Disruptive Technologies & Evolving Global Society

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ABSTRACT

A Disruptive Technology—in its most general sense—may be considered as an innovation, a discovery, a serendipity, or a purely unintended & unconscious striking of an idea to someone, which, when consciously used repeatedly, has potential of changing course of human life, or life in general.

Since the appearance of Clayton Christensen's book 'Innovator's Dilemma: When New Technologies Cause Great Firms to Fail' (1997), the concept has acquired slightly different meaning, restricting it to those technologies which are developed, not necessarily as directly intended, but as consciously developed, and having applications to mainly human economic sphere.

Now, a number of technologies are already in the process of maturing with potential for drastically changing humanity. These technologies include Blockchain, 3D Printing, Artificial Intelligence, Internet of Things (IoT), and Nano-technology. The essential character of the enfolding technologies taken together is virtualization: replacing current material (hardware) components from almost all human activities by energy(software) ones. Instant universal connectivity of everything (human beings and non-living artefacts included) will be one of its effects.

Most of the disruptive technologies, including the ones mentioned above, have beneficially contributed to improve human life in various ways. However, with the passage of time, since at least 2014, there are signs of their disrupting negatively long cherished human values, norms of democracy and the rules of law. The point of worry is that attempted damage is happening at massive scale and global level. Another issue of serious human concern is expected massive unemployment due to the disruptive innovations.

Keywords: Disruptive Technology, Artificial Intelligence, Blockchain, 3D Printing, Nano-technology.

Introduction

Technologies, specially, the digital technologies, are impacting everyday life with ever-increasing intensity. These technologies are providing most of us with immense benefits & privileges, which were not available to even the princes a century earlier. However, at the same time, these are harbingers—if not properly handled—of potential dangers to the humanity to the point of either complete annihilation from earth, or at least, to the complete subservience to the machine, the creation of human's own mind, in not too-distant a future. In this respect, two most immediate worrying aspects of the ongoing technological revolution are (i) expected massive unemployment through replacement by machine and (ii) throttling control of human fate in few hands, worst form of dictatorship ever imagined.

For academics, and specially the social scientists, it is duty to keep watching and to evaluating how various developments are impacting the society at present, and how these are expected to impact human life in future, and periodically keep informed the society & those in power about these developments.

This write-up is divided into the following THREE sections

1. Conceptual Framework
2. Emerging Disruptive Technologies
3. Impact of emerging technologies on the current and the future human life

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Conceptual Framework:

The discussion is started with the central concepts of this communication, viz. Disruptive and Disruption.

Disruption to a system, in general, is a specific form of change which occurs relatively quickly or dramatically, and is caused by some stimulus external to the system. In general, a disruption need not be only negative; it may have both positive/creative and negative/destructive effects on a system, on a section or on the whole of the humanity. Disruption may be initiated by (disruptive) forces which may be natural (e. g. earthquake, cyclone, pandemic), technological (e. g. automobile in 18th/19th century), or socio-cultural-political (e. g. revolutions, warfare) etc. Technology being tangible outcome of socio-cultural-political environment, the nature of technological disruptions is closer to the socio-cultural-political ones than to the natural ones.

For the previous couple of centuries, technology has been a major source of economic, social & political disruptions. However, natural calamities and pandemics have also been frequent sources of disruption. For example, the key disruptive force of 2020, the coronavirus pandemic, is non-technological. Technological developments, which become disruptive forces, give rise to changes of different scales, viz. from individuals' routine activities to rivalries between global superpowers. However, in the current globalized-village world, a disruption, natural or otherwise, may impact globally, and simultaneously many facets of human life including economic (replacing existing business models & employment patterns by new ones), social (norms, values, identities, disparities), political (impacting e. g. democratic institutions, international relations and the global balance of power), and legal (laws and regulations).

Disruption specific to economic & technological innovations: In the current technical sense, the concept of disruption due to technology was introduced, in 1997, by Clayton Christensen [Christensen, 1997]. In respect of disruption due to technology, it is more often referred to as disruptive innovation. Later on, the concept is modified/extended. According to Christensen, disruptive innovation is 'An innovation that creates a new market by providing a different set of values, which ultimately (and unexpectedly) overtakes an existing market'. Here, the emphasis is on market. So, according to Christensen, how so ever wonderful a discovery or invention maybe, if it does not disrupt market, then it is not disruptive innovation. Thus, automobiles which were introduced in 1886 for the first time, are not considered by Clayton as disruptive innovation, but Ford T model which was introduced much later in 1908 is considered as disruptive innovation, because the earlier automobiles were expensive luxury items which did not displace, and the later did displace, horse-drawn vehicles from the market. Also, according to Christensen's definition, only a process, and not an outcome or product, can be a disruptive innovation. However, this definition is extended later by many scholars in the field including Miller et.al [Miller, 2018], according to whom 'Disruptive technology is a product or process with the potential to create disruptions at any of the different levels: industry segment, industry structure, and social system'. For example

1. Industry segment, e. g. pen-drives disrupted the segment of large discs,
2. Industry structure & Social system, e. g. online business has disrupted the traditional business, in the sense, earlier people used to go to shops and malls for purchases, now the delivery persons come to residences of the people. Also, earlier people needed to know the locations of markets for specific goods, which is not needed any more. Generally, there used to be a sort of personal relations between owners of neighbourhood stores and their clients.

Next, some of the technologies, which are at centre of current economic, technological and social disruptions, are discussed.

2. **Emerging Disruptive Technologies**

In this respect, the following technologies are discussed

a. Artificial Intelligence (AI)
b. Blockchain,
c. 3D Printing,
d. Internet of Things (IoT), and

e. Nano-technology

For each of these technologies, to begin with, some working definitions are considered. Then some of their applications and possible adverse consequences are sketched. However, the detailed discussion of social and economic impacts of the technologies, individually and jointly, is covered under the next section, viz. Impact of emerging technologies on Current and Future of Humanity.

It may be also pointed out that all these technologies are enabled by the following facts/ features of foundational digital technologies

a. Computing power, has become at least 10, 000 times faster since 2000, e.g. Japanese supercomputer Fugaku can execute 1×1018 flops;

b. Internet communication speed of 44.2 Terabits (= 44.3 x 1012) per second, is also at least 3, 000 times faster since 2000

c. High quality sensors

d. Deep Learning Algorithms

e. Availability of Big/ Massive datasets

Artificial Intelligence (AI)

Out of the above mentioned (five) technologies, AI is the foundational one in the sense that in each of the others—rather, in any current advanced technology—AI is essentially involved. The term Artificial Intelligence for the discipline was proposed in 1956 by John McCarthy (1927-2011)—one of a couple of pioneers in the discipline—in Dartmouth Conference. AI is inseparably linked to both McCarthy and Dartmouth conference. The discipline of AI is so varied and so encompassing many academic disciplines, both practically and theoretically, that different leaders in the field have viewed it from different perspectives, leading to a number of definitions of AI. For our purpose, the following (working) definition by Elaine Rich [Rich, 1983]is discussed:Artificial Intelligence is the study of how to make computers do things, at which, at the moment, people are better.And, people are still better than computer in the following aspects of problem-solving:

Understanding of and reasoning with natural language: both spoken and written

Unconscious knowledge/ capabilities:

Very large repertoire of skills (how-to knowledge), and, millions of common-sense facts, and their use in solving problems.

Use of judgment (decision making without calculation/computation)

Learning (acquiring new knowledge)

Creativity, strategy making

Abstraction/ finding principles behind various phenomena

Capability to work with knowledge which is imperfect: uncertain, incomplete, fuzzy, imprecise, ambiguous, and even paradoxical/ inconsistent and subjective etc.

AI has mainly two paradigms/approaches for developing software solutions

Symbolic Paradigm, or (a priori) Programmed Computing Approach -- dominating paradigm in A.I. up to around 2010.

Nature-inspired paradigms (Machine Learning Paradigms): Neural Networks (modelling human brain), Genetic algorithms, Swarm intelligence etc.—dominating paradigm now.

The symbolic paradigm may be considered as Expert-system paradigm in the sense that rules for solving problems from complex domains, say, Medical Diagnosis, are extracted through/from experts in the field, and then incorporated in the computer system. Out of the many problems with the paradigm, one major problem is to find complete set of appropriate rules for problem domains concerning social, political or any sphere of human concern, except possibly that of natural sciences.

On the other hand, in the nature-inspired paradigm, the computer system itself extract rules from massive data sets. For this purpose, computer uses a number of mathematical theories including probability theory, fuzzy set theory, Modal logics, belief models and non-monotonic logics, Chaos theory and Rough-set theory. One of the major problems with this paradigm is to give explanation for the conclusion arrived at using the paradigm. For example, an automated legal system, developed using the paradigm, delivers a verdict/ judgement. But it is difficult for the legal system to explain how the verdict is arrived.

Applications (Beneficial) of AI: AI has improved human lives in innumerable ways, a tiny fraction of which include
Making the World a global village with instant communication through mobile phones & Internet;
Availability of knowledge, money, ticket reservations etc. at the click of button through internet, www, credit cards etc.
Medical expertise in respect of diagnosis, treatment, and even of telemedicine, tele-surgery reducing thereby the requirement of experts' availability at every place to the bare minimum and increasing life expectancy and quality of life many folds.
Weather Forecasting & (Crop etc.) damage control
Disaster Forecasting & damage control
Harmful effects & potential danger from unguarded applications of AI include (i) privacy loss(ii) truth has become the biggest casualty of the revolution: prevalence of Fake news has made it almost impossible to know the truth (iii) mega-scale electronic frauds (iv) psychological problems among youth including isolation, obesity and depression.

Blockchain

At basic level, a blockchain is a special kind of database—where, a database stores (generally, large volume of) data in computer system in such a way that its contents may be easily accessed, stored & modified, and at the same time remain secure and uncorrupted—in which relevant information pieces are collected, as in any database into packets or groups called blocks, but with the difference that every new block is chained at the end of earlier stored blocks. Also, each block is given exact time-stamp at the time of its being added to the blockchain. Further, security of contents of block in blockchain is ensured—much more rigorously as compared to that in the general database—through more rigorous cryptographic techniques in which code to a newly added block is calculated as a function of the code of the just earlier block, and its own timestamp.
Thus, for changing the code of a block, knowledge of codes of all earlier blocks is required. Further, it is distributed in the sense it is made available on a large number of computers, and any one having a block of information on it can access (but cannot change) its contents.
In addition to the security and distributed nature of blockchain as database, a blockchain has the characteristics of faster transactions, very large capacity for additional blocks, and immutability, in the sense that information stored in any of its blocks cannot be changed.
The idea of blockchain was first proposed by David Chaum in 1982 in his dissertation entitled 'Computer Systems Established, Maintained, and Trusted by Mutually Suspicious Groups'. However, the idea was realised in 2008 by so far anonymous person (or a group of persons) assuming the name Satoshi Nakamoto which now serves as public transaction ledger of bitcoin, a cryptocurrency.
Advantages of blockchain as database has already been enumerated as secure, immutable, faster, distributed, anonymous, and potentially unlimited etc. For this reason, it is being used to record sensitive documents like property & legal documents. Because of these characteristics, blockchains have been used as a sort of bank, in which money in the form of cryptocurrency, called bitcoins, is kept.
Disadvantage of blockchain: First of all, the ownership by someone of information or money, or legal documents etc. is completely related to the code of the relevant block. So, if code is forgotten or lost, the ownership is completely lost. Next, because of the immutability of the records, a criminal—despite having served the

punishment and having reformed as best possible citizen—will remain a criminal, the relevant record cannot be erased. Also, blockchain information may be used by a group of pornographically oriented people. And, the most serious problem is about employment, displacing millions of human beings engaged in banks, book-keeping/ record-keeping in various sectors like legal agencies, government registries etc.

3D Printing, Additive Manufacturing

3D printing or—technically also called, though not universally accepted as synonym of—additive manufacturing is a group of technologies for manufacture based on the process of material addition or joining under automated control [Bandyopadhyay, 2020]. In this respect, it may be recalled that the so far mostly used method of manufacturing is retrospectively called subtractive process in the sense materials are cut, assembled and soldered etc. For example, doors of automobiles are made by a process including the cutting of aluminum sheets. Like some of the ideas of technologies like satellite initially being given by science fiction writers, the idea of 3D printing was also described by Raymond F. Jones in 1950 in his story entitled Tools of the Trade.

Benefits of 3D printing: Among the many benefits of the prospective of mature 3D printing will be very fine products, economy by saving material waste, efficiency and automated manufacturing, making the products much cheaper. The shape, size, and outlook of goods may be according to one's taste or liking. In the not-so-far future, even Home 3D printers may be available for manufacturing some of the goods for domestic consumption.

Potential Dangers: However, it should be remembered that3D printing can equally be used to make guns at home. Also, again, there is justified apprehension of the technology leading to massive unemployment.

Internet of Things (IoT)

The Internet of Things (IoT) refers to a system of (inanimate) things/objects connected over the Internet for the purpose of communicating data to each other, where communication is enabled by embedded sensors, software, and other technologies in the objects.

Applications of IoT: The technology has immense scope for beneficial applications in almost every sphere of human concern, e. g. for elder care, medical & healthcare, transportation, environmental monitoring; in manufacturing, in agriculture, in energy management for metropolitan cities; and as Internet of Battlefields for military applications.

Potential harmful consequences: In view of connectivity of almost everything, serious concerns are being raised by experts regarding privacy and security.

Nanotechnology

In order to explain the, so far not well-defined, concepts of nanotechnology and nanoweapons, it may be recalled that the prefix nano, in these concepts, stands for the number 10−9 or 0.000000001, called one billionth. Thus, nano-meter, denoted as nm, is one billionth of a meter. The term nanomaterial stands for the material having one or more of its dimensions of the order of 100 nm or less. And, the term Nanotechnology is used for the design, characterization, production and application of materials, structures, devices and systems, using the science and engineering of nanomaterial. For example, nanotechnology is used as nanoelectronics for manufacturing microprocessors and other integrated circuits by Intel and other companies. Finally, nanoweapon is a weapon produced through nanotechnology.

Brief History

The earliest available evidence of applications of nanotechnology is available from ancient India during the period around 600 BC from a village, called Keeladi in Tamilnadu. [Kokarneswaran, 2020]. Further, from at least around 900 A.D., it was used, both in India and in Mesopotamia, for large scale manufacturing: In India for manufacture of wootz steel, the microstructure of which contained carbon nanotubes; and in Mesopotamia for giving glittering effect to pottery. [Wikipedia]

In modern times, the theoretical and conceptual foundations of nanotechnology were laid by renowned physicist Richard Feynman through his lecture, on December 29, 1959, entitled There's Plenty of Room at the Bottom in which he described a process that could possibly be used for manipulating individual atoms and molecules

[Feynman, 1959]. Later, his ideas were popularised and extended by Eric Drexler through his 1986 book [Drexler, 1986].

Beneficial Applications

One of the significant aspects of 'nano' lies in the fact that nanomaterial has quite different reactive, optical, magnetic, and electrical properties than that of macroscale material. In view of these distinct characteristics of nanomaterial, through nanotechnology, materials are effectively made more durable, stronger, lighter, more reactive, or better electrical conductors. These characteristics have led to numerous applications to various fields including those of commercial products, electronics & IT, medical & healthcare, energy. Due to paucity of space, only a couple of examples, out of numerous ones, from each field, are enumerated

Commercial Products:

For machine parts, Nanoengineered ceramic coatings have much greater toughness than otherwise.

Nanoscale films on the display screens of computers and cameras, on windows, and eyeglasses, make them residue-repellent, self-cleaning, resistant to infrared light & ultraviolet rays, electrically conductive etc.

Nano-engineered materials make automotive products like cars, airplanes, and space craft etc. much lighter, and hence lead to significant fuel savings and clean environment.

Nanomaterial-based fabrics have potential for more durable and protective garments, particularly for extreme weather locations.

Electronics and IT Applications: Most significant applications of nanotechnology are to the field of computing and electronics, making computers and other electronic gazettes much faster, smaller, safer and more portable, and capable of storing larger and larger amounts of information. These achievements are based on the facts

Transistors, the basic switches that enable all modern computing, have become gradually smaller through nanotechnology.

Magnetic random-access memory (MRAM) provides for very fast Random-Access Memory

Nanoparticle copper suspensions are safer, cheaper, and more reliable alternative to hazardous lead-based and other materials used for fusing electronics in the assembly process

Medical and Healthcare Applications

Nanotechnology, and Nanomedicine—the application of nanotechnology in medicine—have significantly improved the earlier available medical tools, knowledge, and therapies and is producing precise solutions for disease prevention, diagnosis, and treatment. Some specific applications include

Use of gold nanoparticles are being investigated as potential treatments for cancer and other diseases.

Nanotechnology-enabled better imaging and diagnostic tools provide for earlier diagnosis

The design and engineering of advanced solid-state nanopore materials are investigated for high-speed and low-cost gene sequencing technologies that enable single-molecule detection.

Energy Applications

Nanotechnology is finding applications to developing affordable, and renewable clean energy sources, and to reducing energy consumption.

Nanotechnology is also being applied to oil and gas exploration and extraction through the use of nanotechnology-enabled gas lift valves and the use of nanoparticles to detect microscopic oil pipeline fractures.

To reduce substantially transmission power loss, wires, containing carbon nanotubes having much lower resistance than the high-tension wires, are being discovered.

o Nanotechnology is already being used to develop many new kinds of batteries that are quicker-charging, more efficient, lighter weight, have a higher power density, and hold electrical charge longer.

Potential risks & hazards

In view of the fact that nanotechnologies have very wide range of applications, and involve a number of industrial sectors, and their volumes is quite enormous and increasing day by day, the landscape of risks involved is quite

vast, heterogenous, and is evolving with newer types of applications of nanotechnology. Here, only the following few domains of nanotechnology risks & Hazards associated with manufactured nanoparticles, are discussed.

- human health
- the environment
- Explosive aspects of nanoparticles
- Self-replicating miniature machine.

For this purpose, only some classes of Manufactured Nanoparticles are mentioned below

- Metal oxides used for polymer composites, UV-A protection, Solar cells, Pharmacy /medicine, Additives for scratch resistance coatings
- Carbon nanotubes used for electronic fuel cells, field emitters, batteries and fuel cells
- Compound Semiconductors for electronic and optical devices
- Organic Nanoparticles used in micronized drugs and chemicals
- Metals like Au, Ag, Ni used respectively for catalytic applications, optoelectronics, and wound dressing

Manufactured nanoparticles & human health: As mentioned earlier nanoparticles are more reactive than bulk/macro-sized ones, and hence more toxic for the human body. The risk is especially grave in the case free nanoparticles, now gradually inserted more in the environment. The free nanoparticles can be absorbed through the skin, inhaled, or can be ingested. When inhaled and reach the lungs, toxic effect is to induce inflammation in the respiratory tract, causing tissue damage. On the other hand, if transported through the blood stream, these enter other vital organs or tissues of the body resulting in cardiovascular and other extrapulmonary effects.

Next, there are occupational hazards for those involved in nanotechnology industries. Also, there is risk due to use of nano-products in cosmetics (e. g. in lotions, toothpaste), in medicines and medical devices (e. g. wound dressings), in food products (e. g. drinks, ice-creams, fish), in automotive (e. g. airbag gas generators); Sports article (e. g. ski wax).

Nanoparticles and the environment:

Nanotechnologies are gradually moving globally into large-scale production in many industries, and with this the possibility of increased gradual and accidental releases of engineered nanoparticles into the environment also increases. The following are some of the possible routes for environmental exposure to nanoparticles:

- Leakage and discharge from waste, or during production, transport and storage of nanoproducts,
- Release of particles during use of the products,
- Diffusion, transport and transformation in air, soil and water.
- Also, some applications like cosmetic products or food ingredients can diffuse nanoparticles.

Explosion hazards of nanoparticles

In the case of nanoproducts, an explosion occurs when nanoparticles of combustible material scatter through the air, forming a flammable cloud and the cloud is hit by a flame. As mentioned earlier, nanomaterials are more reactive, occurrences of such explosions have more chances.

Apart from concerns of property damage, workers safety and business damage, nano-powder explosions lead to the danger of release of large quantities of nanomaterial into the environment, which in turn may create potential pollution problem.

Self-replication of nano/miniature machines

Self-replicating machines are, theoretically, machines which can produce machines of their own type. The idea of self-replicating machine is based on the phenomenon among biological entities reproducing entities of their own species. Though the idea is only a theoretical one so far, but in the case of nanomachines, it is considered feasible in view of the requirement of very small amount of material for self-replication. However, if self-replication is achieved, it will have far reaching consequences for humanity. Because, in that case nanoweapons (to be discussed in detail later) may lead to complete elimination of life from the face of earth.

3. Impact Of Emerging Technologies on Future of Humanity

In this section, impacts of the various disruptive technologies—except Nanotechnology, the impacts of which has been already been discussed in detail above—regarding the following are considered

a. Economics
b. Military & Defence
c. Political & Social institutions being affected adversely.

Innovations disrupting economies

For better understanding of the rest of the discussion, the following working definitions may be useful.

"A value chain is a business model that describes the full range of activities needed to create a product or service. For companies that produce goods, a value chain comprises the steps that involve bringing a product from conception to distribution, and everything in between—such as procuring raw materials, manufacturing functions, and marketing activities." [investopedia]

Platform economy is a business model which uses mainly IT tools to provide services and means of communication between various stakeholders.

Regarding economy, since at least the previous century, technological innovations have been a significant factor in changing drastically its established models, value chains, types of asset, and employment domains & opportunities etc. Specially, the digital technologies have made drastic transformation in this respect. For example, up to 2008, the fixed capital constituted the larger share of assets of the big companies, but by 2018, the intangible assets consisting of software & intellectual property became major part of their total assets.

Within ICT, one of the well-known examples of disruptive innovation, affecting economy of a sector, is that of Apple displacing Nokia as leader in the domain of mobile phones: When Apple entered the market in 2007, Nokia, the leader, owned 50% share in the market. By 2019, Apple—through its innovation of software-based smart phones which include mobile operating systems, apps, internet and multimedia video and camera functionalities—captured 20 % market share, and Nokia, sticking to improvement of only hardware-based mobile phones slipped to mere 1 % share.

Next, instances of disruptions to some aspects of economy are just mentioned: The internet and cloud computing have given birth to platform economy disrupting the business models of traditional economy. Because of the distributed nature of internet/Internet, digital technologies allow to make industrial processes—like product design, engineering and manufacturing—increasingly decentralised and globalised, possibly taking place in different locations. Similarly, for service, say, in the field of supply of goods, Amazon has drastically different structure, processes, the consumer expectations & behaviour vis-à-vis the traditional high-street shops. Somebody may order from India for a book published by Oxford University Press in England, and the order may be received and processed in USA. Other examples of platform services include Airbnb and Uber having disrupted the conventional services regarding respectively traditional hotel and taxi booking-and-providing services.

Job Markets: Automation—based on disruptive technologies, including the ones mentioned earlier—has created major disruption in the job market. Robots are being used for various types of jobs, either by displacing human beings, or for performing jobs considered earlier too hazardous, or even infeasible involving human beings. However, some job losses may be reduced through adaption to the new environment of production and business involving automated processes and robots. Also, the disruptive technologies, mentioned earlier, are creating entirely new type of jobs, but not enough to compensate for the losses. In view of the rapid technological developments, the human work force will be required to reskill and retrain, on continual basis, in order to keep up with the pace of technological change.

Another development, relating to job market due to disruptive innovations, is the rise of the gig economy—a labour market characterized by the prevalence of short-term contracts or freelance work as opposed to permanent jobs—has significant social implications. In this emerging economy, there is no provision for employees' well-being and social protection, including medical facilities, maternity leave, pensions, insurance etc. Also, in view of the winner-takes-all economic scenario, the difference between the successful vs. the unsuccessful innovators on one hand, and people having currently-required skills vs. others will further accentuate the income and wealth

inequalities. However, the undesirable impact may be mitigated through various factors like labour costs vs. cost of labour-replacing technologies, labour market regulations, institutional norms, and ethical standards.

Innovations disrupting Military, Warfare & Defence

Technologies, specially, the current AI-based ones, have been disrupting all aspects of military activity: organisation, logistics, personnel training, strategic decision-making, interoperability, and physical combat.

Technological impact on training: AI-based Virtual reality simulations—of the theatres of combatting the enemy—provide for cheaper, safer and environmentally less damaging alternative to the conventional training on the field. Simulation provides opportunity for training for different types of adversary, and also, offer tailored learning experience to each one of the trainees according to one's capabilities, goals and progress.

Smart weapons: These weapons may be categorised as

1. Automated (human-controlled): These weapons can select the target and attack the enemy only when commanded by a human. Automated weapons, including most of the robotic weapons and drones, are remotely controlled by human beings.
2. Semi-autonomous: These are human-supervised weapons which can, of course, select the target and attack by itself, but a human controller can override its actions through remote control.
3. Fully autonomous weapons, the most advanced of the three categories, are capable of searching, identifying, selecting, and attacking the target, all by itself, without human intervention.

Here, a particular distinction may be pointed out between automated and autonomous, concerning the nature of operational environment: If a weapon, like landmine, acts in a predefined, restricted and controlled environment then it is just automated weapon, and not an autonomous one. An autonomous weapon is capable of carrying out its intended action in an open and unpredictable environment.

The smart weapons of various categories are developed using various disruptive technologies including high-energy lasers, 3D printing and AI including cognitive computing. Use of high-tech weapons, of course, gives rise to political side-effects and security concerns. The weapons, being high-tech, are generally designed and developed either in private-public partnership or purely by private parties. Particularly, for less-developed countries, the concerns become more serious in view of the fact that the high-tech weapons have to be purchased from another country.

Each of these raise number of social, ethical and legal issues. For example, in case of unintended, wrongful damage, who is responsible: the designer/ developer, the commissioning authority.

Before discussion on smart weapons is closed, a special mention may be made of nano-weapon (also, written as nanoweapon). Recalling the earlier considered definition of nanoweapon as a weapon produced through nanotechnology. Nano-enhanced lasers, smaller munitions with increased explosive force, and self-replicating smart nanorobots (SSN) are some of the examples of nanoweapons. SSNs search for and destroy targets without human input and self-replicate with materi¬als found in the environment. Because of various characteristics of nanoweapons, specially, their quite small size, almost invisible to the naked human eyes, and their self-replicating nature, the nanoweapons have been ranked—by the Global Catastrophic Risk Conference at the University of Oxford—as the most probable means to cause human extinction by the end of 21st century. According to Louis A. Del Monte, an expert in the field and author of the book [Del Monte, 2017], SSNs are so gravely dangerous that humanity should prohibit nanoweapons.

Organisation & Command Structure: Defence institutions, by the very nature of their job, have to be strictly built on precise structures and chains of command. However, in the current scenario, instant decisions need be taken frequently by the concerned person—irrespective of his/her (relatively lower) rank—who first becomes aware of a critical situation relating to defence. Instant decisions are required in view of the fact that, the disruptive technologies, including the AI-enabled analytical tools enable collecting of gigantic amount of data from various sources, its processing, making inference from it, or at least converting it into a format useable by human operator, all almost instantly. Reemphasizing, depending on a situation, critical decisions might have to be taken in a fraction of a second, and, hence decision-taking has to be flexible.

Machine-soldier collaborative teams

As in the case of civilian jobs, disruptive technologies are eating into military jobs, particularly, the ones regarding repetitive and mechanical tasks, and also regarding hazardous jobs like surveillance of enemy territories. However, still human beings are required for jobs involving strategic and emotional thinking and creativity. For example, drones and other robots are employed for surveillance and gathering huge amounts of data; computers are used for summarizing and drawing some inferences; but, so far, ultimately it is the human beings who decide the action to be taken based on the data and inference vis-à-vis the purpose under consideration.

The advantage of using these disruptive innovations, of course, involve high risks also. For example, the drones, robots and other digital equipment are vulnerable to being detected, jammed or hacked by the adversary.

Intelligent Logistics

Logistics is heavily dependent on transport planning and innovations. In this regard, AI-based semi-autonomous transport systems have been developed, which can optimally deploy the available resources. In order to detect defects and guard against failure of equipment, better predictive maintenance technologies are being deployed. Also, AI-enabled analyses are used for knowing in advance, supply needs and inventory. All these advantages arise out the fact that whole (logistic) system is made highly connected. But with high connectivity, its vulnerabilities to cyber-attacks also increases. Further, in order to guard against cyber-attacks AI-enabled software have been developed to automatically defend or even retaliate. Cyber-attacks and counter-measures may lead cyber war.

Interoperability

In case of joint manoeuvre of two or more allied forces—using different, generally incompatible, underlying platforms—interoperability may be big challenge, bigger than the interoperability of human-only forces. And, it is very much possible that two allies' incompatible systems may classify each other as hostile.

Political & Social institutions being affected adversely.

In this respect, to begin with, brief explanation and working definitions of some of the foundational concepts are given.

Social media— one of the products of disruptive technologies, and which is constituted of a large number of websites including Facebook, Twitter, LinkedIn WhatsApp, YouTube, Instagram, TikTok etc.—provide digital platform for interaction, almost instantly, at individual and group-levels, across the world. Any of the digital communication media including textual, graphic, pictorial, audio and video may be used for the purpose. Initially—the ever-growing social media in terms of its users and the number and types of website—was expected to deliver and disseminate only information, the actual happenings in the spatiotemporal domain and/or the actual ideas, feelings and thoughts of individuals and groups. However, with the passage of time, the misinformation, disinformation, hype and fake news dominate the social media to the extent that it has become almost impossible to know truth from the content on social media.

"Disinformation is false or misleading information that is spread deliberately to deceive. This is a subset of misinformation. Misinformation is false or inaccurate information that is communicated regardless of an intention to deceive. Fake News is false or misleading information presented as news. It often has the aim of damaging the reputation of a person or entity, or making money through advertisement revenue".[Wikipedia]

Regarding impact of social media on Democracy, initially, around 2011, the media, specially, Facebook, Twitter, WhatsApp and Google were seen as propagators of democracy, when during Arab Spring—affecting many Arab countries and their neighbours, including in Tunisia, Egypt, Bahrain, Iran—a sort of democratic movement, was spurred and spread across these countries by bloggers and social media commentators.

But latest by 2016—around the time of presidential election in USA—because of various incidents of massive misuse of the media by anti-democratic forces (some of which are mentioned below), it was fully realized that the social media was being massively misused for propaganda and disinformation in order to propagate personal