-like activities (like running, jumping and carrying objects), and are sometimes designed to look like us, even having human faces and expressions.
- Two of the most prominent examples of humanoid robots are Hanson Robotics' Sophia and Boston Dynamics' Atlas

Autonomous Robots

- Autonomous robots operate independently of human operators.
- These robots are usually designed to carry out tasks in open environments that do not require human supervision.
- An example of an autonomous robot would be the Roomba vacuum cleaner, which uses sensors to roam throughout a home freely.

Teleoperated Robots

- Tele operated robots are mechanical bots controlled by humans.
- These robots usually work in extreme geographical conditions, weather, circumstances, etc.
- Examples of teleoperated robots are the human-controlled submarines used to fix underwater pipe leaks during the BP oil spill or drones used to detect landmines on a battlefield.

Augmenting Robots

- Augmenting robots either enhance current human capabilities or replace the capabilities a human may have lost.
- Some examples of augmenting robots are robotic prosthetic limbs or exoskeletons used to lift hefty weights.

3D PRINTING

- 3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file.
- The creation of a 3D printed object is achieved using additive processes.

- In an additive process an object is created by laying down successive layers of material until the object is created.
- Each of these layers can be seen as a thinly sliced cross-section of the object.
- The process always begins with a digital 3D model - the blueprint of the physical object.
- This model is sliced by the printer's software into thin, 2-dimensional layers and then turned into a set of instructions in machine language (G-code) for the printer to execute.
- The way a 3D printer works varies by process.
- 1. Desktop FDM printers
- 2. Large industrial SLS

Desktop FDM printers melt plastic filaments and lay it down onto the print platform through a nozzle (like a high-precision, computer-controlled glue gun).

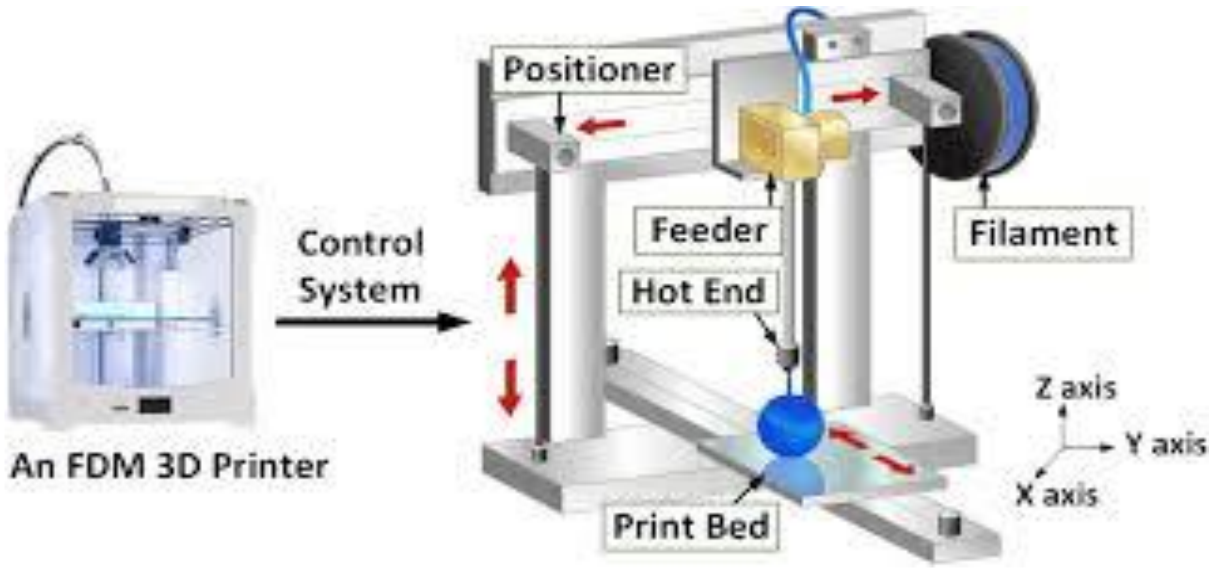


Fig 1.4 FDM printers

Large industrial SLS machines use a laser to melt (or sinter) thin layers of metal or plastic powders.

Fig 1.5 Industrial 3D printer

Modelling Real-World Issues

Cyberspace is the electronic world inside computers. Data from the physical space (real world) are analyzed in cyberspace so as to derive solutions for managing or improving society. Once these solutions are implemented in physical space (real world), the outcomes are evaluated, which generates data. This data is then input back into cyberspace for analysis and, if there are any problems, further solutions will be derived. This cycle, whereby society is continuously adjusted and improved, is what Society 5.0 is all about. To derive solutions for the physical space (real world), cyberspace must have a structure mirroring that of the real world. Consider once again the example of the air conditioner (see Fig. 1.2). In this case, the cyber model must have a real-world mirroring structure necessary for air-conditioning the room. In other words, the system must model the physical characteristics of the room to understand how the room will change if the airflow is increased or decreased. If the system models the room's features as they are in reality, it can run cyber simulations and learn strategies for keeping the room optimally air-conditioned. The impact of a given level of airflow upon the room temperature will depend on various factors, including the room's size, the heat-insulating properties of the walls, the number of inhabitants, and the exterior temperature. It is no easy task to acquire a model that accurately reflects the room's real-life conditions. This is where the Internet of

Things (IoT) and artificial intelligence (AI) come in. IoT allows varied and voluminous data (in this case, the room's size, the temperatures in different parts of the room, the room's inhabitants and their spatial distribution, etc.) to be gathered in cyberspace. AI, on the other hand, can analyze the vast amounts of data obtained and then create a cyber model of the room that behaves just like the real thing.

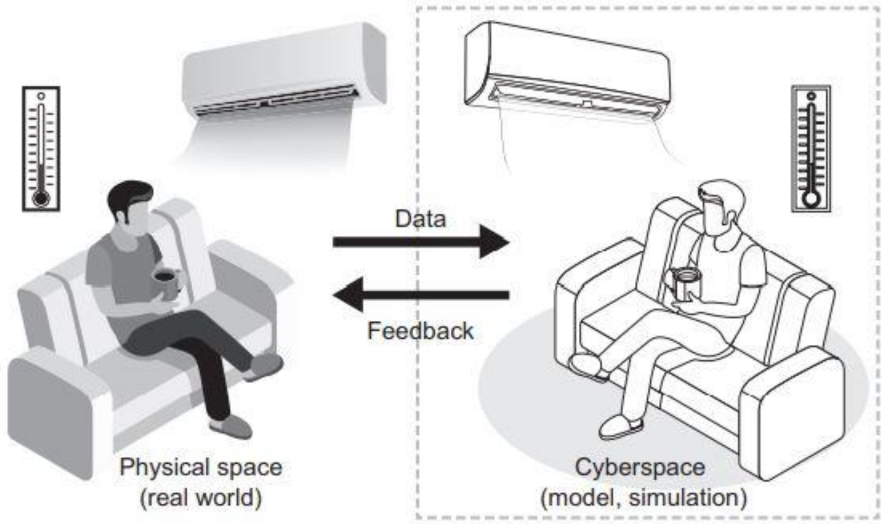


Fig1.6 Modeling the real world

Once this cyber model is established, the system can estimate how best to condition the room and then implement this strategy in the physical space (real world). The system can measure how the airflow is affecting the room temperature and incorporate this information back into cyberspace. If the room's actual temperature differs from the target temperature, then the cyber model of the room must have missed the mark. The AI notes the mistake and readjusts the model accordingly. Through this calibration cycle, the cyber model of the room will eventually come to adequately resemble the actual room. Thus, when the literature mentions the "merging" of cyberspace and physical space, it means that these two spaces have come to resemble one another so much as to be indistinguishable.

The idea of merging the cyber and the physical is not novel. Power generation and rail transport, for example, now use control systems that model their target environment so as to supply the right level of energy or run the trains on time. Such systems are known as cyber-physical systems (CPS). However, the convergence of the cyber and physical that Society 5.0 envisages does not involve separate, isolated systems. Society 5.0 is about cyber-physical convergence at the level of society as a whole. Convergence at this macro-level could perhaps be described as the merging of spaces with spaces.

Knowledge-Intensive Society

Society 5.0 identifies three elements that drive social innovation: data, information, and knowledge. In this section, we clarify what these three terms mean and describe the ways in which Society 5.0 constitutes a knowledge-intensive society

Data, Information, and Knowledge

First, what are data? Generally, data refer to tangible and intangible phenomena in the physical space (real world) that are represented as numerical values, states, names, or binary figures (0 or 1) telling us whether a thing is present or absent. To illustrate this definition, we will refer to the population of a hypothetical municipality (let us call it Town A). In Japan, the town's population could be worked out by referring to the relevant entries in the national registry of citizens (the "Basic Resident Register"). From this source, the attributes of Town A's residents, including their gender, household composition, and address, could be found. These facts represent Town A's data. Data are the most basic of the three elements (data, information, and knowledge) that are accumulated in cyberspace.

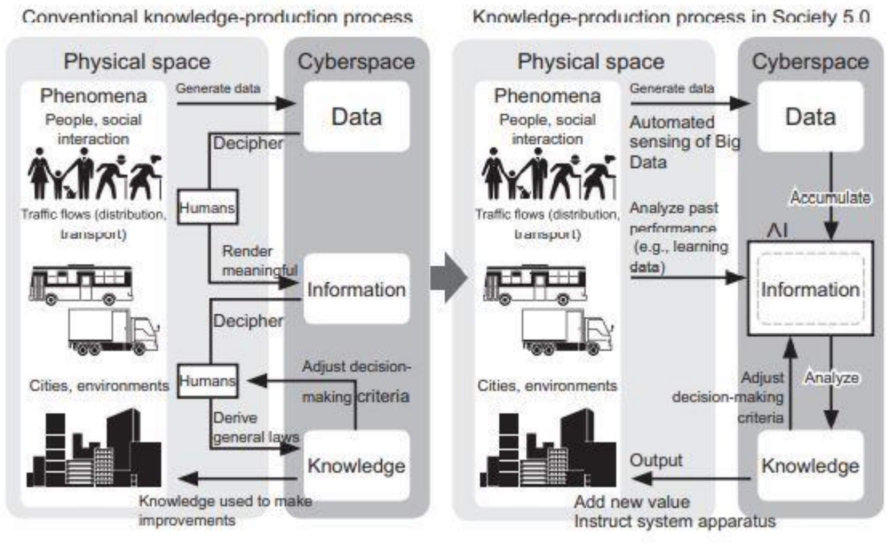


Fig. 1.4 Data, information, and knowledge

If this is data, what is information? Information is data that has been rendered meaningful by selecting and processing it for a particular purpose or as part of a course of action. To return to Town A, once you have the raw population data, it could be broken down by age group to see the demographic trends over the past 10 years or the rate of aging. The age breakdown could also be used to plot a graph showing the population pyramid. The results of such analysis represent Town A's information. By analyzing the demographic trends, you could determine whether Town A is on a growth trajectory (its population is growing) or whether it is on the decline (its population is shrinking). It is the addition of such meaningful indications that turns data into information.

Suppose the information tells you that Town A's population is shrinking. To address this problem, you must analyze the causes of the population decline. Perhaps the decline is driven by falling birthrates and population aging. Or perhaps there is a net outflow (the people moving away from the town outnumber the people coming in). The decision of what to do could be worked out by comparing Town A's population trends with that of other municipalities and referring to best practice models developed by experts. Knowledge, then, is what enables you to make a decision. Information becomes knowledge when it is comprehended, analyzed, and related to general laws, including best practices and precedents. Knowledge can also be described as generalized observations extracted from individual cases. Knowledge allows you to surmise the causes of a problem, and it also helps you to derive solutions to address these causal factors. The more knowledge you have, the more equipped you are to derive a judicious information-based decision.

What Is a Knowledge-Intensive Society?

Data becomes useful to us once we convert it to information, and then into knowledge. Hitherto, this conversion process has been driven by human–computer interactions. In Society 5.0, the process will be driven without human intervention; of the three elements, humans will only gain greater opportunities to access AI-derived knowledge, the final output of the conversion process

How will this change affect society?

New knowledge will arise when data and information are deployed interconnectedly. New knowledge can spark innovation in tertiary industries such as services, but it will also do so in the more traditional primary and secondary industries such as agriculture and manufacturing. Japan's agricultural sector is somewhat inefficient owing to sporadically distributed farmland. A knowledge-intensive Japan, however, could spark an agricultural renaissance by leveraging detailed spatial information and predictive weather knowledge along with drone and robotic technologies. A knowledge-intensive society may also generate new industries and transform the industrial structure.

The role of technology thus far has been to add value to tangible goods, but in the knowledge-intensive society, universities and businesses will need to help cultivate new industries, which in turn will generate new value by clustering and combining knowledge.

Rules and Norms in the Knowledge-Intensive Society

No matter how advanced this process becomes, if the data is unsuitable for analysis, you will fail to derive accurate knowledge. Although automated processes can catch some data errors, it is difficult at present to catch every error owing to the lack of a coordinated system. Another issue was that despite the incomparability of the data, third parties might attempt comparisons anyway, which would result in erroneous knowledge. If anyone can tally the number of visitors with a simple device and then publish the data online, it is all the more important to establish common standards and procedures, so that data producers approach the data judiciously, understanding how it will be used.

Information Literacy

One of the top tasks in relation to Society 5.0 is to ensure that such individuals are literate in personal data and information. As we move toward a truly people-centric life, progress in information technology must be accompanied by efforts to train up industrial innovators and raise the information literacy of each and every citizen. Universities, for their part, in addition to spurring technological progress as before, must additionally be responsible for cultivating literacy among information users through both general curricula and recurrent education, so as to promote the civil society that embodies Society 5.0.

Data-Driven Society

Society 5.0 is described as a data-driven society. What is a data-driven society? We live in a so-called information society, so how does this differ from a data-driven society? The previous section defined information as data that has been processed and rendered meaningful, while it defined knowledge as the general empirical laws extracted from such information.

What Is a Data-Driven Society?

Definition of data driven society is given in 2015 report of the Ministry of Economy, Trade and Industry’s (METI) Industrial Structure Council (Ministry of Economy 2015). This report defines a data-driven society as a society "where the above-mentioned CPS is applied to various industrial societies through digitization and networking of things using IoT, and the digitized data is converted into intelligence and applied to the real world, and then the data acquire added value and move the real world [sic]." In this quotation, "intelligence" equates with the information and knowledge discussed in the previous section.

More simply, the data-driven society is a society where data (gathered by IoT networks) are converted into information and knowledge, which then "drive" (or as the literature says, "move") the real world. As accurate as this definition may be, it may still leave readers nonplussed. The previous section described the relationships between data, information, and knowledge, but this does not give us a clear picture of how data drives the real world. So how exactly does data drive the real world? It drives the world in two different ways. First, data drives the world indirectly via humans. That is, vast resources of data inform and guide human decision-making, which then effects change in the world. Second, data drive the world directly (without the mediation of humans) through automated processes. Let us consider examples of both.

Regarding the former, suppose you are designing an urban transport system; under a conventional approach, you would consult data and then make decisions based on this data. You would rely on numerous researchers to gather traffic volume data using manually operated head counters, and these findings would inform your designs for road traffic, bus services, metro system, and the like. However, because these traffic data are costly to gather, only a limited amount are available (there are only data for a limited number of sites in the city and these are dated several years apart).

In the data-driven society, however, the data available would be staggering in volume and breadth, and be real-time data to boot. Technology allows you to monitor the traffic flows across the city as a whole in real time. For example, to monitor people flows, you could refer to smartphone data or access the data of prepaid transport cards (known as IC cards in Japan). To monitor foot and vehicle traffic volume, you could analyze the footage of CCTV cameras installed along roads and in buildings. You could also collate this data with shopping data to gain insights into A. Deguchi et al. 15 the motives for people's movements. By visually modeling all this urban data in real time, you will grasp the entire workings and dynamics of the city.

Before enacting any changes in the city, you must hold a consultation process in which numerous stakeholders share their understanding of the status quo and how it should be changed, if at all. A visual model of the city grounded in voluminous, varied, and real-time data would radically shape this consultation and decision making processes. This is what it means for data to drive society indirectly, via humans.

Now for the latter meaning—a society that is driven directly by automated systems. One example of automated control systems is traffic signals. Traffic lights shift between red, amber, and green, thanks to the operation of an internal computer program, one that humans designed.

However, if we want the kind of people-centric society that Society 5.0 describes, we must consider numerous variables and needs, even if we limit our focus to a traffic control system. Drivers may want minimal congestion, residents may want minimal traffic flows so as to limit exhaust fumes, and pedestrians might wish to have minimal waiting times at crosswalks. Railway level crossings can be a source of traffic congestion, so rail timetables would also have to be considered. All in all, a traffic control system is a very complex matter.

It is all but impossible for humans to design a program that can control traffic signals absolutely optimally, taking into account all the above variables and needs. Hence, we must look to AI. Humans can define an optimal traffic state and then let AI coordinate traffic signals accordingly. If we regularly input data, such as traffic volumes, exhaust volumes, and pedestrian waiting times, AI will start to learn the outcomes it can expect from a given traffic control pattern. In this way, AI will progressively derive general laws on how best to control traffic. Over time, the AI will learn how transport is affected by factors such as public events and weather conditions and come to understand the optimum responses to such phenomena.

Thus, in the future, AI will convert data into knowledge (general empirical laws) through an automated process, and then use this knowledge to automatically control traffic. Instead of traffic signals being controlled by a human-made computer program, they will be controlled by AI-generated optimum algorithms. This process is mediated by data, but not by humans: that is the second meaning of a data-driven society.

From the Information Society to the Data-Driven Society So far, we have learned that the data-driven society is a society where IoT-gathered data is converted into information and knowledge, which then drives the real world either indirectly (with the mediation of humans) or directly (through automation). How does this differ from an information society? An information society derives value from information. A data-driven society (in both senses) derives value from data. The government’s Growth Strategy 2018 (Growth Strategy Council 2018) describes this idea in stark terms: 1 What Is Society 5.0? 16 “…in the data-driven society of the 21st century, the most important currency of economic activity is high quality, up-to-date and abundant ‘real data’. Data has become so valuable that saying that the success or failure of a business depends on its access to data [is] by no means an exaggeration.”

Some might argue that we should shorten the term “data-driven society” to “data society,” so as to more easily compare and contrast it with the “information society.” However, the government decided to add “-driven” to underscore how future technological progress will result in extensive automation (nonhuman-mediated processes).

In this section, we learned about the two ways in which society will be data driven. Of the two, an automated society may seem the more futuristic. However, it would be a mistake to think of a human-mediated society as a transitionary state between today’s society and the ultimate state of full automation. Instead, human mediation and automation will exist side by side. In the case of traffic signals, AI is responsible for effectuating an optimal state, but it is humans who decide what this state is in the first place. Human-mediated processes, such as consultations in which the participants refer to visual urban data, will play an ever-greater role in building the people-centric society. We are the ones who decide how to strike a balance between different comfort needs, such as between drivers’ desire to travel smoothly without needing to constantly stop at red lights and pedestrians’ desire to cross the road quickly. Likewise, it is humans who define the criteria for measuring comfort and happiness. Standards of happiness vary between cultures and time periods. To find the right balance, consultation processes should involve as many stakeholders as possible, not least of whom should be residents—the chief actors of a local community. Once full consultations have been made and a consensus reached, this consensus can then be put into effect by automated technology. These parallel aspects of a data-driven society, by operating in tandem in this way, will support the peoplecentric Society 5.0 and provide the flexibility necessary to ensure that the underlying architecture is applicable in many different countries and cultures. Thus, solutions generated in Society 5.0 can contribute to other social problems in different parts of the world.

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SCHOOL OF COMPUTING

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

UNIT II

SOCIETY 5.0 – SAIC4002

EMERGING TECHNOLOGIES WITH SOCIETY 5.0 9hrs

Introduction to Big Data – Issues and Challenges in the traditional systems –Intelligent Data Analysis –Big Data Storage Statistical Concepts: Sampling Distributions - Re-Sampling - Prediction Error – Random Sampling– Artificial Intelligence – - Foundations of AI - Intelligent agent - Types of agents - Structure - Problem solving agents -Internet of Things- Introduction to IoT- Basic Architecture of an IoT, From M2M to IoT, M2M towards IoT-Robotics- Robotics system components - Robot classification Coordinate frames - degree of freedom - dynamic stabilization of robots

1. BIG DATA

- Big Data is a collection of data that is huge in volume, yet growing exponentially with time.
- It is a data with so large size and complexity that none of traditional data management tools can store it or process it efficiently.
- Big data is also a data but with huge size.

Types of Big Data

1. Structured
2. Unstructured
3. Semi-structured

1. Structured Data

Any data that can be stored, accessed and processed in the form of fixed format is termed as a 'structured' data.

Employee_ID	Employee_Name	Gender	Department	Salary_In_lacs
2365	Rajesh Kulkarni	Male	Finance	650000
3398	Pratibha Joshi	Female	Admin	650000
7465	Shushil Roy	Male	Admin	500000
7500	Shubhojit Das	Male	Finance	500000
7699	Priya Sane	Female	Finance	550000

Fig 2.1 Sample structured data

2. Unstructured Data

Any data with unknown form or the structure is classified as unstructured data. Heterogeneous data source containing a combination of simple text files, images, videos etc.

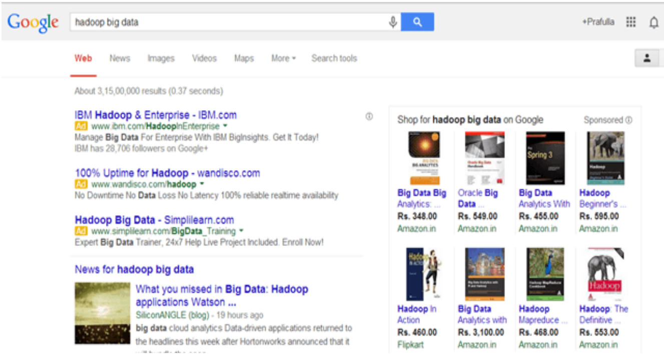

Fig 2.2 Sample Unstructured Data

3. Semi-structured Data

- Semi-structured data can contain both the forms of data.
- We can see semi-structured data as a structured in form but it is actually not defined with e.g. a table definition in relational DBMS.
- Example of semi-structured data is a data represented in an XML file.

Personal data stored in an XML file-

```
<rec><name>Prashant Rao</name><sex>Male</sex><age>35</age></rec>
<rec><name>Seema R.</name><sex>Female</sex><age>41</age></rec>
<rec><name>Satish Mane</name><sex>Male</sex><age>29</age></rec>
<rec><name>Subrato Roy</name><sex>Male</sex><age>26</age></rec>
<rec><name>Jeremiah J.</name><sex>Male</sex><age>35</age></rec>
```

Fig 2.3 Sample Semi-Structured Data

Characteristics of Big Data

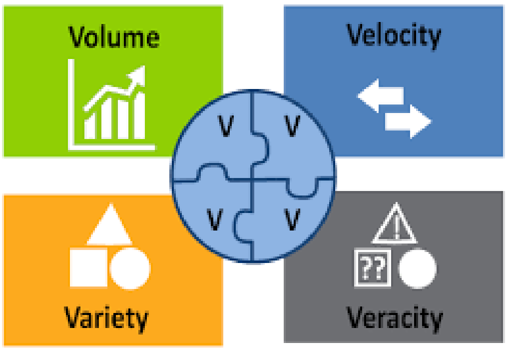

Fig 2.4 Characteristics of Big Data

(i) Volume

- The name Big Data itself is related to a size which is enormous.
- Size of data plays a very crucial role in determining value out of data.
- Also, whether a particular data can actually be considered as a Big Data or not, is dependent upon the volume of data.
- Hence, **'Volume'** is one characteristic which needs to be considered while dealing with Big Data.

(ii) Variety

- Variety refers to heterogeneous sources and the nature of data, both structured and unstructured.
- During earlier days, spreadsheets and databases were the only sources of data considered by most of the applications.
- Nowadays, data in the form of emails, photos, videos, monitoring devices, PDFs, audio, etc. are also being considered in the analysis applications.
- This variety of unstructured data poses certain issues for storage, mining and analyzing data.

(iii) Velocity

- The term **'velocity'** refers to the speed of generation of data. How fast the data is generated and processed to meet the demands, determines real potential in the data.
- Big Data Velocity deals with the speed at which data flows in from sources like business processes, application logs, networks, and social media sites, sensors, Mobile devices, etc. The flow of data is massive and continuous.

(iv) Veracity

- This refers to the inconsistency which can be shown by the data at times, thus hampering the process of being able to handle and manage the data effectively.

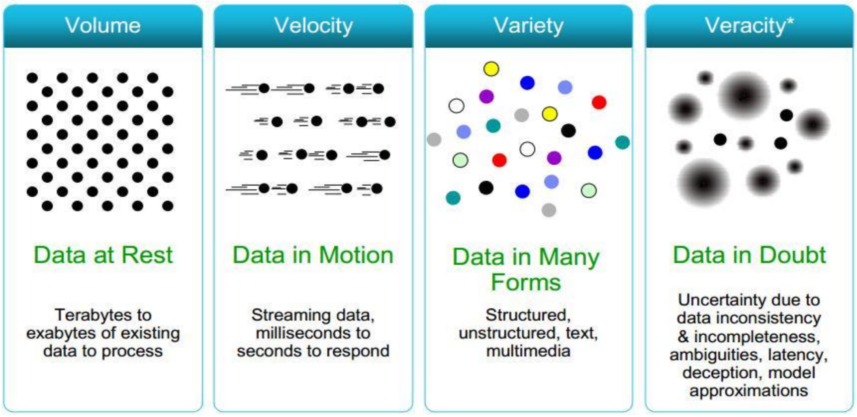

Fig 2.5 Detailed Characteristics of Big Data

<u>Traditional System – Issues and Challenges</u>

- **CONVENTIONAL SYSTEM TECHNOLOGY:**

Storage (MIPS - Microprocessor without Interlocked Pipelined Stages), Voluminous data sizes

- **<u>CPU Speed</u>**

  – 1990 - 44 MIPS at 40 MHz

  – 2000 - 3,561 MIPS at 1.2 GHz

  – 2010 - 147,600 MIPS at 3.3 GHz

- **RAM Memory**

  – 1990 – 640K conventional memory (256K extended memory recommended)

  – 2000 – 64MB memory

  – 2010 - 8-32GB (and more)

- **Disk Latency** (speed of reads and writes) –

  The Speed was very less form the past 7-10 years, currently around 70 – 80MB / sec

- **How long it will take to read 1TB of data?**

• 1TB (at 80Mb / sec):

– 1 disk - 3.4 hours

– 10 disks - 20 min

– 100 disks - 2 min

– 1000 disks - 12 sec

Intelligent Data Analysis (IDA)

- The IDA is an interdisciplinary study concerned with the effective analysis of data.
- Used for extracting useful information from large quantities of online data.
- Extracting desirable knowledge or interesting patterns from existing databases

Big Data Storage Statistical Concepts

Why Sampling?

- The physical impossibility of checking all items in the population, and, also, it would be too time-consuming
- Sampling has an intuitive semantics
  - We obtain a smaller data set with the same structure
- Estimating on a sample is often straightforward
  - Run the analysis on the sample that you would on the full data
  - Some rescaling/reweighting may be necessary
- Sampling is general and agnostic to the analysis to be done
  - Other summary methods only work for certain computations
  - Though sampling can be tuned to optimize some criteria
- Sampling is (usually) easy to understand

So prevalent that we have an intuition about sampling

Alternatives to Sampling

- Sampling is not the only game in town
  - Many other data reduction techniques by many names
- Dimensionality reduction methods
  - PCA, SVD, eigen value/eigen vector decompositions
  - Costly and slow to perform on big data
- “Sketching” techniques for streams of data
  - Hash based summaries via random projections
  - Complex to understand and limited in function
- Other transform/dictionary based summarization methods
  - Wavelets, Fourier Transform, DCT, Histograms
  - Not incrementally updatable, high overhead

<u>Basic Terminologies</u>

Some basic terminology which are closely associated to the above-mentioned tasks are reproduced below.

- **Population:** A population consists of the totality of the observation, with which we are concerned.
- **Sample:** A sample is a subset of a population.
- **Random variable:** A random variable is a function that associates a real number with each element in the sample.
- **Statistics:** Any function of the random variable constituting random sample is called a statistics.
- **Statistical inference:** It is an analysis basically concerned with generalization and prediction.

<u>Sampling Distribution</u>

- The sampling distribution of a statistic is a probability distribution based on a large number of samples of size n from a given population.

- In inferential statistics, we want to use characteristics of the sample (i.e. a **statistic**) to estimate the characteristics of the population (i.e. a **parameter**).

Sampling Methods

- **Probability Sampling**: Each data unit in the population has a known likelihood of being included in the sample.
- **Non-probability Sampling**: Does not involve random selection; inclusion of an item is based on convenience
- **Sampling with replacement**: Each data unit in the population is allowed to appear in the sample more than once.
- **Sampling without replacement**: Each data unit in the population is allowed to appear in the sample no more than once.

Random Sampling Methods

- Most commonly used probability/random sampling techniques are
  - Simple random sampling
  - Stratified random sampling
  - Cluster random sampling

Simple random sampling

- Each item (person) in the population has an equal chance of being included.

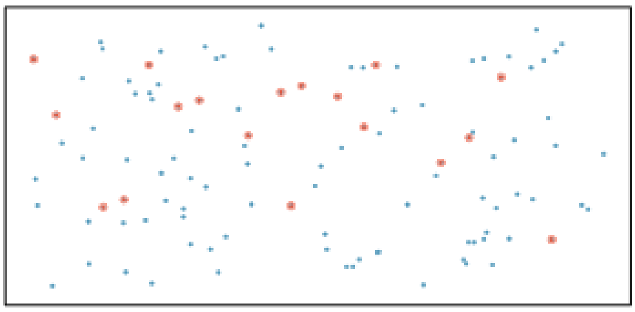

Fig 2.6 Simple Random Sampling

Stratified random sampling

- A population is first divided into strata which are made up of similar observations. Take a simple random sample from each stratum

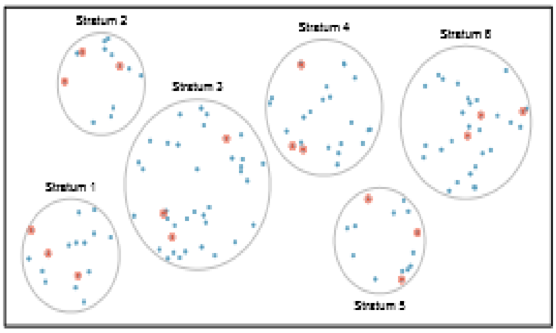

Fig 2.7 Stratified Random Sampling

Cluster random sampling

- A population is first divided into clusters which are usually not made up of homogeneous observations, and take a simple random sample from a random sample of clusters

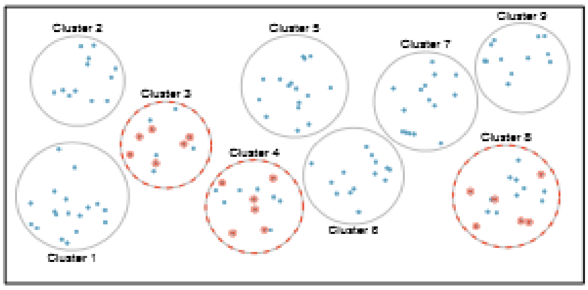

Fig 2.8 Cluster Random Sampling

<u>Sampling error vs non-sampling error</u>

- **Sampling error:** the difference between a sample statistic and its corresponding population parameter. This error is inherent in The sampling process (since sample is only part of the population) The choice of statistics (since a statistics is computed based on the sample).
- **Non-sample Error:** This error has no relationship to the sampling technique or the estimator. The main reasons are human-related data recording non-response sample selection

Resampling

- Resampling is a methodology of economically using a data sample to improve the accuracy and quantify the uncertainty of a population parameter.

Types

1. Bootstrapping and Normal resampling (sampling from a normal distribution).
2. Permutation Resampling (also called Rearrangements or Rerandomization),
3. Cross Validation

(1) Bootstrapping and Normal Resampling:

- **Bootstrapping** is a type of resampling where large numbers of smaller samples of the same size are repeatedly drawn, with replacement, from a single original sample.
- **Normal resampling** is very similar to bootstrapping as it is a special case of the normal shift model—one of the assumptions for bootstrapping (Westfall et al., 1993).
- Both bootstrapping and normal resampling both assume that samples are drawn from an actual population.
- Another similarity is that both techniques use sampling with replacement.

2.Permutation Resampling

- Unlike bootstrapping, permutation resampling doesn't need any "population"; resampling is dependent only on the assignment of units to treatment groups.
- The fact that you're dealing with actual samples, instead of populations, is one reason why it's sometimes referred to as the Gold standard bootstrapping technique (Strawderman and Mehr, 1990).
- Another important difference is that permutation resampling is a without replacement sampling technique.

(c) Cross validation

- Cross-validation is a way to validate a predictive model.
- Subsets of the data are removed to be used as a validating set; the remaining data is used to form a training set, which is used to predict the validation set.

Prediction Error

- **Prediction error** quantifies one of two things:
- In regression analysis, it's a measure of how well the model predicts the response variable.
- In classification (machine learning), it's a measure of how well samples are classified to the correct category.

2. ARTIFICIAL INTELLIGENCE (AI)

Foundations of AI

- Artificial Intelligence (AI) is the ability of a machine to perform cognitive functions as humans do.
- Such as perceiving, learning, reasoning and solving problems.
- The benchmark for AI is the human level concerning in teams of reasoning, speech, and vision.
- With the help of AI, you can create such software or devices which can solve real-world problems very easily and with accuracy such as health issues, marketing, traffic issues, etc.
- With the help of AI, you can create your personal virtual Assistant, such as Cortana, Google Assistant, Siri, etc.
- With the help of AI, you can build such Robots which can work in an environment where survival of humans can be at risk.
- AI opens a path for other new technologies, new devices, and new Opportunities.

Goals of Artificial Intelligence

- Replicate human intelligence
- Solve Knowledge-intensive tasks
- An intelligent connection of perception and action
- Building a machine which can perform tasks that requires human intelligence such as:
- Building a machine which can perform tasks that requires human intelligence such as:
    - Proving a theorem
    - Playing chess
    - Plan some surgical operation

- Driving a car in traffic

- Creating some system which can exhibit intelligent behavior, learn new things by itself, demonstrate, explain, and can advise to its user.

Areas which contribute to Artificial Intelligence

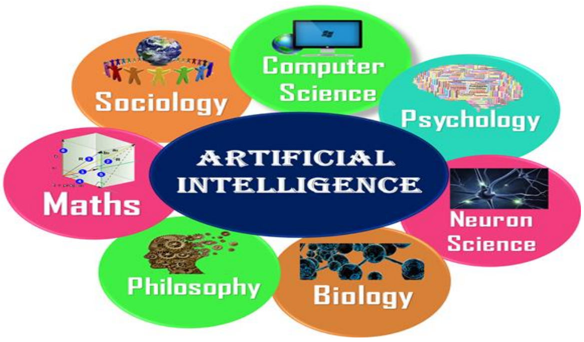

Fig 2.9 Areas of AI

Types of AI

- **Narrow AI**: A artificial intelligence is said to be narrow when the machine can **perform a specific task better than a human**. The current research of AI is here now
- **General AI**: An artificial intelligence reaches the general state when it can **perform any intellectual task with the same accuracy level as a human would**
- **Strong AI**: An AI is strong when it can **beat humans in many tasks**

Advantages of Artificial Intelligence

- **High Accuracy with less errors:** AI machines or systems are prone to less errors and high accuracy as it takes decisions as per pre-experience or information.
- **High-Speed:** AI systems can be of very high-speed and fast-decision making, because of that AI systems can beat a chess champion in the Chess game.
- **High reliability:** AI machines are highly reliable and can perform the same action multiple times with high accuracy.
- **Useful for risky areas:** AI machines can be helpful in situations such as defusing a bomb, exploring the ocean floor, where to employ a human can be risky.

- **Digital Assistant:** AI can be very useful to provide digital assistant to the users such as AI technology is currently used by various E-commerce websites to show the products as per customer requirement.
- **Useful as a public utility:** AI can be very useful for public utilities such as a self-driving car which can make our journey safer and hassle-free, facial recognition for security purpose, Natural language processing to communicate with the human in human-language, etc.

Disadvantages of Artificial Intelligence

- **High Cost:** The hardware and software requirement of AI is very costly as it requires lots of maintenance to meet current world requirements.
- **Can't think out of the box:** Even we are making smarter machines with AI, but still they cannot work out of the box, as the robot will only do that work for which they are trained, or programmed.
- **No feelings and emotions:** AI machines can be an outstanding performer, but still it does not have the feeling so it cannot make any kind of emotional attachment with human, and may sometime be harmful for users if the proper care is not taken
- **Increase dependency on machines:** With the increment of technology, people are getting more dependent on devices and hence they are losing their mental capabilities.
- **No Original Creativity:** As humans are so creative and can imagine some new ideas but still AI machines cannot beat this power of human intelligence and cannot be creative and imaginative.

Berkeley's Stuart J. Russell and Google's Peter Norvig broke AI into five distinct research areas

1. Machine Learning
2. Expert Systems
3. Computer Vision
4. Natural Language Processing
5. Robotics

(1) Machine Learning

Machine learning (ML) is the science of **empowering machines to make decisions without human intervention**. This sub-discipline forms the backbone of AI, enabling computers to learn and interpret patterns in images, sounds, and structured data using multidimensional arrays. ML is further subdivided into four types of learning:

- **Supervised learning**: Given an array of features (i.e., week of the year, price, etc.) and a labeled output variable (e.g., sales), predict the best possible estimate of the label variable given some new input array.

- **Unsupervised learning**: Given an array of features (e.g., demographic information, ZIP code, etc.), expose and visualize hidden relationships and anomalies within the array.

- **Semi-supervised**: Given an array of features and a limited quantity of some labeled output variable, predict the best possible estimates for the missing label variables.

- **Reinforcement learning:** Given some objective, train an artificial agent to maximize its utility according to some user-defined utility function.

(2) Expert Systems

An expert system (ES) is an **artificial agent which leverages pre-programmed knowledge to offer advice or make decisions**. In its simplest form, we can think of an ES as a complicated decision tree or nested if-then logic: if *x*, *y*, and *w* happen, we instruct the computer to do *z*. Though expert systems don't enjoy the same hype as machine learning, there are many reasons why we might prefer an ES over ML:

- An expert system can **take advantage of human insights** discovered through trial and error
- Expert systems are **more predictable** and are **less likely to make extreme errors** when faced with previously-unseen inputs
- Expert systems **have historically been faster and easier to implement**, though ML has become much more accessible in recent years

(3) Computer Vision

Computer vision (CV) is the **automatic extraction, analysis, and interpretation of images or videos**. CV converts photos and videos into numerical arrays, enabling ML algorithms to draw inferences, make predictions, and even generate new images based on user-defined inputs.

Potential uses for CV have been studied for decades, but CV has only recently become possible at scale thanks to three innovations:

- More efficient algorithms: Deep learning (convolutional neural networks, specifically) significantly reduces the memory footprint and computational runtime of CV tasks.
- Better computing resources: GPU improvements, distributed architectures (e.g., Spark), and the availability of inexpensive cloud computing resources have made it cheaper than ever to run memory-hungry CV algorithms.
- Availability of images to train on: The proliferation of social media platforms, community forums, and digital / mobile cameras have drastically increased the number of publicly-available images that can be used to train CV algorithms.

(4) Natural Language Processing

Natural language processing (NLP) is the **automatic extraction, analysis, and generation of human language**. NLP algorithms parse sentences in various ways (e.g., splitting by word, splitting by letter, reading both left-to-right and right-to-left, etc.) to automatically draw inferences about the writer's meaning and intent. NLP's various use cases include:

- Named entity recognition and conference resolution
- Part-of-speech tagging
- Reading comprehension & question answering

- Machine translation
- Text summarization & topic modeling
- Spellcheck & autocomplete

(5) Robotics

Robotics is the **science of designing, constructing, operating, and applying robots** to solve human problems. Robots come in thousands of shapes and sizes, making it difficult to nail down the precise meaning of the term.

Agents

An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.

Examples:

- Human-Agent: A human agent has eyes, ears, and other organs which work for sensors and hand, legs, vocal tract work for actuators.
- Robotic Agent: A robotic agent can have cameras, infrared range finder, NLP for sensors and various motors for actuators.
- Software Agent: Software agent can have keystrokes, file contents as sensory input and act on those inputs and display output on the screen.

Components

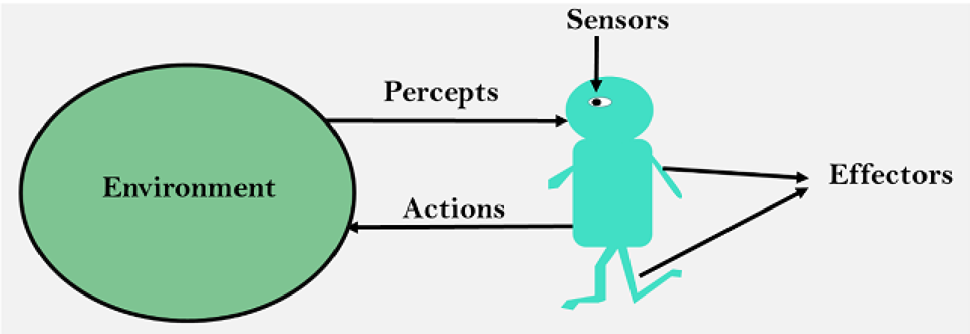

Fig 2.10 Components of AI

Sensor: Sensor is a device which detects the change in the environment and sends the information to other electronic devices. An agent observes its environment through sensors.

Actuators: Actuators are the component of machines that converts energy into motion. The actuators are only responsible for moving and controlling a system. An actuator can be an electric motor, gears, rails, etc.

Effectors: Effectors are the devices which affect the environment. Effectors can be legs, wheels, arms, fingers, wings, fins, and display screen.

Intelligent Agents

An intelligent agent is an autonomous entity which acts upon an environment using sensors and actuators for achieving goals. An intelligent agent may learn from the environment to achieve their goals. A thermostat is an example of an intelligent agent.

Following are the main four rules for an AI agent:

- Rule 1: An AI agent must have the ability to perceive the environment.
- Rule 2: The observation must be used to make decisions.
- Rule 3: Decision should result in an action.
- Rule 4: The action taken by an AI agent must be a rational action.

Structure of an AI Agent

The task of AI is to design an agent program which implements the agent function. The structure of an intelligent agent is a combination of architecture and agent program. It can be viewed as:

Agent = Architecture + Agent program

Following are the main three terms involved in the structure of an AI agent:

Architecture: Architecture is machinery that an AI agent executes on.

Agent Function: Agent function is used to map a percept to an action.

Agent program: Agent program is an implementation of agent function. An agent program executes on the physical architecture to produce function f.

<u>Problem Solving Agents</u>

- Agent first formulates goal and problem, then determines an action sequence, after which it executes the sequence.
- Special type of goal based agent

Four general steps in problem solving:

Goal formulation

– deciding on what the goal states are

– based on current situation and agent's performance measure

– What the successful world states are

Problem formulation

– how can we get to the goal, without getting bogged down in the detail of the world. Walking robot - not concerned about moving one inch ahead, but, in general concerned about moving ahead.

– What actions and states to consider given the goal

– state the problem in such a way that we can make efficient progress toward a goal state.

Search

– Determine the possible sequence of actions that lead to the states of known values and then choose the best sequence.

– Search algorithms – input is a problem, output is a solution (action sequence)

Execute

– Given the solution, perform the actions.

Simple Problem solving Agent

```
function SIMPLE-PROBLEM-SOLVING-AGENT(percept) return an action
    static: seq, an action sequence
            state, some description of the current world state
            goal, a goal
            problem, a problem formulation

    state ← UPDATE-STATE(state, percept)
    if seq is empty then
            goal ← FORMULATE-GOAL(state)
            problem ← FORMULATE-PROBLEM(state,goal)
            seq ← SEARCH(problem)
    action ← FIRST(seq)
    seq ← REST(seq)
    return action
```

3. INTERNET OF THINGS

- The Internet of Things, also called The Internet of Objects, refers to a wireless network between objects, usually the network will be wireless and self-configuring, such as household appliances.
- From any time ,any place connectivity for anyone, we will now have connectivity for anything!

Definition

- The Internet of Things (IoT) is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment.

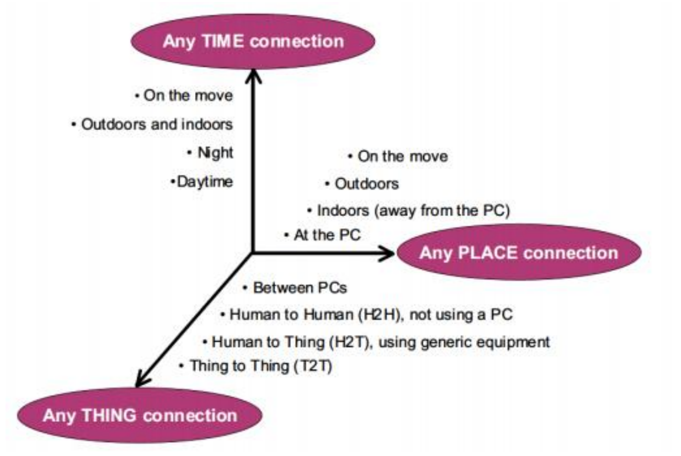

Fig 2.11 IoT Paradigm

Characteristics

- ✓ Efficient, scalable and associated architecture
- ✓ Unambiguous naming and addressing
- ✓ Abundance of sleeping nodes, mobile and non-IP devices
- ✓ Intermittent connectivity

Modern Day IoT Applications

- ✓ Smart Parking
- ✓ Structural health
- ✓ Noise Urban Maps
- ✓ Smartphone Detection
- ✓ Traffic Congestion
- ✓ Smart Lighting
- ✓ Waste Management
- ✓ Smart Roads
- ✓ River Floods
- ✓ Smart Grid
- ✓ Tank level
- ✓ Photovoltaic Installations
- ✓ Water Flow
- ✓ Silos Stock Calculation
- ✓ Perimeter Access Control
- ✓ Liquid Presence

IoT Architecture

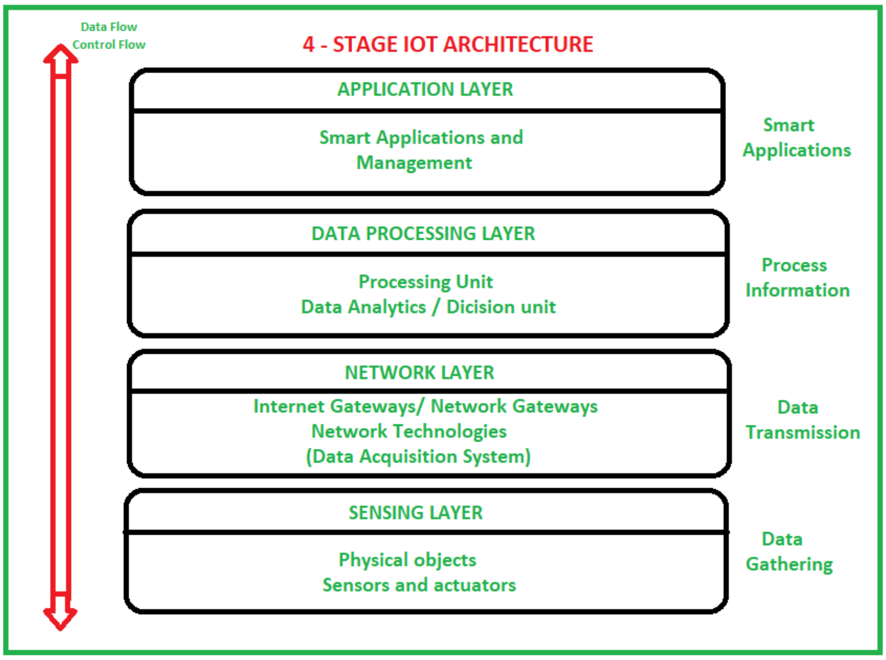

Fig 2.12 IoT Basic Architecture

1. **Sensing Layer**

   Sensors, actuators, devices are present in this Sensing layer. These Sensors or Actuators accepts data(physical/environmental parameters), processes data and emits data over network.

2. **Network Layer**

   Internet/Network gateways, Data Acquisition System (DAS) are present in this layer. DAS performs data aggregation and conversion function (Collecting data and aggregating data then converting analog data of sensors to digital data etc). Advanced gateways which mainly opens up connection between Sensor networks and Internet also performs many basic gateway functionalities like malware protection, and filtering also some times decision making based on inputted data and data management services, etc.

3. **Data processing Layer**

   This is processing unit of IoT ecosystem. Here data is analyzed and pre-processed before sending it to data center from where data is accessed by software applications often termed as business applications where data is monitored and managed and further actions are also prepared. So here Edge IT or edge analytics comes into picture.

4. **Application Layer**

   This is last layer of 4 stages of IoT architecture. Data centers or cloud is management stage of data where data is managed and is used by end-user applications like agriculture, health care, aerospace, farming, defense, etc.

IoT vs. M2M

- ✓ M2M refers to communications and interactions between machines and devices.
- ✓ Such interactions can occur via a cloud computing infrastructure (e.g., devices exchanging information through a cloud infrastructure).
- ✓ M2M offers the means for managing devices and devices interaction, while also collecting machine and/or sensor data.
- ✓ M2M is a term introduced by telecommunication services providers and, pays emphasis on machines interactions via one or more telecom/communication networks (e.g., 3G, 4G, 5G, satellite, public networks).
- ✓ M2M is part of the IoT, while M2M standards have a prominent place in the IoT standards landscape.

- ✓ However, IoT has a broader scope than M2M, since it comprises a broader range of interactions, including interactions between devices/things, things and people, things with applications and people with applications.
- ✓ It also enables the composition of workflows comprising all of the above interactions. IoT includes the notion of internet connectivity (which is provided in most of the networks outlined above), but is not necessarily focused on the use of telecom networks.

4. <u>ROBOTS</u>

- ✓ The word robot was coined by a Czech novelist Karel Capek in a 1920 play titled Rassum's Universal Robots (RUR)
- ✓ Robot in Czech is a word for worker or servant
- ✓ A robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks: Robot Institute of America, 1979

Essential characteristics:

- Sensing First of all your robot would have to be able to sense its surroundings. It would do this in ways that are not unsimilar to the way that you sense your surroundings. Giving your robot sensors: light sensors (eyes), touch and pressure sensors (hands), chemical sensors (nose), hearing and sonar sensors (ears), and taste sensors (tongue) will give your robot awareness of its environment.
- Movement A robot needs to be able to move around its environment. Whether rolling on wheels, walking on legs or propelling by thrusters a robot needs to be able to move. To count as a robot either the whole robot moves, like the Sojourner or just parts of the robot moves, like the Canada Arm.
- Energy A robot needs to be able to power itself. A robot might be solar powered, electrically powered, battery powered. The way your robot gets its energy will depend on what your robot needs to do.
- Intelligence A robot needs some kind of "smarts." This is where programming enters the pictures. A programmer is the person who gives the robot its 'smarts.' The robot will have to have some way to receive the program so that it knows what it is to do.

Types of Robots

- ✓ Legged Robots
- ✓ Wheeled Robots
- ✓ Autonomous Underwater Vehicle
- ✓ Unmanned Aerial Vehicle
- ✓ Manipulators

Components of Robots

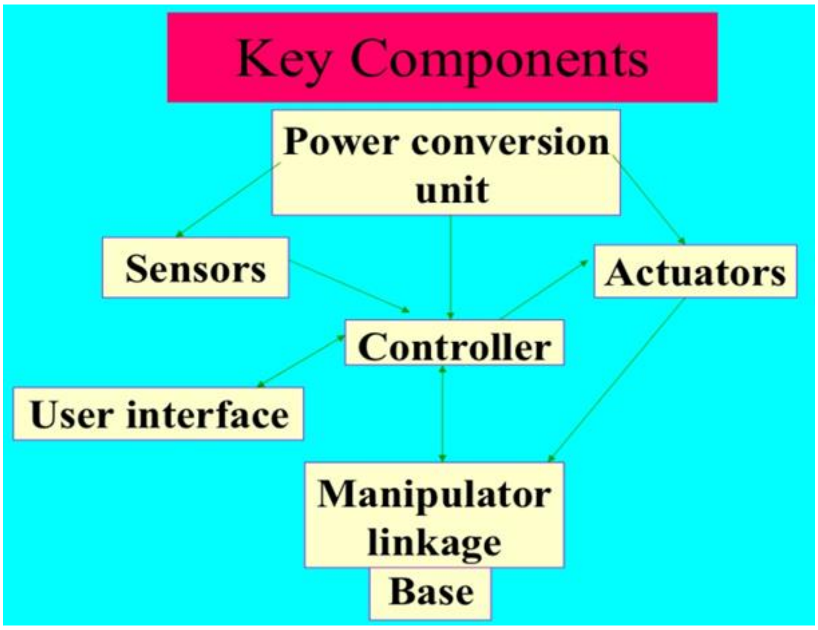

Fig.2.13 Key Components

- Power Supply - The working power to the robot is provided by batteries, hydraulic, solar power, or pneumatic power sources.
- Actuators - Actuators are the energy conversion device used inside a robot. The major function of actuators is to convert energy into movement.
- Electric motors (DC/AC)- Motors are electromechanical component used for converting electrical energy into its equivalent mechanical energy. In robots motors are used for providing rotational movement.
- Sensors - Sensors provide real time information on the task environment. Robots are equipped with tactile sensor it imitates the mechanical properties of touch receptors of

human fingerprints and a vision sensor is used for computing the depth in the environment.

- Controller - Controller is a part of robot that coordinates all motion of the mechanical system. It also receives an input from immediate environment through various sensors. The heart of robot's controller is a microprocessor linked with the input/output and monitoring device. The command issued by the controller activates the motion control mechanism, consisting of various controller, actuators and amplifier.

Classification of Robots

Classification by Japanese Industrial Robot Association (JIRA)

- ✓ **Class 1 or Manual Handling Device:** Device with multiple degrees of freedom (different directions in which a part can move) and actuated by an operator. An example is a Crane.
- ✓ **Class 2 or Fixed Sequence Robot:** Device which performs successive stages of a task as per a fixed method.
- ✓ **Class 3 or Variable Sequence Robot:** Device that performs same as Class 2 robots, but whose control can be modified.
- ✓ **Class 4 or Playback Robot:** Device which repeats tasks performed by humans, by following the recorded version of manual work.
- ✓ **Class 5 or Numerical Control Robot:** Device controlled by a computer through movement program.
- ✓ **Class 6 or Intelligent Robot:** A device which has a good assessment of its environment and performs tasks by manipulating its movements as per changes in the surroundings.

Classification by Association Francoise de Robotique (AFR):

- ✓ Type A: **Manually controlled handling devices.**
- ✓ Type B: **Automatic handling devices with predetermined cycles.**
- ✓ Type C: **Programmable, motor-controlled robots with the point to point or continuous path.**
- ✓ Type D: **Same as Type C, but with environmental sensing capacity.**

Classification as per Application

- ✓ **Industrial:** Industrial robots are generally fixed manipulators which perform in various working environments. They perform various general-purpose tasks like Welding, Painting, machining, etc. In fact, the first robots were the industrial robots which were used for simple repetitive tasks.
- ✓ **Non-Industrial or Special Purpose**: These are robots which assist humans in their chores
- – Medical: There has been an increasing use of robots in the medical field for surgery, rehabilitation and training. Medical robots are not meant to replace the surgeons but serve as a surgical assistant to the surgeon.
- – Space: With the advent of robotic technologies, exploration of various celestial bodies has been a reality. Tasks like space manipulation, surface mobility and scientific experiments are performed by space robots.
- – Defence Robots: These include bomb disposal robots, transportation robots and reconnaissance drones. Equipped with infrared sensors, these robots react more rapidly than humans in emergency and hazardous situations.
- – Security: These robots are used for surveillance and guarding large civilian facilities such as Power generating plants, oil refineries, etc which are under threat from terrorists. An example is DRDO's NETRA (An Unmanned Aerial Vehicle)
- – Domestic: These robots are used to perform daily tasks at home, such as robotic vacuum cleaner, cleaning robots.
- – Entertainment: These robots are used in various entertainment places like amusement parks, joy rides, sports, etc. Examples include KUKA Robocoaster (amusement ride robot), Honda's Asimo, Sony's Aibo, etc.

Classification by Degrees of Freedom

Degrees of freedom refers to the different directions a robotic arm can move. They represent the location as well as the orientation of an object. Basically, such type of robots is pick and place robots, which pick and place the objects on a location and with an orientation.

- – **3 Degrees of Freedom:** A robot with 3 degrees of freedom can only pick up the object and place it anywhere in its workspace, using the 3 different coordinate axes.

- **6-Degrees of Freedom:** A robot with 6 degrees of freedom can pick the object and place it anywhere in its workspace, at any orientation.
- **Other Degrees of Freedom:** A robot with degrees of freedom other than 3 or 6 has restricted movement in either linear or angular direction. In other words, it may orientate the object in any desired direction , but can place the object in only limited directions.

However, a robot with higher degrees of freedom – say 7, can have infinite possible ways to place as well as orientate the object.

Dynamic stabilization of robots

- **Dynamic stability** is a measure of the ability of a robot to maintain its balance while in motion.
- A robot with two or three legs, or that rolls on two wheels, can have **excellent stability while it is moving**, but when it comes to rest, it is unstable.
- A two-legged robot can be pushed over easily when it is standing still.
- This is one of the major drawbacks of biped robots.
- It is difficult and costly to engineer a good sense of balance, of the sort you take for granted, into a two-legged or two-wheeled machine, although it has been done.
- Robots with four or six legs have good dynamic stability, but they are usually slower in their movements compared with machines that have fewer legs.

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SCHOOL OF COMPUTING

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

UNIT III

SOCIETY 5.0 – SAIC4002

INTRODUCTION TO INDUSTRY 4.0 9hrs

Introduction-Globalization and Emerging Issues, LEAN Production Systems, Smart and Connected Business Perspective, Cyber Physical Systems and Next Generation Sensors, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis- An emerging industrial structure for IoT -Cyber security in Industry 4.0-Basics of Industrial IoT. Common Issues in Industry 4.0 and Society 5.0.

3.1.Globalisation And Emerging Issues

Introduction

Globalisation is fast growing, necessitating the dependence of nation. The resultant effect includes; free movement of labour, good and services, technology etc Globalisation allows for worldwide economic activities because there is a borderless world we now refer to as a global village. Globalisation has become a natural occurrence eating deep into the nook and crannies of countries, aiding with industrialization thereby making the developed countries better. It is said that the process of development with respect to countries is relative but the impact of training and re-training can help even underdeveloped and developing nations come up with speed. The new world is change driven and welcomes radical development for businesses: the interaction between countries fosters industrialization. Globalization is the thread that ties nations together, with innovation around technology imperatively affecting trading activity. This paper is centred around the impact globalisation and industry 4.0 has on employees and the role of training and re-training of such employees skills in order to match-up with the demand of todays world.

1. Globalisation

Globalisation has helplessly taken the world into captivity though positive and inevitable. It depict growth and progress when the entire world is interconnected. The history of globalization goes back to the second half of the twentieth century (20^{th}), the development of transport and communication technology led to situation where national borders appeared to be too limiting for economic activity. Globalization is a rising international network, belonging to an economic and social system (Fox, 2001). Globalization refers to a rapid interconnectivity that is broad that is to say it can be viewed at the local, the national and the regional point, connection is made between social and economic relationships and networks. Globalization is a concept that explains the idea for the practice and theory of the business transaction and operations, it also describes the spread of communication production and connection technologies throughout the world. Globalisation brings the world closer involving the spread of ideas, processes. Practice and the use of technology. The issue around globalisation is that the gap that exist between rich and poor countries is never bridged.

Advantages of Globalization

i. Wide spread of technology
ii. Increased liquidity of capital that allows for investment
iii. Increased trade between nations
iv. Greater flexibility of operation

Disadvantages of Globalisation

i. Exploitation of developing and underdeveloped nations
ii. Increased wealth inequality

Dimensions of Globalisation

There are five dimension to be considered for this work

a) Economic
b) Political
c) Democracy
d) Ecological
e) Culture

From the economic dimension, global finance and market of economy, multinationals, networking, international trade and business, new labour markets, new development cooperation are viewed.

Political dimension concerns are human rights, international terrorism, war and new security problems.

Democracy dimension focus is on good governance by people's participation, human rights.

Ecological dimension is interested in sustainability of biosphere e.g. water, forest, earth, air, and atmosphere **Cultural dimension** is multifarious and multicultural at the local, political, gender, family, religious, national, individual and social aspects. There is wide digital divide, we can generalise the saying, the world is unequal seeing that in developing and underdeveloped nations lack access to the most basic and major driving force of globalization today called technology.

Globalization and Developing Nations

Globalization is playing an increasingly important role in the developing countries. It can be seen that, globalization affects the economic processes, political activity, health systems, education too etc. Globalization has propelled a new opportunity for developing countries in the area of technology that affects how we do things as a nation affecting even the learning process of imbibing new knowledge with greater opportunity to access developed nation's market, growth and improved productivity and living standards. The truth is not all effects are positive in the sense that globalization has also brought up new challenges such as, environmental deteriorations, instability in commercial and financial markets, increase inequity across and within nations (Kotilainen & Kaitila 2002). Recently there has been a surge of financial globalisation with respect to capital flow among industrial countries in the line of academics and policies. The flow is associated with high growth rates for developing nation. Globalization has contributed immensely to the development of the educational systems in the developing countries. We can clearly see that education has increased in recent years, because globalization has a catalyst to the jobs that require higher skills set.

Globalization and Underdeveloped Nations

Underdeveloped nation poses a threat to globalisation especially when there is no drive to be at par with other nations of the world. Sadly as a country we seem to fall within this category of people. Globalization is nation specific in the sense that it depends on where nation started off and how globalization is viewed from the perspectives of undeveloped nation, in developing nations, focus is on workers with respect to the factories they work in, their exposure to skills, down to the wages they earn. According to Flemming (2001), Globalization has not really solve the issues of poverty in underdeveloped nations rather it has projected the vulnerability of this region thought somehow they still thrive to interact with other part of the world at a slow pace.

2. Industrial Revolution (Industry 4.0)

Industry 4.0 is a German initiative and the revolution depicts a change that is complete, total and whole, it is a fundamental change at it were in political power resulting from the peoples revolting and engineering against the activities of the incumbent. Industrial revolution is connected to the revolution within the place of business for transformational goods and services. It a major change of technology, socioeconomic and cultural. The first industrial revolution happened in the 18^{th} and early 19^{th} century resulting from the replacement of an economy based on manual labour to an economy dominated by machines. But for the course this work focus is the fourth industrial revolution (industry 4.0). The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, in fact it is a disruption of the third, it a re-invention of the third, it is the digital revolution that has been occurring since the middle of the last century that is being characterised by a blend of technologies that is still in the abstract but exiting in some countries. The fourth industrial revolution is a merger of four worlds: physical, digital, and biological. It is today's transformation and it a distinct one with changes in the entire systems of production, management, and governance (Schwab, 2016). We see the prospects in the large number of people that are being connected via mobile technologies. It is obvious that with an unprecedented power storage capacity and unlimited access to knowledge, there will be a view of possibilities that is propagated by new technology in areas such as artificial intelligence, robotics, autonomous vehicles, 3-D printing, nanotechnology, biotechnology etc.

Benefits of Industry 4.0

1) Transparent information
2) Technical Support
3) Productive and decentralized decisions
4) Cloud technological storage of big data

Challenges of Industry 4.0

Industry 4.0 is a desired end with ample opportunities for all and sundry but it still leaves us in grave dangers of

1) Countries especial developing and underdeveloped to be able to might be adapt because thegovernments foreseen failure to employ and regulate new technologies.
2) IT security issues, which are greatly aggravated by the inherent need to open up those previously closedproduction shops
3) Lack of adequate skill-sets to expedite the move of the fourth industrial revolution
4) Loss of jobs to automatic processes and IT-controlled processes

3. Globalization and Industry 4.0

The Fourth Industrial Revolution is global affecting the entirety of the universe, improving the quality of life of the people around the world. Technology has open a new world of possibilities both for the developed and more for the underdeveloped and developing nations of the world. Affordability and access has been the issue with the 3^{rd} world countries. Available technologies is in bits and pieces of the different categories of industrial revolution. The economic concern of inequality represents the greatest societal and global challenge associated with the Fourth Industrial Revolution. Nations with innovation and creativity on technological advancement will still be the providers of intellectual and physical capital, the innovators, shareholders, and investors leaving the rising gap of wealth between those nations that are capital driven to those that are labour-driven. Technology is therefore one of the main reasons why incomes have stagnated, or even decreased, for a majority of the population in high-income countries: the demand for highly skilled workers has increased while the demand for workers with less education and lower skills has decreased. Globalisation has exposed the population of countries into a technology enhanced economy where over half of the population (especially the young) uses social media platforms to connect, learn, and share information. In an ideal world, these interactions would provide an opportunity for cross-cultural understanding and cohesion (Markus & Andreas, 2013). The emergence of global platforms has transformed thoughts pattern and learning to understand the direction of these new technologies. However, we must develop a comprehensive and globally shared view of how technology is affecting our lives and reshaping our economic, social, cultural, and human environments.

4. Training and Re-Training

The labour act states that, it is the employer's obligation and duty to develop the human resource available to the organisation by way of training and retraining the workers in order to bridge the identified gaps/lapses that will help sharpen their skills and competences (Omole, 1999). Industry 4.0 impacts the current globalization and innovation trend. Organisations will play a major role in training their employees in the line of this new technologies.

Impact of Globalisation and Industry 4.0 on Training and Re-Training of Employees in Developing and Nations.

The advancement of globalization and increasing level of technology has necessitate the drive for the acquisition of knowledge and skills in employees of developing and underdeveloped nations through training, retraining and learning, this singular act is drastically reducing the demand for unskilled labour and uneducated employee, thereby raising the bar of value and competences of individuals. The workplace requires highly skilled workers for a broader and technologically enhanced organisation. Globalisation has birthed new technological changes such as industry 4.0 creating a vacuum of knowledge for the employees especially those within the challenging environment labelled developing and underdeveloped (Markus et al, 2013). Labour force in developed nations has grown so rapidly greatly affecting the economic growth and productivity. Training and retraining can positively enhance income, standard of living form the micro level of the economies to the macro level. Industry is a higher and new frontier of technology posing a skill desiring acquisition especially by organisation willing to stand the new face of technology.

Industry 4.0 (fourth industrial revolution) is not an initiative to secure the survival of developing countries. It is rather a shift towards the new and contemporary production method leading to further globalization for the small and medium organisation crowding the developing and underdeveloped nations. Organisation operates in an enabling environment to create a balanced ecosystem that can boost productions on their global capabilities and potentials in nations below the standard. This a period of major change, McKinsey defines it as the next phase in digitization, driven by a sharp rise in data volumes, computational power and connectivity, the emergence of analytics and business intelligence capabilities, new forms of human machine interaction and improvements in transferring digital instructions to the physical world, such as advanced robotics and 3D printing (Markus & Andreas, 2013). There is a positive direction that will lead to increase in productivity, innovation, and profitability.

Industry 4.0 is huge and changes will very drastic, no organisation wants to be met unprepared. It imperative for the organisation especially in the line tagged developing and underdeveloped nations to be adequately prepare by developing the skills of her labour via training and retraining. The diagram below shows the impact of training and re-training on the 21st century employee:

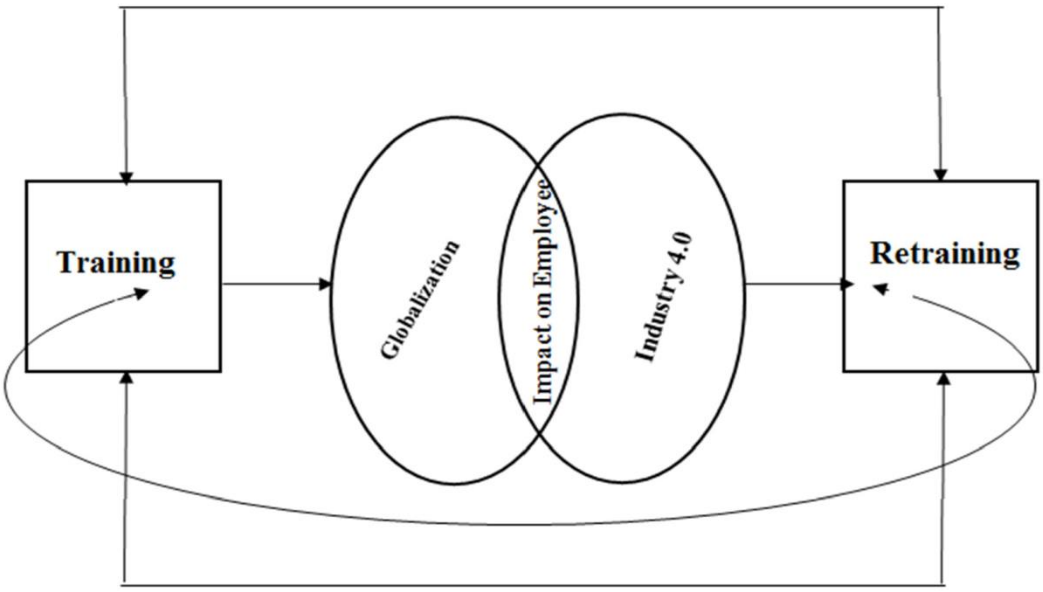

Figure 3.1. The Connectivity Chat of Training and Re-Training of Globalisation and Industry 4.0 on employees.Source: Researches Desk

From the illustration above Globalization and industry 4.0 can be fully be grasp by employee through adequate training and re-training where necessary. Concerns are centred more on how organisation within this environment of development can adapt to this awaiting paradigm shift and the still remain relevant in the future where most advanced technology are at the verge of the next industrial revolution. According to Hermann (2016), this is a period of transformation, the old methods will disappear birthing the new, and he further stated that globalization is a precondition for Industry 4.0, which is dependent on seamlessly sharing data to enable smart production and flexible manufacturing decisions. Some years ago, precisely 1966, the United Nations General Assembly adopted a resolution establishing the United Nations Industrial Development Organisation on a continuous to work to eradicate global poverty by assisting developing and low-income countries in achieving inclusive and sustainable industrial development.

Looking at industry 4.0 and globalisation, it is hard to say that organisation in the developing and underdeveloped nations are ready to adapt to the big-change of the future, knowing fully well that they bag a heavy load of challenges with respect to technological advancement.

Factors to consider for training in developing and underdeveloped regions

1. Awareness and readiness
2. Data explosion
3. Transformation of workforce and workplace

Marr (2014) emphasised the need to upgrade skills at the workplace and we must learn to understand and collaborate with the intelligence of machines at our disposal. There hope for developing and underdeveloped nations because industry is the recent and if we put our minds to it, we can achieve it and be at par with the developed nations of the world.

According to Sundararajan industry 4.0 is a level playing field for those countries that missed the early waves of automation and industrialization, he further outlined the three major challenges to developing countries as

- Skillsets: In developing countries reskilling does not take place. There are specific skillsets that are needful e.g. robotic programming and Big Data Analytics.
- Scalability: several enterprises are at the beginning level of Industry 4.0 (design and implementation).
  But they are yet to scale up beyond organisations.
- Funding: sponsorship is key, organisation need the fund to attain industry 4.0.
- Industry 4.0 technologies: this technology will be possible only when the respective technologies, interfaces, and formats have been put in place.
- Value chain upgrading through the use of digital technologies, processes and products
- Structural transformation: the social and organisational factors influenced by demographic changes in different groups of developing countries.
- Set up knowledge sharing platforms: where learning can take place by doing

3.2.Lean Production – ConceptAnd Benefits

Introduction

In the late 70's, the U.S. companies had a strong interest in the NC machine tools and in the advanced automation as well as in planning the materials necessary for the production processThe Japanese companies focused on applying the Lean Productionprinciples, using relatively simple technologies and lower costs automationat the expense of the computer technology.

The concept of Lean Production is based on the Toyota production system. The Toyota production system focused on reducing waste, considering all aspects of the production process, using a variety of techniques and tools for eliminating waste, such as: just-in-time, cellular manufacturing, Value Stream Mapping, 5S, kanban (pull) systems, Kaizen, synchronous manufacturing, , which resulted in a decrease of stocks and of the execution time, an increase of the delivery performance, a rational use of space, abetter resource utilization and an improved productivity and quality .

The Lean Production Concept

Lean Production can be defined as a philosophy or as a strategy whichdepends on a set of practices used tominimize wasteinorder toimprove an enterprise's performance. Lean Production comes from theToyotaproduction system, a concept adoptedby manymajorcompanies across theworldin an attempt toremain competitivein an increasinglyglobalisedmarket. In an attempt to define Lean Production conceptually, we can say thatit uses the just-in-time practices and aims at the rational use of resources,the strategies to improve the production process and the elimination of waste, and the use of managerial scientific techniques. It is, however, difficult to formulate a complete definition encompassing all the elements of Lean Production, which is in a constant development. Thus, today's definition reflects the current image, which at some point in the future willno longer be valid.

Lean Production: Principles and Tools

Lean Production includes, on the one hand, a strategy which dependson a set of tools and, on the other hand, the Lean thinking, which focusesboth internally by reducing costs, and externally to increase customer satisfaction.

The objective of this multi-dimensional approach is the reduction of costs by eliminating the non-value activities, using tools such as just-in-time, cellular manufacturing, Value Stream Mapping, 5S, kanban (pull) systems, total productive maintenance, production smoothing or production levelling, setup reduction for waste elimination. The implementation of the efficient production practices based on the flow optimization is expected to lead to better operating results, using, for example, an inventory leanness, which–in turn–should enhance the enterprise's performances.

Value Stream Mapping is a Lean Production tool, used to design and analyze the production process. It is designed to create an easy way formanagers to visualize the value flow. The value is defined as that thingwhich brings a product in the form desired by the customers who are willingto pay for it. Thegoal of the Value Stream Mapping is to help managers identify waste in all their processes in order to eliminate them: the waste time of the production process resulting from a faulty organization of the working equipment (motion), waiting, the time spent on handling the products from one stage to another of the production process, from the production workshops to warehouses (transportation), a production larger than it is required for the next stage of the production process (over production), the undesirable characteristics that affect the product functionality or its appearance, the refuse (defects), over processing, inventory.

Another basic tool for the managers who want to adopt Lean Production is the **5 S**. The **5 S** has its origins in the Toyota system and refersto the words that describe the steps to be completed for each stage or phase:

- seiri – separate – is the first step that consists in eliminating allthat is not needed to complete the tasks.
- seiton – sort – identifying the stages of production and the elements necessary for the performance of the tasks required in those stages, which are organized in an optimal manner in orderto avoid wasting time on handling.
- seiso – sweep – everything must be kept clean and the production scraps and refuse should be removed.
- seiketsu – standardize – standardization of processes through efficient organization of the working equipment while programming them in order to have maximum efficiency.
- shitsuke – sustain – the final step consists in consists in maintaining cleanliness and order every day.

The 5S program has a number of benefits, such as: maintaining discipline, reducing production and handling time which leads to lower costs.

Cellular manufacturing is a Lean method which is based on the group technology principles. The workstations and the equipment are organized in order to allow easy transition from one stage of production to another, resulting a minimal handling of materials, greater speed ofworking, eliminating unnecessary costs and having reduced stocks

The **Jidoka** principle is a process of quality control and refers to the automation of the functions of the production supervision, which means that the personnel is warned in case of an abnormal situation in order to stop the production line, thus preventing wastage, refuse and an additional output, focusing the attention on understanding why the problems occurred and how they can be avoided in the future.

Poka-yoke refers to any mechanism that helps staff to avoid errors. Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors. The Lean concept is criticised in the literature from the perspective of the personnel, because this side is less known, focusing primarily on techniques for improving the performance of the system. Jidoka and Poka-yoke suggest that employees can not be trusted inorder to have good quality products, creating a need to eliminate the possibility of human error in the system.

Kanban is a stock control system, and it is usually performed by the FIFO method. Kanban is an effective tool which contributed to the functioning of the production process as a whole. The Kanban system has many advantages over computer technologies, such as: reduced cost of information processing, it is easy to obtain andtransmit information in a dynamic environment, the demand for materials is judiciously sized. Sugimori criticized the lack of respect for the human being of the enterprises whose production was controlled by computer systems. The Japanese consider the Kanban system more transparent, allowing staff to understand the production process without the need to use complex software.

Flow – Cellular manufacturing is adopted by the enterprises that useLean Production, where each module has all the necessary resources to manufacture a product, or, if several modules are organized in order to produce a certain product, in order to obtain a production process by whichthe product smoothly goes through all its stages until it reaches the final user, the client.

Pull – Hopp and Spearman (2004) defined the Pull system as one that explicitly limits the quantity of products entering the production process.The traditional production methods tend to Push products in the manufacturing process, without limiting their quantity in the hope that itwill be a customer to buy the already made products. In a Pull system not even one single production stage will be finalized until there is a demand for moving to a later stage.

once businesses adopt the Lean principles, the improvement of processes is certain. Another principle of the Lean Production concept is the continuous improvement, so that reducing efforts, costs, space used, and production time can be continuously achieved.

Benefits of implementing Lean Production

The Lean Production concept has been developed for many years and it is often considered the most important strategy that can be adopted by the manufacturing companies that wish to obtain global performance . It presents a number of benefits (Figure 1), such as :

- A reduced delivery time;
- Reduced inventory;
- A better management;
- Less rework.

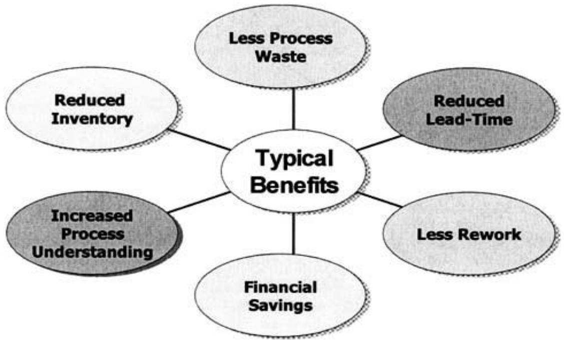

Figure no. 3.2. Benefits of Lean Production

Source: Melton, T. (2005). The benefits of lean manufacturing. What lean thinking has tooffer the process industries. Chemical Engineering Research and Design, 83(A6), 663.

The changes in the business environment in recent years have made the term Lean to be used more and more. Lean Production is a concept that knows a constant development, so the today's attempt to formulate a definition of this concept will reflect a real contemporary image, which at some future point will no longer be valid. It is obvious that the adoption of the Lean Production principles will improve the entire process of production, the purpose of this strategy being that of reducing costs by eliminating waste and by increasing customer satisfaction, increasing thus the performance of the business.

3.3. Smart and Connected Business Perspective

Information technology is revolutionizing products. Once composed solely of mechanical and electrical parts, products have become complex systems that combine hardware, sensors, data storage, microprocessors, software, and connectivity in myriad ways. These "smart, connected products"—made possible by vast improvements in processing power and device miniaturization and by the network benefits of ubiquitous wireless connectivity—have unleashed a new era of competition.

Smart, connected products offer exponentially expanding opportunities for new functionality, far greater reliability, much higher product utilization, and capabilities that cut across and transcend traditional product boundaries. The changing nature of products is also disrupting value chains, forcing companies to rethink and retool nearly everything they do internally.

These new types of products alter industry structure and the nature of competition, exposing companies to new competitive opportunities and threats. They are reshaping industry boundaries and creating entirely new industries. In many companies, smart, connected products will force the fundamental question, "What business am I in?"

Smart, connected products raise a new set of strategic choices related to how value is created and captured, how the prodigious amount of new (and sensitive) data they generate is utilized and managed, how relationships with traditional business partners such as channels are redefined, and what role companies should play as industry boundaries are expanded.

The phrase "internet of things" has arisen to reflect the growing number of smart, connected products and highlight the new opportunities they can represent. Yet this phrase is not very helpful in understanding the phenomenon or its implications. The internet, whether involving people or things, is simply a mechanism for transmitting information. What makes smart, connected products fundamentally different is not the internet, but the changing nature of the "things." It is the expanded capabilities of smart, connected products and the data they generate that are ushering in a new era of competition. Companies must look beyond the technologies themselves to the competitive transformation taking place. This article, and a companion piece to be published soon in HBR, will deconstruct the smart, connected products revolution and explore its strategic and operational implications.

What Can Smart, Connected Products Do?

Intelligence and connectivity enable an entirely new set of product functions and capabilities, which can be grouped into four areas: monitoring, control, optimization, and autonomy. A product can potentially incorporate all four (see the exhibit "Capabilities of Smart, Connected Products"). Each capability is valuable in its own right and also sets the stage for the next level. For example, monitoring capabilities are the foundation for product control, optimization, and autonomy. A company must choose the set of capabilities that deliver its customer value and define its competitive positioning

Capabilities of Smart, Connected Products

The capabilities of smart, connected products can be grouped into four areas: monitoring, control, optimization, and autonomy. Each builds on the preceding one; to have control capability, for example, a product must have monitoring capability.

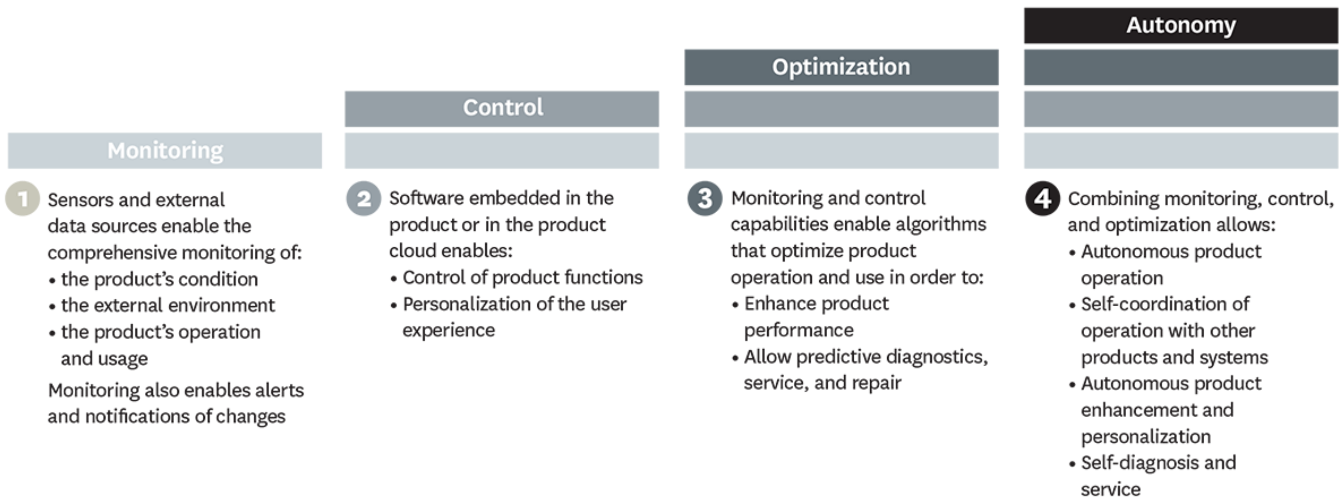

Figure 3.3

Monitoring.

Smart, connected products enable the comprehensive monitoring of a product's condition, operation, and external environment through sensors and external data sources. Using data, a product can alert users or others to changes in circumstances or performance. Monitoring also allows companies and customers to track a product's operating characteristics and history and to better understand how the product is actually used. This data has important implications for design (by reducing overengineering, for example), market segmentation (through the analysis of usage patterns by customer type), and after-sale service (by allowing the dispatch of the right technician with the right part, thus improving the first-time fix rate). Monitoring data may also reveal warranty compliance issues as well as new sales opportunities, such as the need for additional product capacity because of high utilization.

In some cases, such as medical devices, monitoring is the core element of value creation. Medtronic's digital blood-glucose meter uses a sensor inserted under the patient's skin to measure glucose levels in tissue fluid and connects wirelessly to a device that alerts patients and clinicians up to 30 minutes before a patient reaches a threshold blood-glucose level, enabling appropriate therapy adjustments.

Monitoring capabilities can span multiple products across distances. Joy Global, a leading mining equipment manufacturer, monitors operating conditions, safety parameters, and predictive service indicators for entire fleets of equipment far underground. Joy also monitors operating parameters across multiple mines in different countries for benchmarking purposes.

Control.

Smart, connected products can be controlled through remote commands or algorithms that are built into the device or reside in the product cloud. Algorithms are rules that direct the product to respond to specified changes in its condition or environment (for example, "if pressure gets too high, shut off the valve" or "when traffic in a parking garage reaches a certain level, turn the overhead lighting on or off").

Control through software embedded in the product or the cloud allows the customization of product performance to a degree that previously was not cost effective or often even possible. The same technology also enables users to control and personalize their interaction with the product in many new ways. For example, users can adjust their Philips Lighting hue lightbulbs via smartphone, turning them on and off, programming them to blink red if an intruder is detected, or dimming them slowly at night. Doorbot, a smart, connected doorbell and lock, allows customers to give visitors access to the home remotely after screening them on their smartphones.

Optimization.

The rich flow of monitoring data from smart, connected products, coupled with the capacity to control product operation, allows companies to optimize product performance in numerous ways, many of which have not been previously possible. Smart, connected products can apply algorithms and analytics to in-use or historical data to dramatically improve output, utilization, and efficiency. In wind turbines, for instance, a local microcontroller can adjust each blade on every revolution to capture maximum wind energy. And each turbine can be adjusted to not only improve its performance but minimize its impact on the efficiency of those nearby.

Real-time monitoring data on product condition and product control capability enables firms to optimize service by performing preventative maintenance when failure is imminent and accomplishing repairs remotely, thereby reducing product downtime and the need to dispatch repair personnel. Even when on-site repair is required, advance information about what is broken, what parts are needed, and how to accomplish the fix reduces service costs and improves first-time fix rates. Diebold, for example, monitors many of its automated teller machines for early signs of trouble. After assessing a malfunctioning ATM's status, the machine is repaired remotely if possible, or the company deploys a technician who has been given a detailed diagnosis of the problem, a recommended repair process, and, often, the needed parts. Finally, like many smart, connected products, Diebold's ATMs can be updated when they are due for feature enhancements. Often these can occur remotely, via software.

Autonomy.

Monitoring, control, and optimization capabilities combine to allow smart, connected products to achieve a previously unattainable level of autonomy. At the simplest level is autonomous product operation like that of the iRobot Roomba, a vacuum cleaner that uses sensors and software to scan and clean floors in rooms with different layouts. More-sophisticated products are able to learn about their environment, self-diagnose their own service needs, and adapt to users' preferences. Autonomy not only can reduce the need for operators but can improve safety in dangerous environments and facilitate operation in remote locations.

Autonomous products can also act in coordination with other products and systems. The value of these capabilities can grow exponentially as more and more products become connected. For example, the energy efficiency of the electric grid increases as more smart meters are connected, allowing the utility to gain insight into and respond to demand patterns over time.

3.4.Cyber Physical Systems And Next Generation Sensors

A cyber-physical system (CPS) is a computer system in which a mechanism is controlled or monitored by computer-based algorithms. In cyber-physical systems, physical and software components are deeply intertwined, able to operate on different spatial and temporal scales, exhibit multiple and distinct behavioral modalities, and interact with each other in ways that change with context.CPS involves transdisciplinary approaches, merging theory of cybernetics, mechatronics, design and process science. The process control is often referred to as embedded systems. In embedded systems, the emphasis tends to be more on the computational elements, and less on an intense link between the computational and physical elements. CPS is also similar to the Internet of Things (IoT), sharing the same basic architecture; nevertheless, CPS presents a higher combination and coordination between physical and computational elements.

Examples of CPS include smart grid, autonomous automobile systems, medical monitoring, industrial control systems, robotics systems, and automatic pilot avionics. Precursors of cyber-physical systems can be found in areas as diverse as aerospace, automotive, chemical processes, civil infrastructure, energy, healthcare, manufacturing, transportation, entertainment, and consumer appliances.

Unlike more traditional embedded systems, a full-fledged CPS is typically designed as a network of interacting elements with physical input and output instead of as standalone devices. The notion is closely tied to concepts of robotics and sensor networks with intelligence mechanisms proper of computational intelligence leading the pathway. Ongoing advances in science and engineering improve the link between computational and physical elements by means of intelligent mechanisms, increasing the adaptability, autonomy, efficiency, functionality, reliability, safety, and usability of cyber-physical systems. This will broaden the potential of cyber-physical systems in several directions, including: intervention (e.g., collision avoidance); precision (e.g., robotic surgery and nano-level manufacturing); operation in dangerous or inaccessible environments (e.g., search and rescue, firefighting, and deep-sea exploration); coordination (e.g., air traffic control, war fighting); efficiency (e.g., zero-net energy buildings); and augmentation of human capabilities (e.g. in healthcare monitoring and delivery)

3.5.Next Generation Sensors

Autonomous Mobile Robots

Omron's new B5L Series answers the need for workforce-saving solutions. Capable of measuring the distance of people and objects in real time, the 3D sensor module impacts autonomous mobile robots (AMR) used in a number of applications: delivery, logistics, moving goods, sorting and picking, fulfillment and more. Even as they advanced, 3D sensors presented challenges. They demonstrated unstable vision in sunlight and false detection from edge noise, leading to less accuracy in AMRs. The short life span was an additional pain point.

Omron applies next-generation technology to solve these challenges in Time of Flight

(ToF) sensors. With a built-in high dynamic range (HDR) function, the B5L ToF sensor performs the measurement multiple times to provide high-accuracy readings for both near and far objects. This can be disabled for high-speed operation mode, calculating the distance in a single measurement.

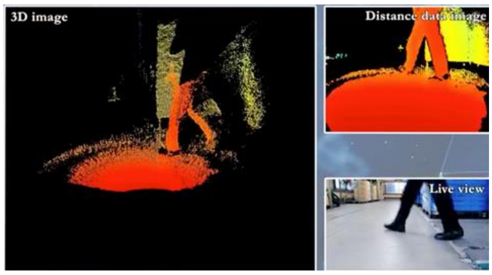

Figure 3.4. *A 3D*. image displays next to a distance data image and a live view of a person walking in a warehouse. (Omron)

The B5L ToF sensor also has a built-in edge noise reduction (ENR) function capable of determining the edge location and reducing the noise associated with these edges. This allows the sensor to reliably detect objects and minimizes the likelihood of false detections. With the ENR function enabled, the ToF sensor is able to capture a crisp image for object detection at any distance or reflectivity.

Thermal Sensors

Micro-electrical-mechanical systems, or MEMS, are moving beyond their original applications for detecting human occupancy accurately and into saving energy in homes, buildings and factories. The ability to provide steady readings without false negatives improves accuracy in reading and evaluating human presence. Omron has increased the signal-to-noise ratio (SNR) in the D6T MEMS Thermal Sensors to the highest in the world. and by enabling touchless temperature measurements with only one connector, the D6T sensor is easy to adapt for any type of system. This advancement beyond surface mount types makes the D6T sensors plug and play for unlimited applications.

Thanks to higher accuracy, smaller footprint, and ease of use, D6T sensors are now used in applications to identify fevers, save energy, sense motion with food and beverage and vending machines, and monitor sensitive fluid levels in machines.

Figure 3.5. The Omron D6T Thermal Sensor is positioned to monitor fluid levels in a machine. *(Omron)*

recision is critically important when choosing IR sensors. By default, Omron's IR sensor guarantees absolute temperature accuracy of ±1.5°C, and clients can achieve accuracy up to ±0.2°C with 2-point calibration. Omron offers software to give customers an easy starting point interpreting raw data into useful information.

Analytical Instruments

The newer aerial switch uses the B5W sensor for hands-free technology. (Omron) Omron has made significant advancements in touchless sensing. Previously, detecting shiny, black or transparent objects required more work hours for development and production processes. In addition, sensing was less reliable if objects shifted.

Figure 3.6.The newer aerial switch uses the B5W sensor for hands-free technology. (Omron)

Omron's B5W-LB Series Light Convergent Reflective Sensor has a limited projection beam and light sensing area, so it reduces work hours needed to enable sensing or shiny, black or transparent objects. It's also unaffected by backgrounds. And by using four types of toroidal lenses, the B5W-LB enables sensing when objects shift, even at minimal light levels. These advancements have implications in automatic handwashing, soap dispensing and hand dryers, as well as vending and coffee machines. They're also used in delicate analytical instruments for test tube detection and rotation control. The newer aerial switch uses the B5W sensor for hands-free technology, and a see-through panel for the LED display, creates a cleaner design.

3.6. Augmented Reality and Virtual Reality

We spend a lot of time looking at screens these days. Computers, smartphones, and televisions have all become a big part of our lives; they're how we get a lot of our news, use social media, watch movies, and much more. Virtual reality (VR) and augmented reality (AR) are two technologies that are changing the way we use screens, creating new and exciting interactive experiences.
Virtual reality uses a headset to place you in a computer-generated world that you can explore. Augmented reality, on the other hand, is a bit different. Instead of transporting you to a virtual world, it takes digital images and layers them on the real world around you through the use of either a clear visor or smartphone. With virtual reality, you could explore an underwater environment. With augmented reality, you could see fish swimming through the world around you.

Virtual reality

Virtual reality immerses you in a virtual world through the use of a headset with some type of screen displaying a virtual environment. These headsets also use a technology called head tracking, which allows you to look around the environment by physically moving your head. The display will follow whichever direction you move, giving you a 360-degree view of the virtual environment.
Types of VR devices
At the moment, there are two major types of headsets. Both have their pros and cons, which you'll want to consider if you're looking to purchase one.

The first type has a screen built in to the headset. These devices connect to a computer and require a pretty powerful system to operate smoothly. They have great graphics and perform well, but they're also pretty expensive. A few popular examples of these include the Oculus Rift, the Vive, and the PlayStation VR, which connects to the PlayStation 4 game console. Some of these devices come with handheld controllers that track your hands' movements as well, providing for a more interactive experience.

Figure 3.7.

The other type of headset houses your phone and uses its screen as the display. These don't require a computer and run completely off of apps on your smartphone. The graphics and performance levels on these headsets aren't quite as good as those with a built-in screen, but they do tend to be much cheaper. Some popular examples include Google Cardboard and the Gear VR.

Figure 3.8.

Augmented reality

Augmented reality allows you to see the world around you with digital images layered on top of it. There are currently a couple of AR headsets available, including the Microsoft HoloLens and the Magic Leap. However, they are currently more expensive than VR headsets, and are marketed primarily to businesses.

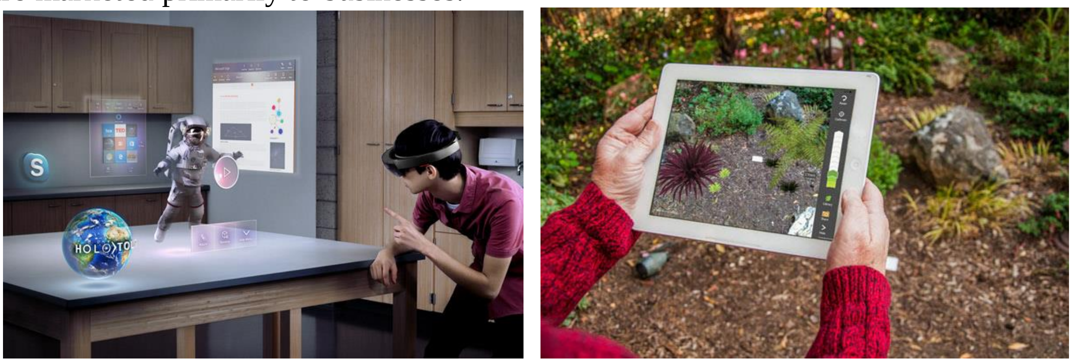

Figure 3.9

Augmented reality can also be used on devices like smartphones and laptops without the use of a headset. There are a variety of apps that use AR, including some that allow you to translate text using your camera, identify stars in the sky, and even see how your garden would look with different plants. You may have even previously used AR without realizing it, while playing a game like Pokemon Go or using filters on Snapchat.

Both VR and AR technologies are growing at a pretty rapid pace. Many experts predict that they'll continue to become more and more popular in the near future. As technology becomes more advanced, it'll be exciting to see how they'll be applied to both business and everyday life!

3.7 Advanced Data Analytics

Advanced data analytics can help drive innovative business decision making. Advanced analytics and reporting use sophisticated tools for data mining, big data and predictive analytics to mine data for important trends, patterns, and performance. As the amount of valuable data your company gathers increases, so will the need to use that data for insights that provide a competitive advantage.

Advanced analytics techniques

Advanced analytics tools dive deep into data to help you better understand why something is happening, identify trends, generate predictive insights, or optimize for a desired outcome. Employing these techniques will help build a solid foundation for advanced analytics to mature. Some advanced analytics methods include:

Data mining -Data mining is the process of identifying sequences, relationships, or anomalies in large amounts of raw data. Connections within data sets can then be created and analyzed to produce information about opportunities and risks.

Machine learning -This advanced analytics technique uses computational methods to find patterns or inferences in data, and automatically create statistical models to produce reliable results with minimal human intervention.

Cohort analysis- Cohort analysis is an advanced data analytics technique that develops broadly applicable insights by examining the behavior of a group of people. Read Making Friends with Cohort Analysis to get five ways to deep dive into your customer data using cohort analysis.

Cluster analysis - Cluster analysis is a way to recognize differences or similarities in sets of data and visually present that data to make comparisons easier. Box plot visualizations are a standard way of showing the distributions of data in a cluster.

Retention analysis - Retention analysis uses advanced data analytics to understand cohorts of users or customers. These insights can help you determine what factors influence retention and inform customer growth strategies. Download our whitepaper on Retention Analysis and the Data that Drives It to learn more.

Complex event analysis - Complex event analysis, also called complex event processing (CEP), is an advanced data analytics process that aggregates and analyzes event data coming from multiple sources as an event happens. Complex event analysis identifies cause-and-effect relationships in data to provide real-time insight that can influence business decision-making.

Predictive analysis -Predictive analysis, in conjunction with data mining, statistical methods, and machine learning, studies data to predict the likelihood of a future outcome and inform business forecasting appropriately.

What are the benefits of advanced analytics?

Modern advanced data analytics tools allow you to analyze and operationalize more data, faster. The insights generated also empower better and more accurate decision-making that drives enhanced ROI.

More time to focus on strategy

The right selection of advanced analytics tools can reduce the resources needed to streamline the process of sorting and analyzing data. Enterprises can input large amounts of data and operationalize the insights faster. This frees up analysts to take on more valuable projects and gives leaders more time to focus on strategy for business improvement.

More accurate decision-making

Advanced analytics gives deeper insight into data, turning that data into actionable information. This information allows businesses to make fact-based decisions quickly and accurately.

Gain a better ROI

Advanced analytics tools can help you effectively decide where and when to employ resources, which increases operational efficiency and reduces costs. Advanced analytics also uncover customer needs so you can develop and evolve products and services and deliver innovation ahead of your competition.

Data sharing and user empowerment

Advanced analytics tools can support the integration of data from disparate sources and enable secure data sharing across your organization. When data is accessible to employees, they are empowered to identify and act on opportunities—further growing your enterprise.

3.8. An Emerging Industrial Structure For IoT

Figure 3.10

The Industrial Internet of Things (IIoT) architecture is made of numerous elements from sensors, connectivity and gateways to device management and application platforms. Assembling these different moving parts can seem daunting, especially for companies who are just at the outset of their IIoT initiative. On top of that, industrial applications entail unique requirements and challenges that need to be addressed tactfully.

The good news is emerging tools and developments are helping simplify and streamline the process of establishing a viable IIoT architecture. As the IIoT landscape continues to evolve in 2020, here are four trends tech leaders might want to consider when architecting their next wireless infrastructure.

Hardware Rapid Prototyping

In the industrial world, the challenge of IoT hardware design lies in the bewildering array of use case requirements. Take temperature sensors as a simple example. Depending on criteria like accuracy, temperature range, response time and stability, there could be hundreds of available sensors to choose from. Most likely, there won’t be an out-of-the-box wireless sensor out there that fully meets your needs or your client’s. And that’s where IoT rapid prototyping comes in.

Hardware prototyping standards like mikroBUS allow you to build a customized IoT device prototype in a matter of a few hours and with efficient resources. From a broad portfolio of ready-to-use, compatible sensor, interface and wireless modules as well as compilers and development boards, you can create the optimal hardware mix-and-match that caters to your industrial use case. With rapid prototyping, companies can ratify the technical and business viability of their IIoT solution in a cost-effective and agile fashion, which lays the cornerstone for a successful roll-out.

Retrofit Wireless Connectivity

An average factory operates with legacy industrial systems that are nowhere near being connected. While these systems employ a number of proprietary communication protocols for automation purposes, data is captive within discrete control loops, creating numerous data silos on the factory floor. The lack of interoperability among these protocols further hinders the implementation of a factory-wide monitoring and control network.

Emerging retrofit wireless connectivity now enables manufacturers to connect and acquire data from their legacy assets and systems in a simple and cost-effective manner – without costly production downtime and invasive hardware changes. Through the use of an integration platform, operational data can be fetched from controllers through wired-based serial and other industrial protocols then forwarded to a remote control center using long-range wireless connectivity.

Software-Defined Radio

As no wireless solution is use-case agnostic, a typical IIoT architecture is likely to incorporate multiple radio protocols and standards. Plus, many industrial facilities today have already implemented wireless networks (e.g. Wi-Fi, WirelessHART…) to a certain extent, and look to deploy new types of connectivity to tap into other high-value use cases. Thus, it's critical to create an efficient and backward-compatible IIoT architecture that can accommodate the co-existence of different wireless technologies, which is why software-defined radio (SDR) is gaining momentum.

SDR refers to a radio communication method where the majority of signal processing is done using software, as opposed to the traditional hardware-driven approach. IoT gateways leveraging SDR can incorporate and decode different protocols concurrently to reduce infrastructure cost and complexity. What's more, adjustments or additions of new wireless solutions to the architecture can be achieved with simple software updates. This allows companies to dynamically adapt to future operational and technological changes while continuing to support legacy wireless devices in the field.

Portable, Container-Based IIoT Platform Design

Depending on criteria like security, reliability, data ownership and costs, companies need to choose among an on-premise, public or private cloud deployment, or even a hybrid approach. As the IIoT use cases and architecture scale, the decision on the deployment model and/or cloud vendor is subject to change as well.

In this context, an IIoT platform, typically a device management platform, that comes with a portable, container-based design renders industrial users with full flexibility in selecting their preferred backend environment. At the same time, it enables a simple migration to another server as needed without compromising the consistency or functionality of the application. The idea of a container-based design is that individual applications are packaged and delivered within discrete, standardized containers called Docker. With this modular architecture, users can decide which specific platform functions/ applications they want to use and where to deploy them. Thanks to its flexibility and portability, the container-based design facilitates an interoperable and future-proof IIoT architecture that keeps up with the industry's dynamic needs.

3.9. Cyber Security In Industry 4.0

Industry 4.0 and the smart factory

McKinsey defines Industry 4.0 as "the next phase in the digitization of the manufacturing sector, driven by four disruptions: the astonishing rise in data volumes, computational power, and connectivity, especially new low-power wide-area networks; the emergence of analytics and business intelligence capabilities (BI); new forms of human-machine interaction such as touch interfaces and augmented-reality systems; and improvements in transferring digital instructions to the physical world, such as advanced robotics and 3-D printing."

With Industry 4.0 comes "the smart factory." More than just the latest buzzword, the smart factory is a confluence of trends and technologies that are reshaping the way things are made and revolutionizing the way factories function. Industrial control systems (ICS), supervisory control and data acquisition (SCADA) systems, big data, the Internet of Things (IoT), the Industrial Internet of Things (IIoT), smart and self-learning machines, advanced analytics, robotics, and cognitive computing all fall under the Industry 4.0 umbrella.

Digital transformation in the industrial sector continues apace as Industry 4.0 gains momentum. KPMG predicts enterprises will spend $232 billion on automation by 2024. And BI Intelligence estimates the number of connected machines in manufacturing environments will increase from 237 million in 2015 to 923 million in 2020.However, willingness to embrace the potential productivity benefits of digital transformation also means accepting and mitigating new risks – and these risks are real.

Cybersecurity as a key enabler of adoption

There's a lot to be gained by adopting Industry 4.0 technologies, so why hasn't adoption kept pace with expectations? The answer is simple: security.

As it continues to adopt Industry 4.0, the manufacturing industry becomes an increasingly appealing target for attackers, who have the opportunity to move laterally across a manufacturing network, jumping across IT and OT systems for their malicious activities. Without strong protections in place, bad actors can take advantage of systems for industrial espionage, intellectual property theft, IP leakage, or even production sabotage.

Industry 4.0 cybersecurity challenges

Manufacturing is the second-most attacked industry, yet the manufacturing sector lags when it comes to security.

Smart factories can be subject to the same vulnerability exploitation, malware, denial of service (DoS), device hacking, and other common attack methods that other networks face. And the smart factory's expanded attack surface makes it extra difficult for manufacturers to detect and defend against cyberattacks. These threats now work on an entirely new level with the dawn of the IoT, and they can result in serious physical consequences, especially in the realm of the IIoT.

Here are a few new security challenges that organizations face in the age of Industry 4.0:

- Every connected device represents a potential risk.
- Manufacturing systems such as Industrial Control Systems (ICS) have unique vulnerabilities that make them particularly susceptible to cyberattacks.
- Industry 4.0 connects previously isolated systems, which increases the attack surface.
- Upgrades are often installed piecemeal since the systems are very complex.
- Manufacturing has many fewer regulated compliance standards than other sectors.
- Visibility is poor across separate systems and isolated environments.

Also, note that the battle is decidedly unbalanced. While organizations must protect a wide swath of technology over a very large attack surface, attackers need only pinpoint the weakest link.

High-profile security breaches

One of our earliest wake-up calls came in 2009, when malware manipulated the speed of centrifuges in a nuclear enrichment plant, causing them to spin out of control. This malware, now known as Stuxnet, was introduced into standalone networks via flash drives, and it autonomously spread across production networks. Stuxnet's sophistication served as a powerful early example of cyber-attack potential in the world of connected factories. More recently, a new type of malware called Trident was discovered, which undermines safety instrumented systems (SIS), enabling attackers to destroy or damage whatever processes those systems protect by feeding false data. The increased connectivity of smart machines only raises the stakes.

Cyber-physical systems (CPS) combine physical components and digital networks to revolutionize the way companies automate processes and share information.The smart factory's combination of virtual and physical systems makes interoperability and real-time capability possible, but it comes with the cost of an expanded attack surface that requires both IT and OT defenses. Organizations must carefully consider the security implications to have a successful Industry 4.0 journey. In the end, security best practices will be key to the success of Industry 4.0.

Emerging Industry 4.0 best practices

As more connected systems are deployed and the opportunities for an attack against intellectual property increase, protecting against evolving threats is becoming a full-time task. The manufacturing sector needs to:

- Adopt a risk-based security mindset (tying business criticality to defense strategies).
- Keep an accurate inventory of all OT assets in real-time.Marry the best of IT and OT as an integrated defense strategy across all attack surfaces.
- Identify and fix outdated systems, unpatched vulnerabilities, and poorly secured files.
- Take a security-first approach to the deployment of new connected systems.
- Remain ever vigilant to spot potential threats with real-time vulnerability assessments and risk-based prioritizations.
- Ensure that technology suppliers and connected equipment manufacturers commit to regular security and software patches and audits.
- Threat intelligence, including monitoring of the dark web, can also act as an early warning system to uncover planned attacks. Thus, the organization can pre-empt a breach and take immediate action to protect their digital corporate assets and physical infrastructure.

3.10. Industrial Internet Of Things(IIoT)

The industrial internet of things (IIoT) refers to interconnected sensors, instruments, and other devices networked together with computers' industrial applications, including manufacturing and energy management. This connectivity allows for data collection, exchange, and analysis, potentially facilitating improvements in productivity and efficiency as well as other economic benefits. The IIoT is an evolution of a distributed control system (DCS) that allows for a higher degree of automation by using cloud computing to refine and optimize the process controls.

The IIoT is enabled by technologies such as cybersecurity, cloud computing, edge computing, mobile technologies, machine-to-machine, 3D printing, advanced robotics, big data, internet of things, RFID technology, and cognitive computing. Five of the most important ones are described below:

Cyber-physical systems (CPS): the basic technology platform for IoT and IIoT and therefore the main enabler to connect physical machines that were previously disconnected. CPS integrates the dynamics of the physical process with those of software and communication, providing abstractions and modeling, design, and analysis techniques.

Cloud computing: With cloud computing IT services and resources can be uploaded to and retrieved from the Internet as opposed to direct connection to a server. Files can be kept on cloud-based storage systems rather than on local storage devices.

Edge computing: A distributed computing paradigm which brings computer data storage closer to the location where it is needed. In contrast to cloud computing, edge computing refers to decentralized data processing at the edge of the network. The industrial internet requires more of an edge-plus-cloud architecture rather than one based on purely centralized cloud; in order to transform productivity, products and services in the industrial world.

Big data analytics: Big data analytics is the process of examining large and varied data sets, or big data.

Artificial intelligence and machine learning: Artificial intelligence (AI) is a field within computer science in which intelligent machines are created that work and react like humans. Machine learning is a core part of AI, allowing software to more accurately predict outcomes without explicitly being programmed.

Architecture

IIoT systems are usually conceived as a layered modular architecture of digital technology. The device layer refers to the physical components: CPS, sensors or machines. The network layer consists of physical network buses, cloud computing and communication protocols that aggregate and transport the data to the service layer, which consists of applications that manipulate and combine data into information that can be displayed on the driver dashboard. The top-most stratum of the stack is the content layer or the user interface.

Table 3.1

Layered modular architecture IIoT	
Content layer	User interface devices (e.g. computer screens, PoS stations, tablets, smart glasses, smart surfaces)
Service layer	Applications, software to analyze data and transform it into actionable information
Network layer	Communications protocols, Wi-Fi, Bluetooth, LoRa, cellular
Device layer	Hardware: CPS, machines, sensors

3.11.Industry 4.0 and Society 5.0

Industry 4.0

Industry 4.0 is characterised like a network in real time, intelligent and digital for equipment, objects and mainly for people concerning the industrial management , enables increased digitalization of the whole value chain and the interconnection between people, objects and systems through the data exchange in real-time .

Modern information and communication technologies could be implemented in machines, workers in production and logistics processes, in order to promote the better communication among all participants in the product development process, analyse data according to defined algorithms and control production flows to promote continuous improvement .

Industry 4.0 could be described by three paradigms:

o Intelligent Product where it is possible to solicit the required resources and coordinate productions processes, since the products have a memory to save operational data and standards individually.

o Intelligent Machine where the traditional production hierarchy is replaced by decentralized self-organization, allowing for a flexible and modular production line.

o Augmented Operator with knowledge automation in order to promote a flexible and adaptive part on production system.

In Industry 4.0, the main components include the Cyber-Physical Systems (CPS), Internet of Services (IoS) and the Internet of Things (IoT) , which will be an important tool in the implementation of Industry 4.0 . The heart of Industry 4.0 structure is the CPS system and consists of integrating hardware and software into a mechanical or electrical system projected for a goal .

Smart Factories stimulated by Industry 4.0

Industry 4.0 enables the use of smart objects that promote adaptability, resource efficiency and process integration [13]. The expression “Smart” refers to Industry 4.0 applications namely: Smart Factory and Manufacturing, Smart Product and Smart City [13]. Intelligent factories operate with a platform able to execute commands, data transmission and other information between equipment and clouds with inclusion of machines and products .

Industry 4.0 encompasses numerous technologies and emergent standards which include Industrial Internet of Things (IIoT), cloud-bases manufacturing and social product development. Industrial Internet of Things (IIoT) will be one of the major contributors of the correct functioning and performance of a factory with Industry 4.0 implementation and results from the convergence of industrial systems with advanced programming, sensors and communication systems. Furthermore, the allocation of resources such as materials, energy and water could be realised more efficiently based on intelligent interconnected modules.

The complexity and management challenges in industrial really need to be solved in order to take advantage on potential opportunities developed by Industry 4.0 and in smart production could offer.

The challenges set by Industry 4.0 for companies

The high level of competition in the current market forces the companies to overcome new challenges regarding the best prices/costs, quality and delivery time [9]. Industry must be the ability to respond to innovation and bring new products to market within a short time due to current competition around the world .

In order to guarantee process competitiveness along the value chain, it is mandatory to design productive, efficient and flexible methods . The main aspect to promote the fast adaptation to changes in production is the connexion between processes, products and equipment with artificial intelligence.

Companies will include storage systems, machines and productions plants from Cyber-Physical Systems (CPS) in a global network . CPS is considered as a high-tech technology to handling systems where could integrate computer skills and physical resources . Furthermore, CPS integration with production, logistics and services in current industrial practices will promote evolution in the implementation of Industry 4.0 in factories with significant economic impact. The life cycle of a mutable product could be managed with a dynamic production and delivery by a challenge of digitization and automation of production processes and promotes a creation of new opportunities for industries.

Control applications and production control centralized and monolithic will originate solutions that could support production processes and supply chain processes in a decentralised manner. The process will be dynamic, efficient and effective concerning the changes, decentralization, self-optimization and automation .

In a factory environment, CPS´s include intelligent machines, storage systems and production facilities capable of autonomously exchanging information, triggering actions and independent control. The continuous growth and evolution in the industry has promoted the implementation of high-tech methodologies.

According to , Industry must learn first to walk before it could dream of flying.

Society 5.0

Society 5.0 is focuses on positioning the human being at the centre of technological and innovation modification for the benefit of humanity and it is considered a quiet revolution started in Japan that promises to revolutionize society . The main purpose of Society 5.0 is to enhance people’s quality life with the use of potentialities acquired by Industry 4.0 . Japan is already moving towards Society 5.0 with the implementation of new methodologies such as autonomous trucks for orders delivered or drones. In the meantime the rest of the World is adapting to the challenges promoted by Industry 4.0.

Movement initiated in Japan

Japan foresees, in 2050, the oldest society with about 40% of population has more than 65 years old. In order to face today´s society´s dilemma should be use advanced technology like big data, robotics, artificial intelligence, drone deliveries and autonomous trucks .The future growth plan promoted by Japan includes a training to meet sustainable development goals and the creation of a super-intelligent society . In order to coordinate cooperation between academia, government and industry, Japan will promote a Society 5.0 services platform. Therefore, Japan moves courageously calling for future development as a Society 5.0, with changes that will influence aspects of society and industrial production. Europe will also be an integral part of this movement.

Computer technologies adapted to this new Society

Society 5.0 is defined by parallel intelligence, where traditional artificial intelligence theories are extended to emerging cyber-physical-social systems (CPSS). Nowadays, advances through innovation in science and technology, mainly in computer science, contribute to the improvement of business and society . Parallel intelligence enables to handle effectively with socially and engineeringly complex issues and aims to find agile, focused and convergent solutions to understand uncertain, diverse and complex issues.

In the meantime, the world is facing global challenges such as global warming, scarcity of natural resources, terrorism and economic divergence.

Following the great advance in mechanization, electrification, information and networking technology, modern society entered a new era of technological development, which is the parallel era of virtual-real intelligence technology. The connection between people and things and between the real and cyber worlds will enable the effective and efficient resolution of societal issues, create more quality of life for people and sustain healthy economic growth .

The key techniques of Society 5.0 follow the idea of automation, which is the direction for the next development of artificial intelligence technology and the general structure to deal with management and control of CPSS systems. The Japanese Society expect the formation of a Super Smart Society, with the creation of sustainable society where the various types of values are connected through CPS and people could live in safety, security and comfort. Intelligent society is a system that utilize the potential of digital technology, digital instruments and networks to improve the quality of human life. CPS could connect different sectors, countries, regions and societies.

A complex analytical approach to the development of virtual artificial systems use a system namely ACP: (A) Artificial systems, (C) Computational experiments, (P) Parallel execution. The evolution and development of the information society originated Society 5.0, focused on improving enterprises and individual strengths and solving social problems.

The Future and Society 5.0

Employment, public administration, people´s privacy and industrial structure are all aspects of society that are undergoing drastic changes and digital information must respond to current demands. Society 5.0 has to be implemented considering the integration of various dimensions such as Entrepreneurial Skills, Entrepreneurial Spirit and Innovation Policy.

Technological development allows the possibility to improve living standards, but it could also negatively impact employment, unequal distribution of wealth and information. Society 5.0 enables the use of advanced technologies such as IT, IoT, robotics, artificial intelligence and augmented reality in people´s lives, health and other spheres of activity while Industry 4.0 restricts technology advances only in industrial sector. Thus, it depends on mankind which direction we want to choose and what kind of society we want to create in the future, with the innovative technologies we have a tour disposal . The diversity of technologies for the benefit of humanity such us increased production, mitigation of costs related with ageing society, equal distribution of wealth, reduction of greenhouse gases, reduced food products, the correction of regional inequalities and other could solve the social problems and the economic growth .

Society 5.0 combines digital transformation with the creativity of different people for sustainable development through problem solving and value creation and enables it to meet the goals proposed by United Nations for sustainable development.

The table I presents the main aspects related to the Industry 4.0 and the Society 5.0.

Table- 3.2: Industry 4.0 and Society 5.0

INDUSTRY 4.0	**SOCIETY 5.0**
End of 20th century	21st century
Information Society	Super smart society
Automation, information (computer, internet)	Digital transformation
Cloud	Big Bata

The new technologies of Industry 4.0 could be use in benefit of humanity. Recently Japan encountered with the ageing of its population and felt the need to create a system to improve the quality life of society and adopt immediate actions to promote advantages with this high technology. The use of technology to benefit the society has promoted a new industrial revolution called Society 5.0.

Society 5.0 focuses on application of technology in constant development and innovation stimulated for Industry 4.0 to solve mankind problems such as population ageing, natural disasters, social inequality, security and improving people's quality of life. The integration of technology with society will be crucial as it is relevant to use drone deliveries, artificial intelligence, big data, autonomous trucks and robotics in the near future for the benefit of humanity.

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UNIT IV

UNIT - IV - SOCIETY 5.0 - SAIC4002

CHALLENGES AND TECHNOLOGIES TOWARDS SOCIETY5.0 9hrs

Overcome with Economic Development and Solution to Social Problems in Society 5.0- Security of Cyber Physical Systems -Embedded and CPS security - attacks and countermeasures, authentication, identification, confidentiality, data integrity, authorization, access control, malware attacks and counter-measures, security protocols- Social Issues in Society 5.0 - human-centered society (Society 5.0)- Sustainable Development Goals-Economic Advancement- Resolution to Social Problems.

1. Overcome with Economic Development and Solution to Social Problems in Society 5.0

1.1 Introduction

Society 5.0 achieves a high degree of convergence between cyberspace (virtual space) and physical space (real space). In the past information society (Society 4.0), people would access a cloud service (databases) in cyberspace via the Internet and search for, retrieve, and analyze information or data. In Society 5.0, a huge amount of information from sensors in physical space is accumulated in cyberspace. In cyberspace, this big data is analyzed by artificial intelligence (AI), and the analysis results are fed back to humans in physical space in various forms.

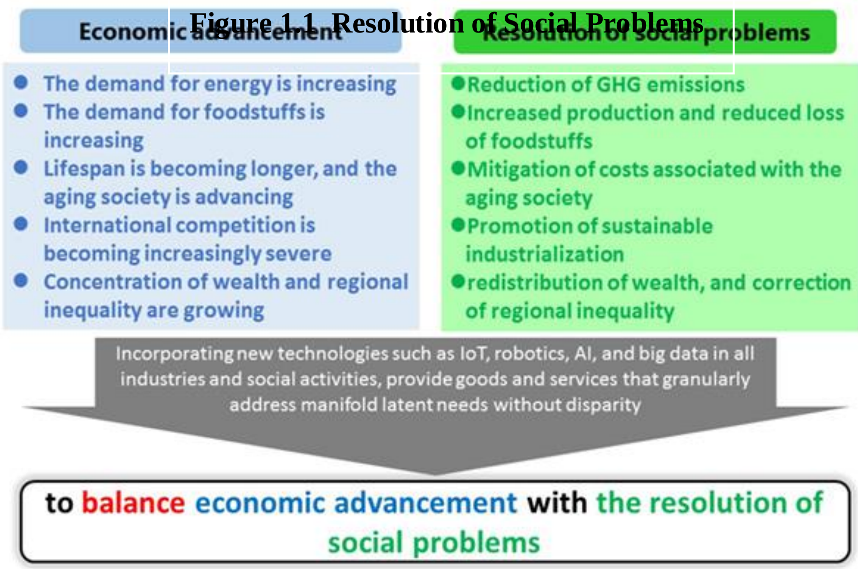
In the past information society, the common practice was to collect information via the network and have it analyzed by humans. In Society 5.0, however, people, things, and systems are all connected in cyberspace and optimal results obtained by AI exceeding the capabilities of humans are fed back to physical space. This process brings new value to industry and society in ways not previously possible.

1.2 Society 5.0 Balances Economic Development and Solves Social Issues

It can be said that the environment surrounding Japan and the world is in an era of drastic change. As the economy grows, life is becoming prosperous and convenient, the demand for energy and foodstuffs is increasing, lifespan is becoming longer, and the aging society is advancing. In addition, the globalization of the economy is progressing, international competition is becoming increasingly severe, and problems such as the concentration of wealth and regional inequality are growing. Social problems that must be solved in opposition (as a tradeoff) to such economic development have become increasingly complex. Here, a variety of measures have become necessary such as the reduction of greenhouse gas (GHG) emissions, increased production and reduced loss of foodstuffs, mitigation of costs associated with the aging society, support of sustainable industrialization, redistribution of wealth, and correction of regional inequality, but achieving both economic development and solutions to social problems at the same time has proven to be difficult in the present social system.

In the face of such major changes in the world, new technologies such as IoT, robotics, AI, and big data, all of which can affect the course of a society, are continuing to progress. Japan seeks to make Society 5.0 a reality as a new society that incorporates these new technologies in all industries and social activities and achieves both economic development and solutions to social problems in parallel.

Figure 1.1 Resolution of Social Problems



1.3 Economic Development and Solutions to Social Problems in Society 5.0

We have passed through (Society 1.0) hunting society, (Society 2.0) agricultural society, (Society 3.0) industrial society, (Society 4.0) information society and we are initiating to pass through (Society 5.0) IOT & Big data. Society 5.0 refers to human-centered society where economic development and social challenges will be solved with the help of cyber space and technologies.

In Society 5.0, new value created through innovation will eliminate regional, age, gender, and language gaps and enable the provision of products and services finely tailored to diverse individual needs and latent needs. In this way, it will be possible to achieve a society that can both promote economic development and find solutions to social problems.

Achieving such a society, however, will not be without its difficulties, and Japan intends to face them head-on with the aim of being the first in the world as a country facing challenging issues to present a model future society.

- Society 5.0 can be a boon for India, It can address various problems in various ways

- Agriculture problem can be solved with mixed agriculture, mechanization and automation
- Senior citizen can access services at affordable rates using technology and innovations.
- Block chain technology can ensure good governance and maximum governance
- Illiteracy can be eradicated with the help of digitization and cloud computing
- Big data, Robotics and Artificial intelligence can solve the problem of traffic, medical health care, productivity of industry and service sector.

No doubt Society 5.0 can be game changer for Indian economy and society , But It has some drawbacks and challenges.

- It leads huge unemployment which will hamper social and political tranquility.
- It tends to digital divide, rising inequality, alienation and separation of family and society
- It requires huge infrastructure and funding , which itself is a huge question mark
- Cyber crime and digital security is major concern.

More than 40 % population live in village , 22 % population are illiterate and 90 % population are digital illiterate. In such conditions Society 5.0 will be dream. We need to fulfill first basic needs then desire.

1.4 RESOLUTION OF SOCIAL PROBLEMS IN SOCIETY 5.0

Health Issues

The world is ageing at a faster pace this presents the challenge of medical and social security expenses and demands for caring for the elderly. Society 5.0 will solve the problem of health issues by connecting and sharing information between medical data users as wells as robots will take care of the elderly people.

Infrastructure

AI and robots will be used to inspect and maintain roads, bridges, tunnels and dams,

Mobility

t will promote use of autonomous transportation system and it will also improve distribution and logistics efficiency by introducing innovative technologies.

Finance

Improving efficiency of banks and promoting cashless transactions.

Manual Shortage

It will eliminate shortage of manpower in agricultural as well as industrial sector by using automatic technology such as robots, artificial intelligence etc.

Society 5.0 aims at balancing economic advancement with the resolution of social problems. This proposed society presents a picture of an inclusive society which will eliminate regional, age, gender and language gaps. This will also help in achieving sustainable development by reducing green house gas emissions, sustainable agriculture and industrialization and increasing production of food stuffs along with reducing waste.

2. Cyber-Physical Systems

2.1 Introduction

Cyber-Physical Systems (CPS) is engineered systems combining computation, communications, and physical resources. The term Cyber-Physical Systems (CPS) emerged just over a decade ago as an attempt to unify the emerging application of embedded computer and communication technologies to a variety of physical domains, including aerospace, automotive, chemical production, civil infrastructure, energy, healthcare, manufacturing, materials, and transportation. The term CPS was coined in 2006 by Helen Gill from the National Science Foundation NSF in the United States. CPS is related to other popular terms including the Internet of Things (IoT), Industry 4.0.

In their program announcement, the NSF outlined their goal for considering these various industries under a unified lens: by abstracting from the particulars of specific applications in these domains, the goal of the CPS program is to reveal cross-cutting fundamental scientific and engineering principles that underpin the integration of cyber and physical elements across all application sectors.

Soon after the term CPS was coined, several research communities rallied to outline and understand how CPS cyber security research is fundamentally different compared to conventional Information Technology (IT) cyber security. Because of the cross-cutting nature of CPS, the background of early security position using the term CPS, ranged from real-time systems, embedded systems, control theory and cyber-security.

2.2 **Characteristics of CPS**

CPS is the result of several computing efforts in embedded systems, real-time systems, (wired and wireless) networking and control theory. One of the most general characteristics of CPS is that because several of the computers interfacing directly with the physical world (sensors, controllers, or actuators) perform only a few specific actions, they do not need the general computing power of classical computers or even mobile systems and, therefore, they tend to have limited resources.

Some of these embedded systems do not even run full operating systems, but rather run only on firmware, which is a specific class of software that provides low-level control of device hardware. Even when embedded systems have an operating system, they run a stripped-down version of it to concentrate on the minimal tools necessary for the platform; for example, a fairly popular operating system in IoT consumer devices is Busybox, and another popular operating system for embedded devices that provides networking functionalities is OpenWrt. For safety-critical systems, the time in which computations are performed is important in order to ensure the correctness of the system. Real-time programming languages can help developers specify timing requirements for their systems, and Real-Time Operating Systems (RTOS) guarantee the time to accept and complete a task from an application.

Another characteristic of CPS is that these embedded systems communicate with each other, usually over IP-compatible networks. While many critical infrastructures such as power systems have used radio communications to monitor operations in their SCADA systems remotely, it is only in the past two decades that the information exchanged between different parts of the system have migrated from serial communications to IP-compatible networks. reason about the properties of cyber and physical-controlled systems.

Figure 2.1 CPS and its parts and characteristics

CPS's are powered by two types of computing system:

(i) Notebooks, Desktop servers and PCs. Computers at every desk to do business activities

(ii) Embedded Computing - Transformation of Industry and Invisible part of Environment.

The main characteristics of CPS are:

(i) Intelligence - Adaptive and Robustness

(ii) Network – Communication, Cooperation and Cloud solutions

(iii) Functionality

(iv) User friendly. The main features are as follows: CPS is said to be closely integrated with computation and physical processes, the software is embedded with physical systems and CPS networks use wireless sensor networks.

2.3 CPS Security

A CPS consists of Programmable Logic Controllers (PLC), sensors, actuators, Supervisory Control, and Data Acquisition (SCADA) workstation and Human Machine Interface (HMI) that are interconnected via a communications network. The PLCs control a physical process based on the sensor measurements. The advances in communication technologies help to better monitor and operate CPS, but this connectivity also exposes physical processes to malicious entities on the cyber and physical domains.

The architecture of CPS systems consists of different layers and components, which rely on different communication protocols and technologies to communicate among each other across the different layers. CPS layers

The CPS architecture consists of three main layers, the perception layer, transmission layer, and application layer,

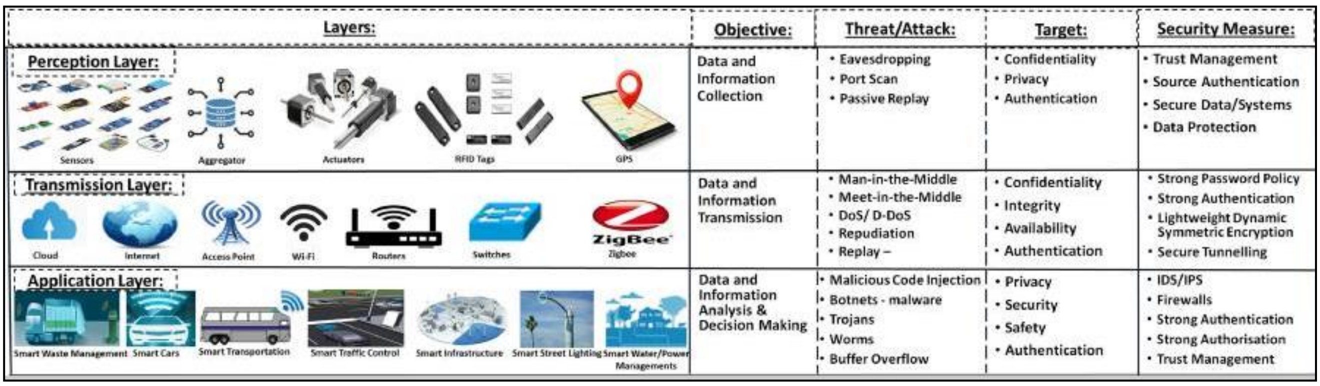


Figure 2.2 CPS threats & Measures

- **Perception Layer:** It is also known as either the recognition or the sensing layer. It includes equipment such as sensors, actuators, aggregators, Radio-Frequency IDentification (RFID) tags, Global Positioning Systems (GPS) along with various other devices. These devices collect real-time data in order to monitor, track and interpret the physical world. Examples of such collected data include electrical consumption, heat, location, chemistry, and biology, in addition to sound and light signals, depending on the sensors' type. These sensors generate real-time data within wide and local network domains, before being aggregated and analyzed by the application layer. Moreover, securing actuators depends on authorized sources to ensure that both feedback and control commands are error-free and protected. Generally, increasing the security level requires an end-to-end encryption scheme at each layer. Therefore, heavyweight computations and large memory requirements would be introduced. In this context, there is a need for the design of efficient and lightweight security protocols, which take into consideration the devices capabilities and the security requirements.

- **Transmission Layer:** It is also known as the transport layer or network layer, and it is the second CPS layer. This layer interchanges and processes data between the perception and application layers. Data transmission and interaction is achieved through the Internet using Local Area Networks (LANs) and communication protocols including Bluetooth, 4G and 5G, InfraRed (IR) and ZigBee, Wi-Fi, Long Term Evolution (LTE), along with other technologies. For this purpose, various protocols are used to address the increase in the number of internet-connected devices, such as the Internet Protocol version 6 (IPv6) [33]. This layer also ensures data routing and transmission using cloud computing platforms, routing devices, switching and internet Gateways, firewalls and Intrusion Detection/Prevention Systems (IDS/IPS) . Before outsourcing data contents, it is essential to secure their transmission to prevent intrusions and malicious attacks including malware, malicious code injection, Denial of Service/Distributed Denial of Service (DoS/DDoS), eavesdropping, and unauthorised access attacks. This introduces a challenge, especially for resource-constrained devices due to the imposed overhead in terms of the required processing and power resources.

- **Application Layer:** It is the third and most interactive layer. It processes the received information from the data transmission layer and issues commands, which are executed by the physical units including sensors and actuators. This is done by implementing complex decision-making algorithms based on the aggregated data. Moreover, this layer receives and processes information from the perception layer before determining the rightly invoked automated actions . In fact, cloud computing, middleware, and data mining algorithms are used to manage the data at this layer. Protecting and preserving privacy requires protecting private data from being leaked. The most known protective approaches include anonymization, data masking (camouflage), , privacy-preserving, and secret sharing. Moreover, this layer also requires a strong multi-factor authentication process to prevent unauthorised access and escalation of privilege. Due to the increase in the number of

Internet-connected devices, the size of the generated data has become a significant issue [21]. Therefore, securing big data calls for efficient protection techniques to process huge amounts of data in a timely and efficient manner.

2.4 CPS components

CPS components are used for sensing information, or for controlling signals). In this regard, CPS components are classified into two main categories:

Sensing Components (SC) that collect and sense information, and

Controlling Components (CC) that monitor and control signals.

- **Sensing Components:** are primarily located at the perception layer and consist of sensors that collect data/information and forward them to aggregators. Then, this data/information is sent to the actuators for further analysis to ensure accurate decision making. In the following, we list the main CPS sensing components.

    - **Sensors:** collect and record real-world data following a correlation process named "calibration", to assess the correctness of the collected data. Sensing data is essential since the decisions that will be made are based on the analysis of this data.
    - **Aggregators:** are primarily located at the transmission layer (i.e routers, switches and gateways) to process the received data/information from sensors, before issuing the corresponding decision(s). In fact, data aggregation is based on the collected information about a specific target, where this information is gathered and summarized following a statistical analysis. Online Analytical Processing (OLAP) is a prime data aggregation type used as an online reporting mechanism for processing information.
    - **Actuators:** are located at the application layer to make the information visible to the surrounding environment based on the decisions made by the aggregators. Since actuators highly depend on other network nodes, then each action performed by the CPS relies on an earlier data aggregation sequence [5]. Also in terms of operations, actuators process electrical signals as input and generate physical actions as output.

- **Controlling Components:** are used to control Signals and they play a key role in signal control, monitoring and management to achieve higher levels of accuracy and protection against malicious attacks or accidents, mainly signal jamming, noise and interference. As a result, the reliance on Programmable Logic Controllers (PLCs) and Distributed Control System (DCSs) along with their components (i.e Programmable Automation Controller (PAC), Operational Technology/Information Technology (OT/IT), Control Loop/Server, and Human-Machine Interface (HMI)/Graphical User Interface (GUI)) has become highly essential. Next, we list the different types of control systems that are used in CPS systems:

- **Programmable Logic Controllers (PLC):** were initially developed to replace hard-wired relays, and are considered as industrial digital computers that control the manufacturing processes such as robotic devices performance and/or fault diagnosis processing; hence achieving better flexibility and resiliency.

- **Distributed Control Systems (DCS):** are computerized control systems that allow the autonomous controllers' distribution throughout the system using a central operator supervisory control. As a result of the remote monitoring and supervision process, the DCS's reliability is increased, whilst its installation cost is reduced. In some cases, DCS can be similar to Supervisory Control and Data Acquisition (SCADA) systems.
- **Remote Terminal Units (RTU):** or "Remote Telemetry Unit", are electronic devices controlled by a microprocessor such as the Master Terminal Unit (MTU) . Unlike the PLC, they do not support any control loop nor control algorithm(s). Thus, making them more suitable for wireless communications over wider geographical telemetry areas. RTU's main task is to interface SCADA to the physical object(s) using a supervisory messaging system that controls these objects through the system's transmission of telemetry data

2.5 CPS Vulnerabilities, threats, attacks & failures

In a similar manner to most networking systems, security services were not incorporated into CPS systems by design, leaving the door open for various vulnerabilities and threats to be leveraged by attackers to launch security attacks. This is also due to the heterogeneous nature of CPS devices since they operate in different IoT domains and communicate using different technologies and protocols.

2.5.1CPS security threats

CPS security threats can be classified as cyber or physical threats, as explained below, and if combined, these can result into cyber-physical threats.

2.5.2 Cyber threats

The main attention on Industrial IoT security was highly focused on cyber threats rather than physical threats. This includes the electrical grid evolution into an Advanced Metering Infrastructure (AMI), which resulted into the rise of newly unknown cyber threats aside from SCADA vulnerabilities. Electronic attacks are now easier to launch from any device, unlike physical attacks that require physical presence and physical tools. Moreover, the smart meter interfacing and interconnection with other meters in the Near-me Area Network (NAN) and Home Area Network (HAN) increase its exposure to various remote threats. Finally, electronic attacks are difficult to mitigate and overcome in the absence of the right prevention and defensive countermeasures.

Since cyber security is not limited to a single aspect, it can be considered from different perspectives, such as:

- **Centring Information:** which requires protecting the data flow during the storage phase, transmission phase, and even the processing phase.
- **Oriented Function:** which requires integrating the cyber-physical components in the overall CPS.

- **Oriented Threat:** which impacts data confidentiality, integrity, availability, and accountability .

The above issues make CPS systems prone to:

- **Wireless Exploitation:** It requires knowledge of the system's structure and thus, exploiting its wireless capabilities to gain remote access or control over a system or possibly disrupt the system's operations. This causes collision and/or loss of control.
- **Jamming:** In this case, attackers usually aim at changing the device's state and the expected operations to cause damage by launching waves of de-authentication or wireless jamming signals, which would result into denial of device and system services.
- **Reconnaissance:** An example of such a threat is where intelligence agencies continuously perform operations targeting a nation's Computational Intelligence (CI) and Industrial Control System (ICS) mainly through a malware spread. This results in violating data confidentiality due to the limitation of traditional defences.
- **Remote Access:** This is mainly done by trying to gain remote access to the CPS infrastructure, for example, causing disturbances, financial losses, blackouts, as well as industrial data theft and industrial espionage. Moreover, Havex Trojans are among the most dangerous malware against ICSs, as they can be weaponized and used as part of cyber-warfare campaign management against a nation's CPS.
- **Disclosure of Information:** Hackers can disclose any private/personal information through the interception of communication traffic using wireless hacking tools, violating both privacy and confidentiality.
- **Unauthorised Access:** Attackers try to gain an unauthorized access through either a logical or physical network breach and to retrieve important data, leading to a privacy breach .
- **Interception:** Hackers can intercept private conversations through the exploitation of already existing or new vulnerabilities leading to another type of privacy and confidentiality breach.
- **GPS Exploitation:** Hackers can track a device or even a car by exploiting (GPS) navigation systems, resulting in a location privacy violation.
- **Information Gathering:** software manufacturers covertly gather files and audit logs stored on any given device in order to sell this huge amount of personal information for marketing and commercial purposes in an illegal manner.

2.6 Physical threats

CPS systems are recently evolving into the industrial domain by introducing an Advanced Metering Infrastructure (AMI), and Neigh bourhood Area Networks (NANs), along with data meter management systems to maintain the robustness of CPS in industrial domains. In fact, physical threats might be classified according to the following three factors:

- **Physical Damage:** since different facility types implement different levels of protection, power-generating stations (E.g power grid, power plants, base stations) are well protected. This is due to the fact that these stations are well-manned and well-guarded based on the implementation of access controls, authorisation and authentication mechanisms such as usernames and passwords, access cards, biometrics and video surveillance. However, the main concern is related to the less protected power-generating sub-stations since transmission lines are vulnerable to sabotage attacks and disruption.

- To address this problem, smart meters must be tamper-resistant by relying on outage detection or even host-based intrusion detection. However, it is almost impossible to prevent physical tampering or theft by adversaries (such as Advanced Persistent Threats (APTs)), except that it is possible to mitigate the risk and reduce its impact.
- **Loss:** the most worrying scenario is having more than a single substation failure caused by a malicious attacker. In case of a severe damage in the smart grid, a total blackout of major metropolitan areas may occur for several hours.
- **Repair:** it can be based on a self-healing process, which is based on the ability to either sense faults or disruptions, whilst isolating the problem and sending alerts to the corresponding control system to automatically reconfigure the back-up resources in order to continuously provide the necessary service. The aim is to ensure a fast recovery in as short of a time as possible. However, critical components do suffer from either a lack or a limited backup capability. Therefore, self-healing can respond faster to a severe damage.

Some of the threats associated with CPS systems include:

- **Spoofing: It** consists of masquerading the identity of a trusted entity by a malicious unknown source. In this case, attackers are capable of spoofing sensors, for example, by sending misleading and/or false measurements to the control center.
- **Sabotage:** Sabotage consists of intercepting the legal communication traffic and redirecting it to malicious third party or disrupting the communication process. For example, attackers can sabotage physically exposed CPS components across the power grid, to cause a service disruption or even denial of service that leads to either total or partial blackout.
- **Service Disruption or Denial:** Attackers are capable of physically tampering with any device to disrupt a service or to change the configuration. This has serious effects, especially in the case of medical applications.
- **Tracking:** Since devices are physically exposed, an attacker can gain access to a given device, and/or even attach a malicious device or track the legal ones.

In the following, we present the main CPS vulnerabilities that can be targeted by the above-mentioned threats.

2.7 CPS vulnerabilities

A vulnerability is identified as a security gap that can be exploited for industrial espionage purposes (reconnaissance or active attacks). Hence, a vulnerability assessment includes the identification and analysis of the available CPS weaknesses, while also identifying appropriate corrective and preventive actions to reduce, mitigate or even eliminate any vulnerability [88].

In fact, CPS vulnerabilities are divided into three main categories:

- **Network Vulnerabilities:** include weaknesses of the protective security measures, in addition to compromising open wired/wireless communication and connections, including man-in-the-middle, eavesdropping, replay, sniffing, spoofing and communication-stack (network/transport/application layer), back-doors, DoS/DDoS and packet manipulation attacks.
- **Platform Vulnerabilities:** include hardware, software, configuration, and database vulnerabilities.
- **Management Vulnerabilities:** include lack of security guidelines, procedures and policies.

Vulnerabilities occur due to many reasons. However, there are three main causes of vulnerabilities:

- **Assumption and Isolation:**It is based on the “security by obscurity” trend in most CPS designs. Therefore, the focus here is to design a reliable and safe system, taking into consideration the implementation of necessary security services, without assuming that systems are isolated from the outside world.
- **Increasing Connectivity:**More connectivity increases the attack surfaces. Since CPS systems are more connected nowadays, manufacturers have improved CPS through the implementation and usage of open networks and open wireless technologies. Most ICS attacks were based on internal attacks up until 2001. This was before utilizing the internet which shifted attacks to external ones.
- **Heterogeneity:**CPS systems include heterogeneous third party components which are integrated to build CPS applications. This has resulted in CPS becoming a multi-vendor system, where each product is prone to different security problems.
- **USB Usage:** this is a main cause of CPS vulnerabilities, such as the case of the Stuxnet attack that targeted Iranian power plants, since the malware is inside the USB. Upon plugging it, the malware spread across several devices through exploitation and replication.
- **Bad Practice:** is primarily related to a bad coding/weak skills that lead to the code to execute infinite loops, or to become too easy to be modified by a given attacker.
- **Spying:** CPS systems are also prone to spying/surveillance attacks, mainly by using spyware (malware) types that gain a stealthy access and remain undetected for years with the main task to eavesdrop, steal and gather sensitive/confidential data and information.
- **Homogeneity:** similar cyber-physical system types suffer from the same vulnerabilities, which once exploited, can affect all the devices within their vicinity, a prime example is the Stuxnet worm attack on Iranian nuclear power plants.
- **Suspicious Employees:** can intentionally or inadvertently damage or harm CPS devices, by sabotaging and modifying the coding language, or granting remote access to hackers through the opening of closed ports or plugging in an infected USB/device.

Thus, CPS vulnerabilities can be of three types, including cyber, physical, and when combined, they result into a cyber-physical threat.

2.8 Cyber vulnerabilities

Since ICS heavily relies on open standard protocols including Inter-Control Center Communications Protocol (ICCP) and Transmission Control Protocol/Internet Protocol (TCP/IP), ICS applications are prone to security attacks. In fact, ICCP suffers from a critical buffer overflow vulnerability and also lacks the basic security measures . In fact, the Remote Procedure Call (RPC) protocol and ICSs are prone to various vulnerabilities including the Stuxnet (1 & 2)and Duqu malware (1.0, 1.5 & 2.0) attack types , Gauss malware, and RED October malware , as well as Shamoon Malware (1, 2 & 3), Mahdi malware, and Slammer Worm.

Open/Non-secure wired/wireless communications such as Ethernet are vulnerable to interception, sniffing, eavesdropping, wiretapping and wardialing and wardriving attacks and meet-in-the-middle attacks. Short-range wireless communications are also vulnerable, since they can be captured, analysed, damaged, deleted or even manipulated by insiders. Moreover, employees' connected devices to ICS wireless network, if not secure, are prone to botnet, remote access Trojan and rootkit attacks, where their devices will be remotely controlled by an attacker. Long-range wireless communications are vulnerable to eavesdropping, replay attacks, and unauthorized access attacks. Yet, SQL injection remains the most Web-related vulnerability since attackers can access any server database without authorization through the injection of a malicious code that keeps on running endlessly once executed without the user's knowledge.

2.9 Physical vulnerabilities

Physical tampering may result into misleading data in cyber-physical components. The physical exposure of ICS components is classified as a vulnerability due to the insufficient physical security provided to these components. Thus, making them prone to physical tampering, alteration, modification or even sabotage. CPS field devices (i.e smart grids, power grids, supply chains etc.) are prone to the same ICS vulnerabilities since a large number of physical components is exposed without physical security, making them prone to physical destruction.

2.9.1. Cyber-physical system attacks

In this section, we present the different types of attacks that target the different aspects of CPS systems, including cyber and physical ones:

2.9.2 Physical attacks

Physical attacks were more active in past years, especially against industrial CPS systems. Broader range of physical attack types:

- **Infected Items:** this includes infected CDs, USBs, devices and drives such as the case of the Stuxnet worm , which upon their insertion into a cyber-physical device, a covert malware is installed containing a malicious software.
- **Abuse of Privilege:** this attack occurs when rogue or unsatisfied employees access the server rooms and installation areas within the CPS domain. This allows them to insert a

rogue USB for infection through the installation of malicious malware/code or as keystroke, or to capture confidential data.

- **Wire Cuts/Taps/Dialing:** since communication lines including telephony and Wi-Fi of many cyber-physical headquarters (HQs) are still physically visible, attackers can cut the wires or wiretap into them to intercept the communicated data .
- **Fake Identity:** this attack occurs when attackers masquerade themselves as legitimate employees, with enough experience to fool the others. They mainly act as cleaners to gain an easier access and better interaction with other employees.
- **Stalkers:** these are usually legal employees who act curious (with malicious intents) by being on the shoulder of CPS administrators and engineers to acquire their credentials to blackmail or sell them to other competing CPS organisations.
- **CCTV Camera Interception:** this includes intercepting the footage of Closed-circuit television cameras that are securing entry and key points within CPS areas. This can be done by distorting the signals of cameras, cutting off the communication wires, deleting the footage, gaining access to the remote control and monitoring area, etc., before performing a physical attack in an undetected manner.
- **Key-Card Hijacking:** this includes cloning legitimate cards that are stolen from employees, or creating look-alike genuine copies to gain full/partial access and to compromise the CPS domain.
- **Physical Breach:** This allows an attacker to damage and shut-down network-connected manufacturing systems and CPS devices, resulting into loss of availability and productivity.
- **Malicious Third Party Software Provider:**the main purpose of this attack is to target the company's CPS by compromising the legitimate "Industrial Control Systems"

- **Abuse of Privilege:** is mainly led by insiders or "whistle-blowers" to perform or help perform a (cyber)-attack from within. Such high privilege grants them the ability to conduct these attacks by exposing valuable knowledge on CPS systems' vulnerabilities and weaknesses.

2.10 Cyber attacks

In recent years, there was a rise in the rate of cyber-attacks targeting CPS and IoCPT with very devastating consequences. According to current studies carried out by, CPS is highly prone to malicious code injection attacks and code-reuse attacks, along with fake data injection attacks, zero-control data attacks, and finally Control-Flow Attestation (C-FLAT) attacks. Such attacks can result into a total blackout targeting CPS industrial devices and systems

2.10.1 Malware: is used to compromise CPS devices in order to steal/leak data, harm devices or bypass access control systems. The malware can take many forms, however, the main forms that target CPS are briefly listed and presented in the following.

- **Botnets:** this includes exploiting CPS devices vulnerabilities to turn them into bots or zombies, mainly to conduct hardly-traceable DDoS attacks
- **Trojan:** is a disguised malware that seems legitimate and tricks users to download it. Upon download, the Trojan infects the device and offers a remote access to steal data credentials and monitor users activities. This also includes Remote Access Trojans which in turn, can be used to turn a device into a bot
- **Virus:** it can replicate and spread to other devices through human/non-human intervention. Viruses spread by attaching themselves to other executable codes and programs to harm CPS devices and steal information.
- **Worms:** spread by exploiting operating system vulnerabilities to harm host networks by carrying payloads to steal, modify and delete data, or overload to web-servers
- **Rootkit:** is designed to remotely and covertly access or control a computer to execute files, access/steal information or modify system configurations
- **Polymorphic Malware:** constantly and frequently changes its identifiable to evade being detected to become unrecognizable against any pattern-matching detection technique.
- **Spyware:** is a malicious software covertly installed on a device without the user or authorization knowledge, for spying purposes (e.g surveillance, reconnaissance, or scanning). In fact, they can be used for future cyber-attack purposes.
- **Ransomware:** is a malicious software that holds and encrypts CPS data as a ransom by exploiting CPS vulnerabilities, targeting oil refineries, power grids [208], manufacturing facilities, medical centers and encrypting all data-backups until a ransom has been paid.

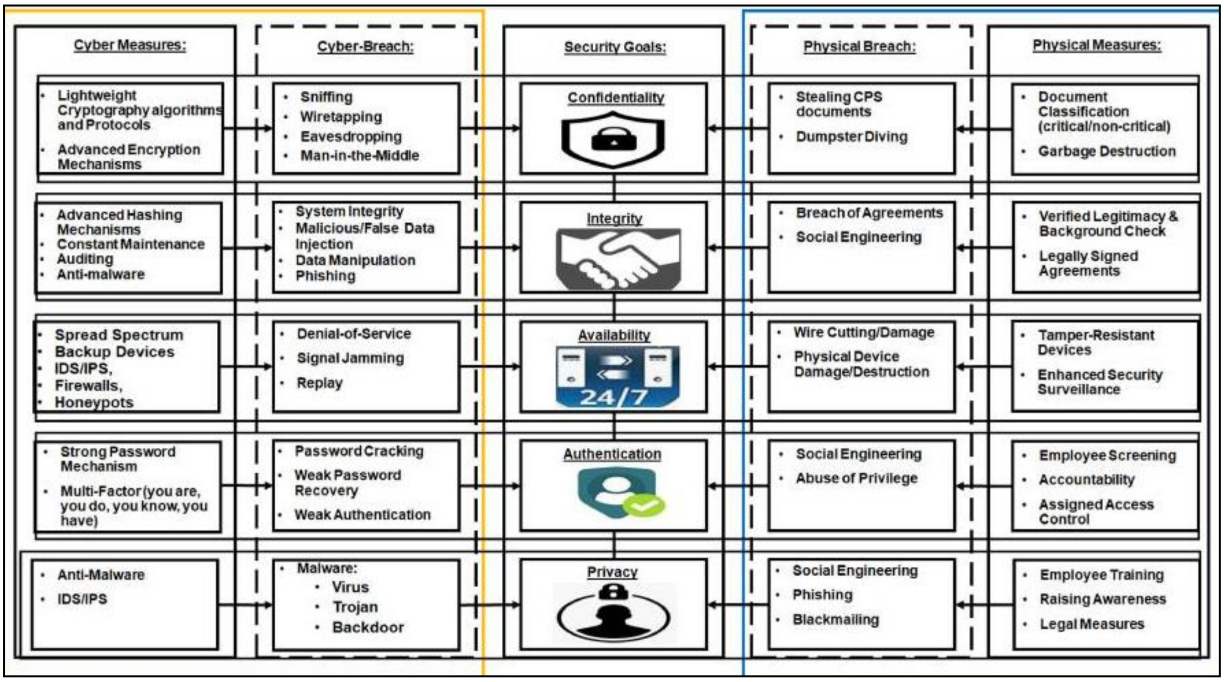


Figure 2.3 Targeting CPS security goals.

Confidentiality: securing CPS communication lines is essential. As a result, various cryptographic solutions were presented. In the authors presented a solution based on the use of compression techniques before being encrypted. Their solution reduces the overhead and mitigates the problem. This was due to their low-cost and low-latency with the ability to provide cryptographic blocks for any resource constrained, normal, industrial, or even medical devices. Installation of encryption-decryption modules at both ends of non-secure Modbus communication to protect its connection from confidentiality attacks. Results ensure the ability to ensure confidentiality, privacy and availability in a secure and reliable CPS environment.

Integrity: Maintaining the integrity of CPS devices require preventing any physical or logical modification of incoming/outgoing real-time data. Hence, different solutions are presented. Software reconfiguration and network attacks on ICS through the description of their presented approach called Trustworthy Autonomic Interface Guardian Architecture (TAIGA). TAIGA offers protection against the attacks that originate from both supervisory and plant control nodes, whilst integrating a trusted safety-preserving backup controller.

Availability: Maintaining the availability of CPS devices is a must. Hence, different solutions are presented to mitigate and overcome availability issues. For this reason, the Tennessee-Eastman Process Control System (TE-PCS) model is used to test integrity and DoS attacks. Upon testing, this model reveals how DoS attacks are ineffective against sensor networks. Thus, requesting to prioritize security defences against integrity attacks due to their effectiveness to overcome DoS attacks only.

Authentication: Authentication is the first line of defense that should be well-built, designed and maintained. As a result, public key-exchange authentication mechanism to prevent unauthorized parties from gaining access. Their mechanism relies on external radio frequency rather than batteries as an energy source. In fact, out-of-band authentication were deployed in certain wearable devices, where the authentication mechanism uses additional channels including audio and visual channels. On the other hand, Medical CPS (MCPS) biometrics, including mainly heart rates and blood pressure, can possibly be used to generate a key to encrypt and secure the body sensor network communication.

Firewalls: Firewalls saw rare use of employment in CPS domain due to the advancement of IDS and Artificial Intelligence technologies. Therefore, a handful number of firewall-based solutions were presented. Use of paired Firewalls between enterprise and manufacturing zones to enhance the cyber security of servers. Their choice of paired firewalls is due to the stringent security and clear management separation. Effective powerful open-source network-level firewall for SCADA systems that inspects and filters SCADA protocol messages. A framework for defending a public utility against cyber-physical attacks. Its implementation tests revealed its effectiveness in detecting single and complex multi-component deception attacks.

2.11 Social Issues in Society 5.0

India suffers from a host of social issues ranging from poverty to gendered violence. This article covers the concept of social issues and highlights the different experiences of rural and urban sectors. Further, it studies six important social issues namely poverty, unemployment, illiteracy, the caste system, gendered violence and communalism by analyzing their causes and the specific measures adopted to combat them.

What Are Social Issues?

- Rural versus Urban Social Issues
- Poverty
- Unemployment
- Illiteracy
- Caste System
- Gendered Violence
- Communalism

Rural versus Urban Social Issues

Many scholars have identified fundamental differences between the causes and consequences of issues experienced the rural and urban sectors.

The rural sector has five identifying characteristics. Firstly, people are either directly or indirectly dependent upon agriculture. Next, the upper caste citizens are the largest landholders. Thirdly, the roles and values of rural people are traditional. Also, the farmers receive inadequate compensation for their hard work. Finally, people are scattered in rural areas as compared to urban cities. This isolation means that their access to services like banks, hospitals and schools is also minimal.

On the other hand, the urban sector is characterized by the concentration of large populations in small areas. This results in many issues such as slums, high crime rates, pollution, drug abuse and unemployment. Also, cities are highly interdependent on every small part. For example, a strike by bus workers could result in many problems for the functioning of a city.

Poverty

Poverty can be defined as the inability to secure the minimum standard of living appropriate to society. According to the Planning Commission, 22% of India's population lived below the poverty line in 2012.

Causes of Poverty

The sociologist David Elesh determined three causes of poverty namely individual, culture of poverty and social structure. The first ideology is propagated by those who believe that if an individual ends up in poverty, it is their own fault and due to a lack of hard work and initiative. This thought is rooted in the functionalist approach of sociology. It maintains that poverty is a good thing for society since it propagates the survival of the fittest. The culture of poverty concept was introduced in 1959 by Oscar Lewis. He believed that the lifestyle of the lower socio-economic classes fostered behaviours and attitudes associated with poverty. Hence, no amount of economic rehabilitation could help alleviate the poor. Finally, the social structure approach was propagated by sociologist Herbert Gans. He associated poverty with unjust social conditions and pointed out that the middle and higher classes had a vested interest in the poor. For example, the existence of the poor helped alleviate their social status. Thus, they had no interest in changing the social structure (Ahuja 2014).

Within the Indian context, many unique causes of poverty have been identified. The first is the rapidly rising population. This year, the population reached 138.72 crores which was a 1.26% increase from last year. Such a high population raised the demand for consumption of a limited number of resources. The second is low agricultural productivity due to lack of capital, technology and fragmented land holding. The next cause is unemployment which is present in the form of both underemployment and disguised unemployment in the agricultural sector. Social factors have also contributed to poverty through the caste system, gendered laws of inheritance and a lack of infrastructure. Finally, political factors such as the British exploitation of natural resources also led to a weakened Indian economy.

Unemployment

Unemployment has often been described as the most significant social issue in society. This is because an individual is dependent on their work for both their livelihood and their status. Sociologically, unemployment is defined as the inability to find remunerative work in the face of both potential and desire to earn. The three elements of unemployment are that the individual must be capable, willing and making an effort to be gainfully employed.

Causes of Unemployment

Sociologists have suggested that unemployment is a result of both economic and social factors.

Degrading social status means that many people consider themselves overqualified for certain jobs and thus prefer to remain unemployed. For example, many youths consider teaching in universities to be a prestigious job whereas teaching in a school is looked down upon.

Geographical immobility refers to surplus labor in one location and inadequate labor in another. People may be unable to move to areas with higher job opportunities due to a lack of information, language barriers or family responsibilities. For example, women in rural areas often lose out on paid work because they do not get the opportunity to migrate to cities like their husbands.

Population explosion has led to increased unemployment due to the limited number of job opportunities in the economy. Many people lose out on work due to personal reasons such as lack of education or experience or even illness and disability. The high rates of unemployment increase the dependency on parents to provide for their children and for the government to assume responsibility for them.

The *defective education system* fails to give importance to primary education and vocational training. The benefits of education are mostly availed only by middle- and high-income youth with access to private schools and universities. The conditions in most government schools are unsuitable for studying and are often a result for many girls to drop out (Ahuja 2014).

Remedial Measures

The Indian government has recognized the issue of unemployment within the country. They have taken many steps in the form of employment generation schemes. The MGNREGA scheme mentioned previously is one major measure. Unemployment cannot be solved by making India more labour-intensive which has been suggested in the past. Instead, the focus should be on educating the youth and making them employable within the upcoming service sector.

Illiteracy

As mentioned in the previous section, illiteracy is a major barrier to development since it results in unskilled labor. According to the Census Commission of India, literacy refers to any person who can read and write with understanding in a recognized Indian language. The 2011 census revealed that the literacy rate of India was around 74% with many regional variations and gender disparities. All over India, Kerala has the highest literacy rate and Bihar the lowest.

Measures to Eradicate Illiteracy

Many programs have been introduced by the government in accordance with the education policies of India. A few of these have been mentioned below.

The National Adult Education (NAE) program was introduced in 1978 to promoted education within the age group of 15-35 years. The Rural Functional Literacy (RFL) program is a sub-program of the NAE and was launched in 1986. It aimed at creating awareness among adults about the numerous government schemes they could benefit from. Moreover, it involved student volunteers from universities in teaching adults. Finally, the National Literacy Mission was launched in 1988 by Rajiv Gandhi and aimed at involving volunteer agencies in the mission to educate illiterate persons all over the country (Ahuja 2014).

Caste System

The Indian caste system is based on the cultural features of hierarchy, pollution and purity. It subscribes to the doctrines of Karma and Dharma. The Indian government introduced the category of Scheduled Castes (SCs) to the constitution in 1935. Currently, SCs constitute around 16% of the Indian population. The main issues faced by Dalits are those of untouchability, exploitation, exclusion from religious and educational institutions and social discrimination.

Gendered Violence

Women have always been victims of exploitation and violence within the Indian subcontinent. Violence against women consists of criminal, domestic and social violence. Criminal violence consists of rape, murder, female foeticide and abduction. Domestic violence includes wife battering, dowry deaths and sexual violence. Social violence comprises eve-teasing, inheritance laws favouring men etc.

3. Sustainable Development Goals

As a part of its oversight responsibility, NITI Aayog has led the process of VNR preparation. A multidisciplinary Task Force was constituted to coordinate the review and process documentation. From the sub national level, state and union territory governments reported their progress on the various programmes and initiatives. While reporting about the various facets of the SDGs, this VNR focuses on the progress made towards achieving Goals 1, 2, 3, 5, 9, 14 and 17. These Goals have been agreed upon in the HLPF as focus areas for this year.

The nature of SDGs, however, is such that the advancement of one global goal may lead to progress in other goals as well.

Goal 1: End Poverty in All its Forms Everywhere

Poverty has fallen across all economic, social and religious groups nationally and in all states in the post-reform era. Sustained growth (6.2% from 1993-94 to 2003-04 and 8.3% from 2004-05 to 2011-12) has created gainful employment and helped raise wages thereby directly empowering the poor. It has also brought the government an increased volume of revenues enabling it to sustain a high level of social spending and, thus, doubling the direct effect of growth on poverty.

Several large-scale anti-poverty programmes have been implemented. The Mahatma Gandhi National Rural Employment Guarantee Act, for instance, has generated over 2 billion person-days of employment during 2016-17 alone, largely for the disadvantaged sections of society. Additionally, initiatives have been launched for providing pension and insurance to workers in the unorganised sector, widows and the differently abled. Over 130 million people have accessed life and accident insurance under these programmes.

Further, efforts are underway to universalise access to basic services. In order to achieve the goal of housing for all by 2022, direct financial assistance is being extended to poor households. Nearly 3.21 million houses were constructed last year as part of this initiative in rural areas. Programmes are also being implemented for ensuring access to education, health and nutrition security, with a special focus on vulnerable groups such as women and children. Other priority areas are drinking water and sanitation. Currently, nearly 77.5% of rural habitations are being provided with 40 litres of drinking water per capita on a daily basis. Another 18.9% habitations have been covered partially thus far. Over 63.7% of households in rural areas had access to an improved sanitation facility in 2016-17 as compared to 29.1% in 2005-06. With respect to clean sources of cooking fuel, over 22 million families have been provided with Liquefied Petroleum Gas connections under the Pradhan Mantri Ujjwala Yojana. Between 2005-06 and 2015-16, households having access to clean fuel have increased from 25.5% to 43.8%.

Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Significant progress has been made in improving food and nutrition security. For instance, stunting among children less than 5 years has declined from 48% to 38.4% between 2005-06 and 2015-16. During the same period, the percentage of underweight children has declined from 42.5% to 35.7%. The absolute levels of stunted and underweight children, however, remain high. To address this, a number of schemes are being implemented. For instance, more than 800 million people are covered in India by providing the food grains at affordable prices through the Public Distribution System. The Mid-Day-Meal Programme is providing nutritious cooked meals to 100 million children in primary schools. Additionally, food distribution governance is being strengthened through the digitization of ration cards and an online grievance redressal mechanism.

Further, sustainable and climate-adaptive agriculture has been boosted by, inter alia, promoting organic farming and issuing of 62 million Soil Health Cards to farmers. A comprehensive plan is also being implemented for doubling farmers' income by 2022.

Goal 3: Ensure healthy lives and promote wellbeing for all at all ages

India has made significant strides in improving various health indicators. The Infant Mortality Rate has declined from 57 in 2005-06 to 41 in 2015-16. Similarly, Under-5 Mortality Rate has fallen from 74 to 50 over the same period. This has been enabled, at least partially, by a significant improvement in vaccination coverage for children between 12-23 months of age. Moreover, institutional deliveries have increased from 38.7% in 2005-06 to 78.9% in 2015-16. The country's strategy in health is focused on providing essential services to the entire population, with a special emphasis on the poor and vulnerable groups.

The National Health Policy, 2017 has specified targets for universalising primary health care, achieving further reductions in infant and under-5 mortality, preventing premature deaths due to non-communicable diseases as well as increasing government expenditure on health. A composite index is being used to monitor and incentivise improvements in health services delivery across states in the country. The government is aiming to immunize all unimmunized and partially immunized children against vaccinepreventable diseases by 2020. Towards achieving universal health coverage, a health insurance cover of INR 100,000 (USD 1,563) is being extended to all poor families.

Goal 4: Equitable Quality Education

First, the bad news on education. Poverty, armed conflict and other emergencies keep many, many kids around the world out of school. In fact, kids from the poorest households are four times more likely to be out of school than those of the richest households. Now for some good news. Since 2000, there has been enormous progress on the goal to provide primary education to all children worldwide: the total enrolment rate in developing regions has reached 91%. By measures in any school, that's a good grade. Now, let's get an even better grade for all kids, and achieve the goal of universal primary and secondary education, affordable vocational training, access to higher education and more.

Goal 5: Achieve gender equality and empower all women and girls

While much more progress remains to be made, a number of indicators pertaining to the status of women in India have moved in the right direction over the years. For instance, 68.4% of women were literate in 2015-16, as compared to 55.1% in 2005-06. Additionally, 53% of women were independently using a bank or savings account in 2015-16, which is a significant improvement from 15.1% in 2005-06.

Goal 6: Water and Sanitation for all

Everyone on earth should have access to safe and affordable drinking water. That's the goal for 2030. While many people take clean drinking water and sanitation for granted, many others don't. Water scarcity affects more than 40 percent of people around the world, and that number is projected to go even higher as a result of climate change. If we continue the path we're on, by 2050 at least one in four people are likely to be affected by recurring water shortages. But we can take a new path—more international cooperation, protecting wetlands and rivers, sharing water-treatment technologies—that leads to accomplishing this Goal.

Goal 7: Affordable and clean energy for all

Between 1990 and 2010, the number of people with access to electricity increased by 1.7 billion. That's progress to be proud of. And yet as the world's population continues to rise, still more people will need cheap energy to light their homes and streets, use phones and computers, and do their everyday business. How we get that energy is at issue; fossil fuels and greenhouse gas emissions are making drastic changes in the climate, leading to big problems on every continent. Instead, we can become more energy-efficient and invest in clean energy sources such as solar and wind. That way we'll meet electricity needs and protect the environment. How's that for a balancing act?

Goal 8: Descent work and economic growth

An important part of economic growth is that people have jobs that pay enough to support themselves and their families. The good news is that the middle class is growing worldwide—almost tripling in size in developing countries in the last 25 years, to more than a third of the population. But today, job growth is not keeping pace with the growing labour force. Things don't have to be that way. We can promote policies that encourage entrepreneurship and job creation. We can eradicate forced labour, slavery and human trafficking. And in the end we can achieve the goal of decent work for all women and men by 2030.

Goal 9: Industry innovation and infrastructure

Technological progress helps us address big global challenges such as creating jobs and becoming more energy efficient. For example, the world is becoming ever more interconnected and prosperous thanks to the internet. The more connected we are, the more we can all benefit from the wisdom and contributions of people everywhere on earth. And yet four billion people have no way of getting online, the vast majority of them in developing countries.

Goal 10:REDUCE INEQUALITY WITHIN AND AMONG COUNTRIES

It’s an old story: the rich get richer, and the poor get poorer. The divide has never been starker. We can and must adopt policies that create opportunity for everyone, regardless of who they are or where they come from. Income inequality is a global problem that requires global solutions. That means improving the regulation of financial markets and institutions, sending development aid where it is most needed and helping people migrate safely so they can pursue opportunities. Together, we can now change the direction of the old story of inequality.

Goal 11: MAKE CITIES AND HUMAN SETTLEMENTS INCLUSIVE, SAFE, RESILIENT AND SUSTAINABLE

If you’re like most people, you live in a city. More than half the world’s population now lives in cities, and that figure will go to about two-thirds of humanity by the year 2050. Cities are getting bigger. In 1990 there were ten “mega-cities” with 10 million inhabitants or more. In 2014, there were 28 mega-cities, home to 453 million people. Incredible, huh? A lot of people love cities; they’re centers of culture and business and life. The thing is, they’re also often centers of extreme poverty. To make cities sustainable for all, we can create good, affordable public housing. We can upgrade slum settlements. We can invest in public transport, create green spaces, and get a broader range of people involved in urban planning decisions. That way, we can keep the things we love about cities, and change the things we don’t

Goal 12;ENSURE SUSTAINABLE CONSUMPTION AND PRODUCTION PATTERNS
Some people use a lot of stuff, and some people use very little—in fact, a big share of the world population is consuming too little to meet even their basic needs. Instead, we can have a world where everybody gets what they need to survive and thrive. And we can consume in a way that preserves our natural resources so that our children can enjoy them, and their children and their children after that. The hard part is how to achieve that goal. We can manage our natural resources more efficiently and dispose of toxic waste better. Cut per capita food waste in half globally. Get businesses and consumers to reduce and recycle waste. And help countries that have typically not consumed a lot to move towards more responsible consumption patterns.

Goal 13; TAKE URGENT ACTION TO COMBAT CLIMATE CHANGE AND ITS IMPACTS

Every country in the world is seeing the drastic effects of climate change, some more than others. On average, the annual losses just from earthquakes, tsunamis, tropical cyclones and flooding count in the hundreds of billions of dollars. We can reduce the loss of life and property by helping more vulnerable regions—such as land-locked countries and island states—become more resilient. It is still possible, with the political will and technological measures, to limit the increase in global mean temperature to two degrees Celsius above pre-industrial levels— and thus avoid the worst effects of climate change. The Sustainable Development Goals lay out a way for countries to work together to meet this urgent challenge.

Goal 14: Conserve and sustainably use the oceans, seas and marine resources

A clear agenda has been formulated for promoting the ‘Blue Revolution’. For tracking the levels of marine pollution along the coastline, the country has developed the Coastal Ocean Monitoring and Prediction System. Additionally, an oil spill management system has been put in place for responding to emergencies arising out of oil spills. Further, the Integrated National Fisheries Action Plan, 2016 is being implemented to promote the livelihoods of fishing communities as well as the ecological integrity of the marine environment. Giving new impetus to port-led development, the Sagarmala programme is improving port connectivity, port-linked industrialization and coastal community development.

Goal 15: PROTECT, RESTORE AND PROMOTE SUSTAINABLE USE OF TERRESTRIAL ECOSYSTEMS, SUSTAINABLY MANAGE FORESTS, COMBAT DESERTIFICATION, AND HALT AND REVERSE LAND DEGRADATION AND HALT BIODIVERSITY LOSS

Goal 16: PROMOTE PEACEFUL AND INCLUSIVE SOCIETIES FOR SUSTAINABLE DEVELOPMENT, PROVIDE ACCESS TO JUSTICE FOR ALL AND BUILD EFFECTIVE, ACCOUNTABLE AND INCLUSIVE INSTITUTIONS AT ALL LEVELS

Goal 17: Revitalize the global partnership for sustainable development

While working towards revitalising the global partnership for the achievement of the SDGs, India reaffirms the principle of common but differentiated responsibilities. Despite significant efforts for domestic resource mobilisation, India is unlikely to gather sufficient revenues for achieving the SDGs. Therefore, India reiterates that the developed countries have an essential obligation to provide financial assistance to the developing countries, especially for global public goods such as climate change mitigation and control of pandemics, so that they can fully achieve the SDGs. India also highlights the need for international cooperation for curbing illicit financial flows, defining aid unambiguously and establishing robust systems for monitoring commitments made by donor countries.

3.1 Resolution to Social Problem

Social problem-solving might also be called ‘*problem-solving in real life*’. In other words, it is a rather academic way of describing the systems and processes that we use to solve the problems that we encounter in our everyday lives.

The word ‘*social*’ does not mean that it only applies to problems that we solve with other people, or, indeed, those that we feel are caused by others. The word is simply used to indicate the ‘*real life*’ nature of the problems, and the way that we approach them.

- Education will help the people to become aware of the disadvantages of Caste system.
- There is a need for widespread social change in favor of equality of human-beings. Caste system can be discouraged through social education in rural areas.

- There should be special classes at schools that imparts value and moral education to the children.
- Superstitious people are extremely fearful and discourage any change in social norms. Education will help shed away superstition, which in turn, will help shed casteism as well.
- With better education and economic progress, people belonging to diverse caste get opportunity to mix and work together. Many of them become friends while working together on a project.
- poverty can be checked by increasing job opportunities. It will decrease the rate of unemployment which ultimately results in decrease of poverty in economy.
- Government should take more steps towards charity, trusts and have some transparency while spending money in those social institutions.
- There is a need for initiatives of paid leave to the workers.
- The education system should be reformed and initiatives should be taken to bring more children to schools.
- Imparting education and knowledge to children.
- If incomes of the parents can be increased then it is possible for the children's to get education.
- Government will have to take more steps towards proper enforcement of labour laws.
- People who are employed and are above the poverty line should take steps towards replacing child workers with adult workers. It will benefit not only the society, but the country at large.
- Education is the only and the best way to stop child marriage. Educated people from society should raise voice against child marriage.
- The empowerment of women is of utmost importance for solving the problem.
- Awareness must be created to change the narrow mindset of the society. Campaigns must be launched to acknowledge the role and contribution of women in the society.
- Education can also help to solve the problem of low status of women in the society.
- Mass-media campaigns should be promoted.
- People should stop discrimination between a boy and a girl.
- Girls should also be allowed to have their education and proper knowledge.
- Awareness must be created and for these people with the help of media.
- Last, but not the least, parents should change the thoughts of dowry from their mind and children should stand against their family for doing this.

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UNIT 5

UNIT V INNOVATION WITH FUTURE TRENDS WITH APPLICATIONS 9hrs

Mobility – Health Care –Agriculture- Food Products – Disaster Prevention

The innovations of the 19th and 20th Centuries mainly concerned technological advances.

Telephone	1861	Floppy disk	1950
Electric bulb	1883	Compact disc	1979
TV	1929	World Wide Web	1991
Atomic bomb	1945	Cell phone	1992
Computer (1st gen.)	1946		

Major Recent Innovations

The other feature of these innovations is that they are quickly occupying managerial areas and that they are developing faster. The evolution of innovation can be represented in the below Figure.

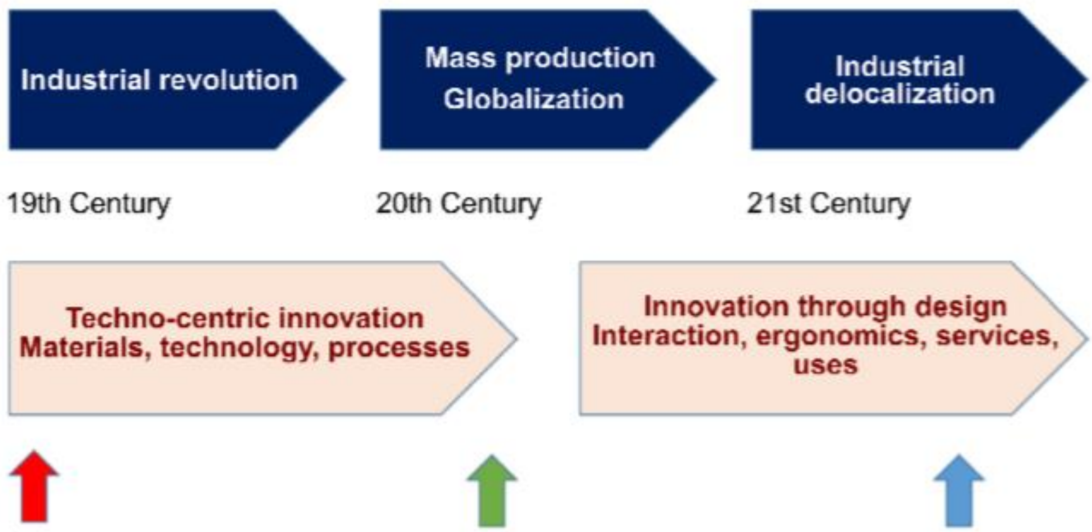


Fig 5.1 Major Innovations

The innovations of the 19th and 20th Centuries (Fig 5.1) were mainly based on technological advances. More recently, innovations have become less characteristic for their technical aspects than those related to uses. This has resulted in the idea of innovations through use and changes in production methods.

"France has fallen behind in the field of innovation. [France] has no culture of use. For decades, our firms, mainly those technology-centered, have been oriented towards national aid programs for improving innovation and have consequently forgotten "user experience", on which really depends the success of innovation. However is the design that establishes the connection, which acts as the gear between technology and use, and which adds the share of imagination which makes objects desirable. Regardless of whether this technology is new or superficial, It is evident that France does not possess a design culture"

Innovation balance :

The paradigm of innovation (Fig 5.2) is that of a complex balance between viability, feasibility and desirability. This balance can be achieved in different ways: it can be due to the user, the uses or the societal context, or it can be due to changes in regulations. One of the best-known examples is that of the radiators at the exterior of restaurant terraces, which are related to the ban on smoking in public places. This change in social order relies on a fully mature technology. Another example, bike rental through terminals in the city, is related to localization technology and the implementation of terminals. Saint-Gobain heated glass made it possible to build transparent radiators. Carbon fiber composites are useful for reducing the weight of technical bikes.

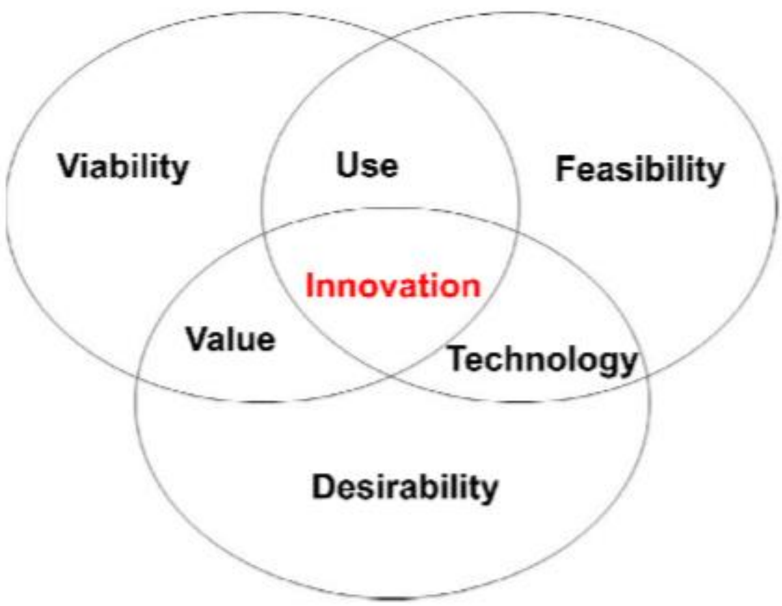


Fig 5.2 Innovation balance.

The new forms of innovation :

In the face of the end of innovations and the social determinism of innovations, new forms of innovation (Fig 5.3) which emerged with the advent of society 5.0, that is to say, social innovation and frugal innovation. The latter is often associated with the idea of the Low society or to that of the Less society.

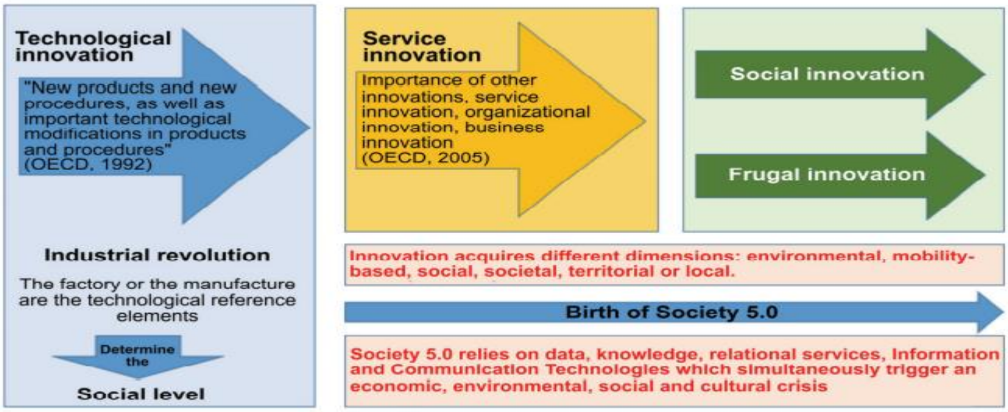


Fig 5.3 New forms of innovation

The paradigm of innovation :

Innovation is defined as the appearance of the product-service pair, achieving balance between viability, feasibility and desirability. This balance can be achieved by accessing different paths or doorways, depending on the initial analysis of the context and the user. It can be reached provided that the walls that prevent their development do not prevent innovation from appearing. According to the chosen path, different types of innovation may emerge.

Entry doors	Examples
Uses/Societal context	The radiators at the exterior of restaurant terraces are a reaction to a societal change (ban on smoking in public places), through the exploitation of a fully mature existing technology
Uses	Bike rental at city terminals
Technology	Saint-Gobain heated glass, enabling transparent or composite radiators, or carbon fiber for technical bikes
Desirability/Recognition/Appreciation	Radiator artwork for luxurious interiors or design bikes evoking a community, a universe

The risks of innovation :

Innovating involves risks that have been studied by many authors. These risks can be classified according to different types.

Type of risk	Observation
Executive	Can we develop, produce, distribute the new product/service? Can support functions be deployed as expected?
Technological	Will the performance of the product/service satisfy consumer expectation?
Marketing	Acceptance of the product/service in price, quantity and disseminating period on the market
Ecosystemic	Need for co-innovation, for example, smartphones and apps
String of adoption	This risk appears, for example, when other actors are necessary for the use chain of a product[8]

The risks of innovation :

The risk in the adoption chain is a new risk, also related to ecosystems. The most commonly quoted example is the tire offered by Michelin which made it possible to drive for a long time without being obliged to fix it, but elicited the use of specific equipment by experts, which they refused

Mobility Innovations :

Mobility produces effects in transportation and at home, which are increasingly becoming more "mobile" and more intelligent. The city and mobility are the key elements of this "revolution".

1. Intermodal ticketing

   Integrated ticketing across several transport modes. Passengers buy only one ticket valid across the subway, bus, taxi, bike-sharing and other travel option
2. Intermodal planner

   An integrated travel platform that allows passengers to plan their travel in the most efficient way, combining all available modes of transport
3. Innovative freight solution

   The ever-increasing volume of parcels demands new innovative solutions Such as delivery drones and hub networks beyond city centers.
4. Cargo pooling

Cargo pooling connects people or companies with a suitable transport company, merging different orders as needed. Cargo pooling reduces logistics costs and increases efficiency by avoiding empty runs

5. Mobility services

Car, scooter, and bike sharing, Services allowing users to share different means of transport reduce the number of vehicles in the area while also reducing the costs per driven kilometer for the user. Ride sharing is a powerful tool addresses the problems of congestion, emissions, and dependence on fossil fuels. It fills otherwise empty seats and travel costs among all passengers

6. Autonomous vehicles

A self-driving car, robot car, or driverless car; a vehicle capable of sensing its environment and navigating without human input

7. Electric vehicles

Vehicles run on electric power instead of fossil fuels reduce carbon gas emissions; also referred to e-mobility or electro mobility

8. Connected vehicles

Vehicles networked or integrated via WLAN to Internet-enabled devices inside and outside the vehicle offer advanced driving assistance systems, greater safety, and more comfort

9. Smart bus/bus rapid transit (BRT)

Intelligent bus transport systems, using elements of autonomous and connected vehicles, are integrated into overall traffic management solutions. They typically run on reserved lanes.

10. Rail, metro, and tram

All rail-mounted transport modes run in inner-cities as well as outside urban areas

11. New transportation concepts

Innovative public transport solutions such as drones or hyperloop combine and leap-frog today's transportation modes and vehicles

12. Smart parking

Reporting available parking spaces in real time can be combined with the the capability to reserve and pay for those parking spaces via an app. This system saves time, money, and fuel for the user and reduces traffic and emissions.

13. E-charging infrastructure

Supplies electric energy to charge electric vehicles. Required to increase the number of EVs on the road

14. Intelligent road management

These systems control all traffic signals centrally to regulate the flow of traffic. They connects to and communicates with vehicles, allowing real-time regulation of traffic that reduces congestion, pollution, and the number of accidents.

Innovations in Health care :

Advances in healthcare allow us to live healthier lives, society as a whole will be much happier. In other words, if, as we move toward Society 5.0, we manage to improve socioeconomic conditions and promote better physical and mental health. The advancement in health care leads to (Fig 5.4) improved patient experience, better health outcomes, Improved staff experience, Lower cost of care.

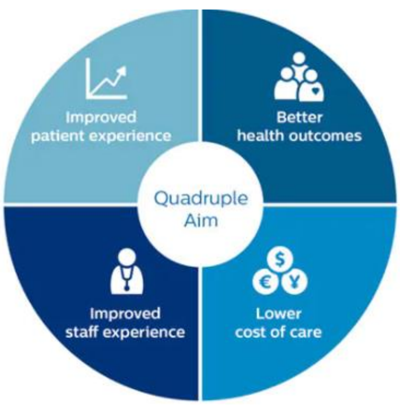


Fig 5.4

Medical devices connected with Wi-Fi allow a machine to machine communication which stands as a base to the IoMT.

Some of the ways in which IoMT can help the healthcare industry are:

1.Remote monitoring of patients with chronic symptoms.

2. Easily tracking down the medication orders of patients.

3. Location of the patients admitted to the hospitals.

4. Allows communication with medical experts even in remotest places.

5. Increased operational efficiency.

How AI is changing the dynamics of the healthcare industry:

1. **Managing medical records and data:** Health industry cannot do away with this very first step. What lies at its heart is analyzing and compiling the information. Robots help to store, collect, trace and re-format data to provide faster access.

2. **Doing repetitive jobs:** Mundane tasks of the day can easily be managed with the help of robots. Radiology and cardiology are two disciplines where the amount of data to analyze can be time-consuming. Hence, artificial intelligence can help in minimizing human efforts.

3. **Treatment design:** Selecting a customized treatment plan becomes more comfortable with AI as it can analyze data relating to a patient's previous history records, clinical expertise, external research and more.

4. **Digital consultation:** Apps like **Babylon** have been very helpful in giving valuable advice to patients based on medical knowledge and personal medical history. It has succeeded in breaking barriers between doctors and patients. Users can easily report their symptoms in the app by using speech recognition feature to compare against a base of illnesses.

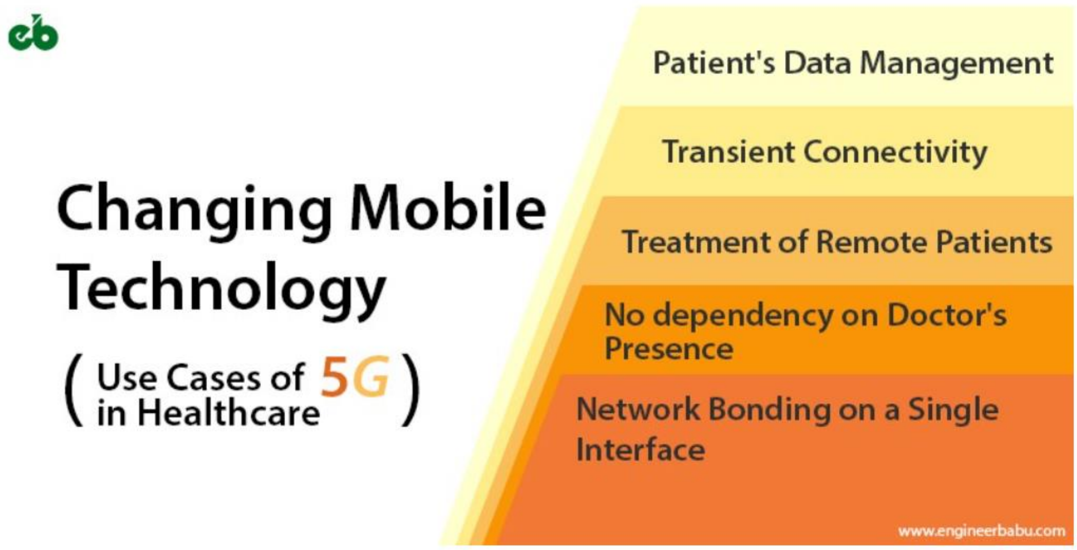
5. **Virtual nurses:** Digital assistant who helps people to do follow up treatments by monitoring patient's condition. *It uses **machine learning** techniques to support patients.*

6. **Health monitoring:** Health trackers like **Garmin**, **Fitbit**, and others can help one keep a check over the activity levels and heart rate. They can provide useful information to doctors

regarding the regular habits of the patients. Doctors can then prescribe a proper medical treatment based on such crucial data.

7. Centralized Management of Hospitalized Patients: Managing a vast number of patients can be cumbersome for the management of large hospitals. Hence, some of the critical tasks can easily be decentralized by relying on advanced technology. Easy monitoring is possible even without the doctor-patient interaction on day to day basis. With the use of sophisticated equipment like HD cameras and sensors, regular monitoring of the patient's heart rate, blood pressure, and pulse oximetry can be carried out without any hassles. Thus, it eliminates the need for the physical presence of a doctor and can be extremely helpful during actual emergencies. Apart from that, it also enables patients to book appointments online, receive test reminders and updates regarding appointments, and communicate doctor through chat features and more.

Innovation in the field of healthcare has helped increase the efficiency of insurance companies as they can now quickly access data about the patient as well as reliable service providers



Use cases of 5G in Healthcare

Fig 5.5

Reaching out to the doctor online can thus become easier. All he will do is analyze your condition and provide a personalized solution immediately. These are some of the advantages of 5G network technology (Fig 5.5) on healthcare market:

- Effective and efficient handling of patient’s data
- Offers an opportunity to gather all networks on one single interface
- Uniform, consistent and uninterrupted connectivity across the world
- Eliminates the need for physical presence of the doctors
- Easy and comfortable treatment for patients who are located in remotest parts of the globe

How Big Data is utilized in Health care :

Big Data has changed the way we can leverage, analyze and manage data in the healthcare industry. It holds immense potential to predict outbreaks of epidemics, reduce costs of treatment, improve quality of life and more.
Its applications which can be adopted in the healthcare industry are:

• Patients predictions for improved staffing:

One of the biggest challenges which are faced by the healthcare sector revolves around availability of staff to manage the patients. If there will be too many workers, then the hospital will have to bear unnecessary labor cost. At the same time, also few workers can profoundly impact the customer service outcomes. In such cases, big data can help to solve the problem where data can be analyzed to come up with hourly predictions of the number of patients which can be expected at each hospital.

*Using **“time series analysis”** techniques, one can use machine learning to predict future admissions trends.* Hence, big data can be used to reduce waiting time for the patients and ensuring better healthcare facilities.

• Electronic Health Records:

It is one of the most sought-after applications of big data in medicine. Every patient has its digital record which includes detailed information relating to medical history, allergies, demographics, laboratory test results and more. Doctors can implement new changes without paperwork procedures and data replication.

Enhanced Security and Reduced Frauds:

According to studies, the healthcare sector is most vulnerable to data breaches than any other industry. It is 200% more likely to suffer significant consequences. As personal data is precious, organizations have now started using analytics to prevent security threats by identifying changes in network traffic or reflecting on other suspicious activities like a cyber-attack.

The Advantages of Innovation:

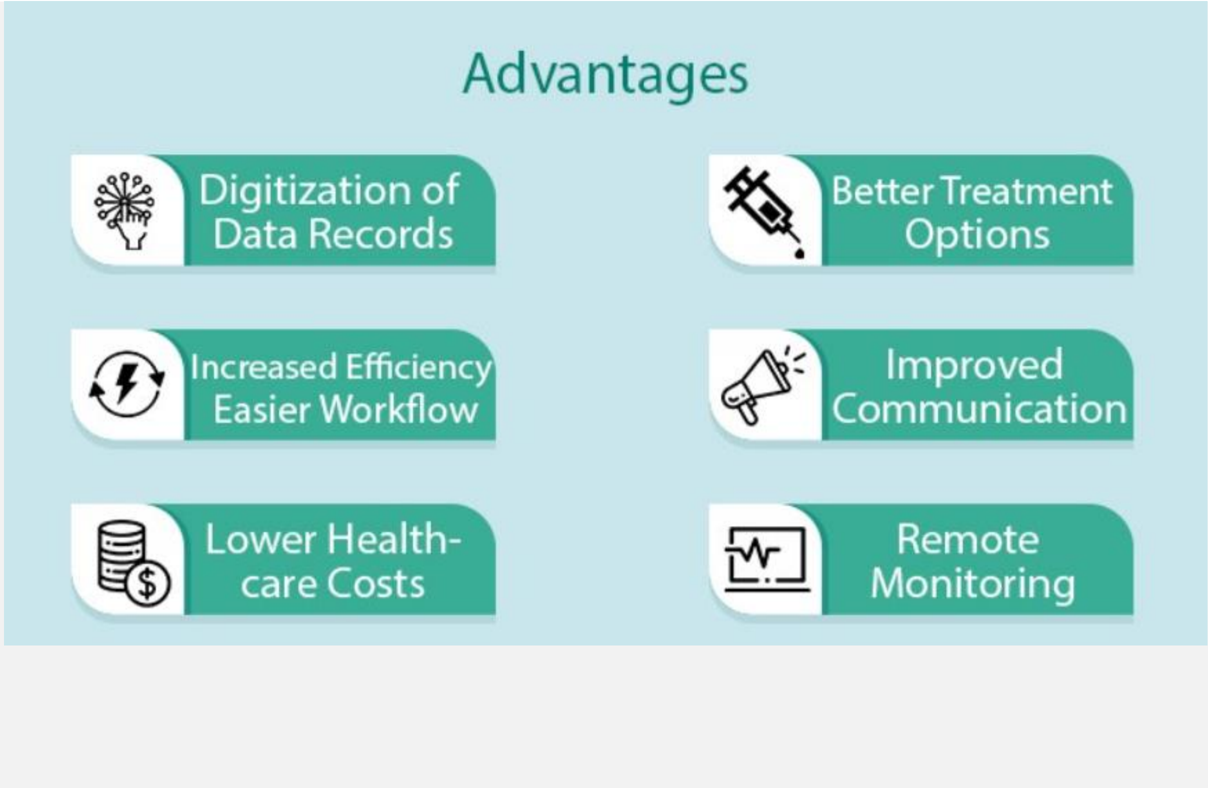


Fig 5.6

Digitization of Data Records:

Proper maintenance of data is essential for the smooth functioning of healthcare industries. From filling patient treatment histories to analyzing diagnostic reports, healthcare facilities need to maintain plenty of records. Thus, the introduction of Electronic Health Records has brought about a positive change in eliminating paperwork. It has been a game changer for healthcare professionals as everything can now be managed through a centralized digital system. Input information relating to a patient's weight, vital symptoms, and test results can now easily be tracked on a single interface. Apart from that, scheduling appointments, submitting medical claims, updating patient records with diagnostic codes have become more comfortable with digitalization.

• Increased Efficiency and Easier Workflow:
Managing things in an organized and systematic manner becomes hassle free with feeding data into a computerized system. It is less time consuming and leads to increased efficiency due to the replacement of paper-based methods. Also, it reduces the risk of human errors while maintaining financial details and patient data.

• Lower Healthcare Costs:
The transition to electronic health records has the potential to reduce the cost by 3%. According to the researchers, this can lead to savings of up to$5.14 per patient each year.

• Better Treatment Options:
New technology has helped to provide new machinery and equipment and improved medicines which has, in turn, led to the improvement of the quality of life of people.

• Improved Communication:
It can be challenging to get in touch with doctors due to busy schedules and limited timings. Technological advancements have facilitated in bridging this chasm between doctors and patients. Some of the exclusive options like translation software allow easy conversion of a doctor's spoken words into another language. Also, social networks provide a collaborative platform for doctors who can easily interact with each other. This increased communication has helped the industry in a significant manner.

• Remote Monitoring:
It allows patients to access the records from the comfort of their homes. Usage of home monitoring systems can help to save a lot of cost and time associated with frequent visits to hospitals for regular check-ups. This specially designed device allows doctors to detect

specific medical issues with the patients. Also, this device enables health specialists to analyze data of their patients and forewarn them in case something doesn't seem right.

How Internet of Things (IoT) is transforming the agriculture sector?

Fig 5.6

The impact of Internet of Things (IoT) and connected devices in this modern day world is undeniable (Fig 5.6). Today it has reached almost everywhere, from home, to health sector, smart cities, fitness, to industrial sector. Its presence can be seen in most industries, and the domain of agriculture is no different. In fact, IoT and connected devices can have an incredible impact on farming practices, so the farmers would no longer need relying on the horses and plows. After all, in the times of self-driving cars, and augmented and virtual reality, what is the point of depending on the age-old methods? Hence, the concept of IoT is a much-welcomed in Agriculture and Farming.

In the past some time, several of technological advancements have taken place in farming, and thus today it is way more industrialized and technology-driven as it was decades before. Today, we can see the farmers successfully utilizing smart farming gadgets, which enable them have better control over this procedure of growing crops and raising livestock. There are cattle tracking systems, agriculture robotics, smart greenhouses, and smart pest management. This makes it more efficient and predictable.

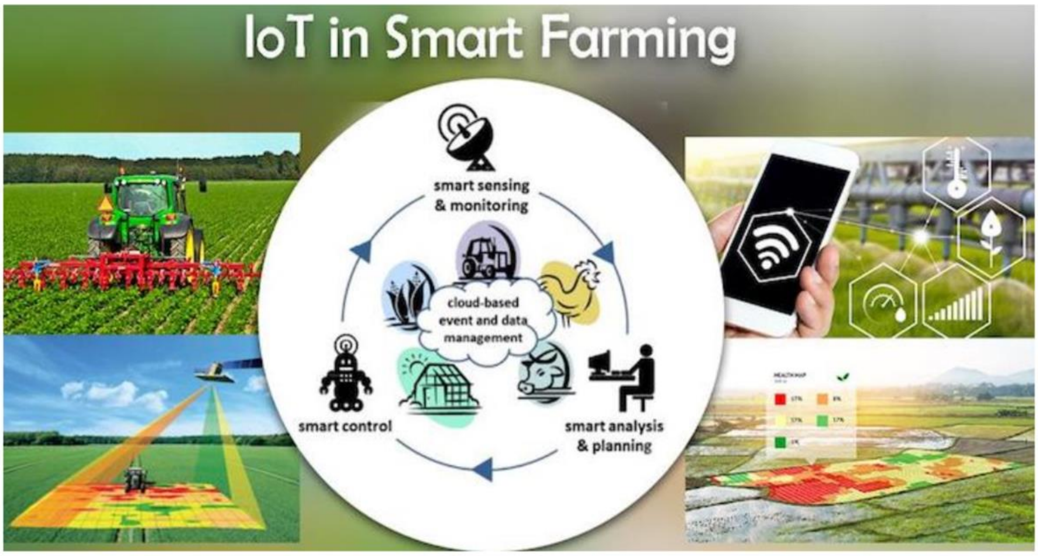


Fig 5.7

Integration of Internet of Things technology in the agricultural operations minimizes the requirement for manual labour with automation, accelerates machinery commands with remote & real-time monitoring, and at the same time, it allows the farmers to utilize resources much efficiently with precautionary maintenance & environmental prediction. Once these advancements are implemented in agriculture sector, they are certain to scale up the revenues and will also enable the farmers to manage more acreage.

Needless to mention that with more acreage there will be higher potential for profits and higher yields on upfront investments made by farmers.

Concept of Smart Farming :

Basically, Smart Agricultural Technology enables the farmers to have better control over process of growing crops and rearing livestock. This way it brings massive efficiencies of scale, cuts costs, and helps in saving scarce resources, like water. Farmers and growers are able to reduce the waste and increase the productivity that ranges from quantity of fertilizer utilized to number of journeys made by farm vehicles.

But what exactly is Smart Farming? Well, Smart Farming is a capital intensive and hi-tech system enabling to grow food cleanly & sustainably for masses. Mainly, it is the application of *the modern Information & Communication Technologies (ICT) into the agriculture. In the scenario of IoT-based smart farming, a system is built to monitor crop field with use of sensors (soil moisture, temperature, humidity, light, etc.) and to automate irrigation system. This way, farmers will be able to monitor field conditions from just anywhere regardless of their current location. As compared to conventional farming, IoT-based smart farming is way ahead in the game and is highly efficient.*

With the applications of IoT-based smart farming, it will be possible to target conventional, large farming operations as well as there could be new levers to elevate other growing/common trends in the agricultural, such as family farming, organic farming, as well as boost highly transparent farming.

Speaking of the environmental concerns, IoT-based smart farming will be beneficial to provide immense benefits, like optimization of inputs & treatments, more efficient water usage, and much more.

Now we know that adoption of IoT solutions in agriculture is growing constantly and global smart agriculture market size is rapidly expanding as well. So, now let's explore that in what ways IoT technology can transform agriculture.

Efficient Scaling: This is made possible via process automation. Multiple processes around production cycle, such as fertilization, pest control, or irrigation, can be automated with the use of smart devices. Among the well-known smart agriculture gadgets that combine several smart farming sensors are weather stations. They can be located all across a farm in order to collect several data from environment and send that to cloud. With the help of provided measurements, climate conditions can be mapped, appropriate crops can be chosen, and necessary measures can be taken to enhance their capacity.

Better Quality: With an effective IoT solution it is possible to have increased control over production process as well as maintain high standards of growth capacity and crop quality via automation. This way, farmers can expect higher revenues eventually. A specific kind of IoT products that enables precision farming are the crop management devices. Just as weather stations, they also can be placed in field for collecting data specific to crop farming. The factors that can be easily tracked are leaf water potential, temperature, precipitation, and the overall crop health. When crop growth and any other irregularities are monitored, it gets easier to prevent the diseases/infestation that may end up harming crop yield.

Be in Control: Integrating IoT technology allows to maintain control over internal processes and this way production risks can be decreased. Being able to predict the output of your production will be helpful in planning for enhanced product distribution. Like, when the farmers are aware how much crop they would be harvesting, they can ensure that their product doesn’t go unsold.

Data collection: The data which is collected by the smart sensors would be able to track things, like crop’s growth progress, soil quality, weather conditions, as well as cattle’s health. Farmers can use this data for tracking state of operation and other factors like equipment efficiency and staff performance.

Manage the Costs: Increased control over the production leads in reduced waste levels and allows to effectively manage the costs. The ability to have an insight into any irregularities in rate of the crop growth of livestock health helps in mitigating risk of diminished yield or complete crop failure.

Implementing IoT Technology :

While creating an IoT solution for the farming and agricultural purposes, it gets essential to choose sensors for the device. This ultimately depends on type of information which you are looking to collect and what you desire to do with the collected data. Ensure that the sensors’ quality is great as that is vital for the success of your IoT solution. After all, the success depends on collected data’s accuracy and reliability

How Internet of Things (IoT) is changing the game of Web development?

The IoT potential is limitless in developing markets, like the Middle East, Southeast Asia, Africa, and Latin America. In fact in 2018, it was predicted by IDC that in Africa & Middle East, IoT will see a growth of 15 percent to $7billion in coming times. And the growth is already evident in South Africa as there the businesses are forced to adapt to new business models brought by IoT.

Meanwhile, a great IoT solution must be able to operate at three levels, like:

- Allowing real-time collection & data presentation.
- Offering a solution that is accessible on global level, and not limited to operator or the local networks.
- Providing a solution that is easy to install, cost-effective, and low-powered.

When an effective IoT solution is applied in agriculture business, then the farm must be able to optimize labour usage, costs, quality, and yield in following manner:

- Water: Accurate management of irrigation, which will result in overall savings in water consumption by farm.
- Electricity: Allows to save money by accurate irrigation and less electricity usage. s
- Labor: No requirement for a dedicated person to manage data logging. Instead, this person can be efficiently used somewhere else in the farm operations.
- Reduced stress: With the help of informed & timely decisions, it will be possible to manage the operations efficiently.
- Better yields: When all the above mentioned aspects are taken care of, it will result in better yields.

When an IoT solution is integrated successfully, it allows for the expansion of global smart agriculture into the remote areas and it offers many other benefits that can be attained using latest technology.

Innovation in food products :

What is food innovation, and why is it important ?Food innovation is the development and commoditization of new **food** products, processes, and services. **Food** and beverage companies are looking for ways to make healthy, nutritious offerings that are not only enticing, accessible, exciting, and unique, but also sustainable.

Innovation in the food industry combines technological innovation with social and cultural innovation. It occurs throughout the entire food system, including production, harvesting, primary and secondary processing, manufacturing and distribution. The ultimate innovation is a new or improved consumer product and service. Innovations can be focused in one area of food technology, for example process engineering, product formulation, food qualities or consumer needs; but ripples spread causing changes in other parts of the food system, in consumer eating patterns and in general social and cultural areas. Food industry innovation strategies need to be based on the total technology in the food system and concerned not only with the technological changes but also with the social and environmental changes, so as to produce food that satisfies the nutritional, personal and social needs and wants of all communities.

Few examples for food innovation are as follows:

Ekim : (Fig 5.8)

Fig 5.8

The 24-hour automated fresh-pizza kiosks that are each equipped with a pizza-making robot called PAZZI that can prepare a single pizza in 30 seconds. An interesting idea for transit stations and locations where people need to eat on-the-go at all hours, Ekim is also looking to serve salads, drinks, and desserts.

Fig 5.9

Pizza Hut (Fig 5.9) is building a pizza-delivery car and robo-chef built into one. The company aims to reduce costs and increase speed by having the human-driven vehicle prepare and cook pizza on the way to your door. Along with minimizing the time you need to wait, this innovation has the potential to reduce the risk of your pizza being cold.

Taster :

With food delivery becoming increasingly popular, ghost restaurants that are designed solely for delivery are popping up everywhere. One of these ventures is Taster. The company has a chain of online-order-only restaurants that can prepare food in five minutes and have it deposited at your door via Deliveroo in just 20 minutes on average.

GastrographAI : (Fig 5.10)

Fig 5.10

AI and machine-learning platform Gastrograph AI compiles and analyzes data on the raw ingredients in the food we buy. The company uses this to help food and beverage producers predict which products customers in their target demographic will pay for. Manufacturers can see the flavors, scents, and textures consumers prefer, and develop products, optimize branding, and produce cognitive marketing campaigns accordingly.

Tufts' food sensor :

Fig 5.11

Tufts University had developed a tooth-mounted sensor [Fig 5.11] which could detect or measure your alcohol, sugar, or salt intake. The 2mm x 2mm sensor could be useful for medical purposes, and to enable people on specific diets to monitor and track what they're eating.

Innovation in Disaster Management :

Disaster Management can be defined as the organization and **management** of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to lessen the impact of disasters.The need for increased application of innovation and technology for disaster risk reduction (DRR) has never been greater in order to foster new development

Automated Wildfire Protection Systems :

An infrared tower that detects wildfires up to 50 miles away and alerts both property owners and emergency responders. It contains piping filled with water or fire retardant that can be sprayed over an area of 30 feet around the structure. Well-placed roof soakers can ease some of the strain of detecting and dealing with wildfires for emergency responders.

Geographic Information Systems :

Geographic information systems (GIS) have extreme value for emergency responders. This analytical mapping technology helps them understand where hazards are located, how many people are affected, and what response is needed.

Intelligent Street Lamps:

Though street lamps may seem like an unlikely tool for emergency management and response, the innovative design of Intellistreets lamps gives seemingly ordinary lighting a powerful new layer of functionality. These street lamps are equipped with environmental sensors that detect hazards like rising water levels, strong winds, high temperatures, and lethal gas. They are also equipped with 180-degree cameras that offer a real-time look at pedestrian traffic and developing situations.Emergency management teams can use these Intelligent streets lamps to respond to threats and communicate essential information to citizens in the area. The lamps illuminate in four different colors, so area management can use them to indicate warnings, danger, or the safest escape route. Concealed speakers make it easier to make critical public announcements and a double-sided LED banner can display alerts.

With these powerful street lamps in place, emergency responders can gather essential information about threats and communicate with citizens at the street level before they’re able to arrive on the scene.

Emergency Communication Apps :

Widespread smartphone adoption makes these devices the ideal means for communicating emergency response efforts with the public at large