PERSPECTIVES ON THE FOURTH INDUSTRIAL REVOLUTION UNDER THE OPTICS OF AMARTYA SEN

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Abstract: The present paper introduces the concepts of the so-called fourth industrial revolution. It presents its main technologies, which are endowed with the potential to bring about sweeping changes in diverse human activities, and discusses, in particular, the convergence of such technologies, which would allow for the creation of products hitherto unthinkable. In this sense, it addresses how it could affect the labor market and the economy, the social organization and people's freedom. It also includes a perspective on the fourth industrial revolution according to Amartya Sen's concept of development as freedom, weaving conjectures about its social and economic impacts, as well as the impact it may exert on the anthropocentric view, due to the possibility of the emergence of a more developed artificial intelligence.

Keywords: Anthropocentrism; Development as freedom;

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Disruptive technologies; Fourth Industrial Revolution (4IR); Social and economic changes;

PERSPECTIVAS DA QUARTA REVOLUÇÃO INDUSTRIAL SOB A ÓTICA DE AMARYA SEN

Resumo: O presente artigo apresenta os conceitos da chamada quarta revolução industrial. Ele apresenta as suas principais tecnologias, que são dotadas de potencial para produzir mudanças radicais em diversas atividades humanas, e discute, em particular, a convergência de tais tecnologias, o que permitiria a criação de produtos até então impensáveis. Nesse sentido, aborda como isso poderia afetar o mercado de trabalho e a economia, a organização social e a liberdade das pessoas. Inclui também uma perspectiva sobre a quarta revolução industrial de acordo com o conceito de desenvolvimento como liberdade de Amartya Sen, tecendo conjecturas sobre seus impactos sociais e econômicos, bem como o impacto que pode exercer sobre a visão antropocêntrica, devido à possibilidade do surgimento de uma inteligência artificial mais desenvolvida.

Palavras-Chave: Antropocentrismo; Desenvolvimento como liberdade; Mudanças sociais e econômicas; Quarta Revolução Industrial (4RI); Tecnologias disruptivas;

1. INTRODUCTION

Humanity is about to face a new technological revolution that will change the way we live, work, and relate to one another. Klaus Schwab[3] considers that in its scale, scope and complexity this revolution is unlike anything that humankind has

[3] SCHWAB, Klaus. *The Fourth Industrial Revolution.* World Economic Forum, 2016. Geneva.

experienced before, and will imply nothing less than a transformation of humanity. Schwab argues about the "unlimited possibilities of having billions of people connected by mobile devices, giving rise to unprecedented processing power, storage capabilities and knowledge access".[4]

A revolution is defined by abrupt and radical changes resulting from the emergence of disruptive technologies, which, in the present case, consists of robotics, artificial intelligence, autonomous vehicles, 3D printing, augmented reality, big data, biology, and the so-called Internet of things (IoT), which allows devices to connect directly via the internet or other networks.

According to Schwab[3], these technologies will enable the almost complete automation of most industries, as well as processes that today demand human labor, leading to new business models and the reshaping of the production, consumption, transportation, and delivery systems. This will eliminate millions of jobs and create social and economic hardship that will ask for adjustments in the political, legal, and work organization during the transition. At first, social inequality will tend to increase, since large economic groups will no longer need human labor to carry out their productive activity. But if there are no consumers with resources to buy the goods and services, the current economic model will not be sustainable.

According to the concept of economic efficiency, the tendency of the market is to balance at the point where the supply curve crosses the demand curve. So, considering the probable increase in the supply due to a reduction in the production costs induced by the 4IR, the demand must change its balance point as these variables influence its curve. Sen criticizes this concept of Pareto optimality, proposing a model that provides greater freedom to all involved, explaining: "But efficiency can also be similarly defined in the spaces of liberties, rights, incomes, and so on. For example, corresponding to Pareto

[4] Ibid., p.7.

optimality in the space of utilities, efficiency in terms of liberty would demand that the situation is such that no one's liberty can be increased without cutting down the liberty of someone else."[5]

When someone thinks of inequality it is common to think of income inequality, but there are many types of inequality, and for Sen the focus is on the inequality of freedoms or opportunities, and in this sense he argues: "The extent of real inequality of opportunities that people face cannot be readily deduced from the magnitude of inequality of incomes, since what we can or cannot do, can or cannot achieve, do not depend just on our incomes but also on the variety of physical and social characteristics that affect our lives and make us what we are."[6]

4IR thus tends to cause significant changes in the equilibrium point of the economic efficiency, which will keep changing as technologies alter labor relations, demands for products and services, and even government relations. These changes can lead to an increase in individual freedoms as the human workforce migrates from physical labor to intellectual activities.

2. THE FOURTH INDUSTRIAL REVOLUTION

The Fourth Industrial Revolution (4IR) was named by Schwab[7], according to whom it has already started and will merge the physical, digital, and biological worlds at a speed and scale never seen in human history. It will generate unimaginable economic and social impacts with potential for great achievements and dangers alike, bringing about a transition from our current reality to the next, which may cause great difficulties due to a change in several economic and social paradigms.

> On the societal front, a paradigm shift is underway in how we work and communicate, as well as how we express, inform and

[5] SEN, Amartya. *Inequality Reexamined.* Oxford: Oxford University Press, 1992, p.25.
[6] Ibid., p.28.
[7] SCHWAB, Klaus. *The Fourth Industrial Revolution,* p.7.

> entertain ourselves. Equally, governments and institutions are being reshaped, as are systems of education, healthcare and transportation, among many others. New ways of using technology to change behaviour and our systems of production and consumption also offer the potential for supporting the regeneration and preservation of natural environments, rather than creating hidden costs in the form of externalities.**Erro! Marcador não definido.**

In this way, Effoduh[8] considers that Schwab was the first person to introduce the world to the concept of the 4IR, and that delimited the previous revolutions in the following form:

> The 4IR is, simply put, the fourth major industrial era since the first Industrial Revolution, which took place during the eighteenth century. Schwab asserts that the world has experienced four industrial revolutions: the first employed the use of steam engines for mechanical production; the second utilized electricity and the concept of division of labor to create mass production; the third (which grew in the middle of the last century) introduced information technology; and automated production processes; and now we have reached the fourth. At this stage, the 4IR, we are witnessing a digital transformation that pervasively impacts every work of life across the globe.[8]

Schwab considers three reasons why this revolution is not a simple part of the third industrial revolution:

> *Velocity*: Contrary to the previous industrial revolutions, this one is evolving at an exponential rather than linear pace. This is the result of the multifaceted, deeply interconnected world we live in and the fact that new technology begets newer and ever more capable technology.
>
> *Breadth and depth*: It builds on the digital revolution and combines multiple technologies that are leading to unprecedented paradigm shifts in the economy, business, society, and individually. It is not only changing the "what" and the "how" of doing things but also "who" we are.
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> *Systems Impact*: It involves the transformation of entire systems, across (and within) countries, companies, industries and

[8] EFFODUH, Jake Okechukwu. *"The Fourth Industrial Revolution by Klaus Schwab." The Transnational Human Rights Review 3. (2016)*: Available at: http://digitalcommons.osgoode.yorku.ca/thr/vol3/iss1/4 Accessed December, 2017. p.3.

> society as a whole.[9]

Schwab argues that it is necessary to try to understand what this revolution represents for humanity.

> Shaping the fourth industrial revolution to ensure that it is empowering and human-centred, rather than divisive and dehumanizing, is not a task for any single stakeholder or sector or for any one region, industry or culture. The fundamental and global nature of this revolution means it will affect and be influenced by all countries, economies, sectors and people. It is, therefore, critical that we invest attention and energy in multi-stakeholder cooperation across academic, social, political, national and industry boundaries. These interactions and collaborations are needed to create positive, common and hope-filled narratives, enabling individuals and groups from all parts of the world to participate in, and benefit from, the ongoing transformations.[9]

Based on the study of Amartya Sen that relates development to freedom,[10] the new possibilities of the 4IR might reduce inequalities of opportunity in society. However, the moving from the current situation to the coming future tends to create social hardship due to changes in the types of jobs and their required qualifications. It may be that income inequality is aggravated during the transition until a new social equilibrium is achieved.

Sen, in arguing that development is a process of expanding freedoms, refers to freedom as the level of *advantage (well-being and agency)*,[11] and ultimately evaluates a person's ability to lead the life he/she desires, with *well-being* as secondary. In

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[9] SCHWAB, op. cit., p.8-9.

[10] SEN, Amartya. *Development as Freedom.* New York: Knoph, 2000.

[11] "The critical issue, I would submit, is not complete precedence, but whether a person's liberty should get just the same kind of importance (no more) that other types of personal advantages-incomes, utilities and so on-have. In particular, the question is whether the significance of liberty for the society is adequately reflected by the weight that the person herself would tend to give to it in judging her own overall advantage. The claim of preeminence of liberty (including basic political liberties and civil rights) disputes that it is adequate to judge liberty simply as an advantage-like an extra unit of income-that the person herself receives from that liberty". Ibid., p.64-65.

this sense, by reducing the scarcity of resources, the 4IR will allow access to the basic needs with greater ease, generating an increase in free time and creating products that will reduce physical inequality.

In theory, it will allow more people to turn their *capabilities* into *functionings*, for these technologies will help them increase their possibilities of action. For example, a disabled person who cannot drive, as long as the vehicle is autonomous will no longer need to drive and will thus increase his/her possibilities of moving from one place to another and the actions resulting from that.

3. DISRUPTIVE TECHNOLOGIES AND HOW THEY CONVERGE

These innovative technologies have a common feature: they all harness the power to transform real world information into digital forms, amenable to computational processing. Schwab exemplifies: "Gene sequencing, for example, could not happen without progress in computing power and data analytics. Similarly, advanced robots would not exist without artificial intelligence, which itself, largely depends on computing power."[12] In this reasoning, Schwab states that the technological innovations of the fourth industrial revolution can be grouped into three groups: physical, digital and biological; which converges in the sense that "all three are deeply interrelated and the various technologies benefit from each other based on the discoveries and progress each makes"[12]

3.1. PHYSICAL

In the physical group, the manifestations that are easier to perceive are:

[12] SCHWAB, op. cit., p.19.

3.1.1. AUTONOMOUS VEHICLES

The car without a driver is just the most visible face of a whole range of autonomous vehicles, which include trucks, agricultural machines, aircraft, boats and drones.

The possibilities of this technology in everyday life are almost limitless. Systems for driving persons and objects regardless of the existence of a human driver will reduce delivery costs. Besides, a human driver has several limitations that machines do not have, such as the need for sleep, food, rest, cold and heat, in addition to reducing the risks of recklessness or lack of skill, ingestion of alcoholic beverages and the like, among innumerable others.

3.1.2. 3D PRINTING

3D printing is to build a digital model of an object, and using 3D printers, apply layers of materials on top of each other until they completely form a three-dimensional object. Schwab defines it as follows:

> 3D printing consists of creating a physical object by printing layer upon layer from a digital 3D drawing or model. This is the opposite of subtractive manufacturing, which is how things have been made until now, with layers being removed from a piece of material until the desired shape is obtained. By contrast, 3D printing starts with loose material and then builds an object into a three-dimensional shape using a digital template.[13]

This technology is already being used to make models, replace parts that have gone out of circulation, precision parts, jewelry, among many objects. In medicine it is already possible to print small orthopedic prostheses, models for study that replace cadavers. Advances in this area seek to develop printers

[13] Ibid., p.20.

that use biological material to create organs for transplantation, as well as techniques to artificially multiply cells with the genetic material of the person who will receive the organ, avoiding rejection and use of immunosuppressive medication.

Schwab explains that "researchers are already working on 4D, a process that would create a new generation of self-altering products capable of responding to environmental changes such as heat and humidity. This technology could be used in clothing or footwear, as well as in health-related products such as implants designed to adapt to the human body."[14]

3.1.3. ADVANCED ROBOTICS

Automated machines have been around for decades, especially in mass production lines, but recently they have become more flexible and structurally complex. These new robots incorporate a large number of increasingly advanced sensors enabling high-precision environment capture, which combined with control algorithms for large data volume and the increasing processing capacity of microprocessors, allows them to perform complex tasks and interact more and more with humans.

> Contrary to the past when they had to be programmed through an autonomous unit, robots can now access information remotely via the cloud and thus connect with a network of other robots. When the next generation of robots emerges, they will likely reflect an increasing emphasis on human-machine collaboration.[15]

These new technology combinations allow the emergence of new products, such as the machine that prepares and bakes a pizza at the same time it moves to the delivery address that requested it online.

3.1.4. NEW MATERIALS

[14] Ibid., loc. cit.
[15] Ibid., p.21.

New materials with impressive features have emerged. They go far beyond those already known with regards to resistance, conductivity, lightness, and malleability. Combined with 3D printing and advanced robotics these materials will enable the creation of currently unthinkable technological solutions, thus revolutionizing the entire market affected by them.

> There are now applications for smart materials that are self-healing or self-cleaning, metals with memory that revert to their original shapes, ceramics and crystals that turn pressure into energy, and so on. Like many innovations of the fourth industrial revolution, it is hard to know where developments in new materials will lead.[16]

Among these materials is graphene, which is considered the first 2D material in the world, which can have a multitude of applications, as it is lightest and strongest material, compared with its ability to conduct heat and electricity better than anything else, mean that it can be integrated into a huge number of applications.[17] Schwab**Erro! Marcador não definido.** describes graphene as an "advanced nanomaterial, which is about 200-times stronger than steel, a million-times thinner than a human hair, and an efficient conductor of heat and electricity" and considers that "it could also profoundly affect countries that are heavily reliant on a particular commodity.".[18]

3.2. DIGITAL

3.2.1. INTERNET OF THINGS (IOT)

One of the most visible faces of the 4IR is the so-called Internet of things (IoT), which allows machines and devices to communicate with each other in an increasingly integrated way.

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[16] Ibid., loc. cit.

[17] *What can graphene do?* Available at: http://www.graphene.manchester.ac.uk/explore/what-can-graphene-do/ Accessed in: December, 2017.

[18] SCHWAB, op. cit., p.21.

Also their connection via the Internet allows them to be controlled and diagnosed remotely, adding value to these devices.

> Sensors and numerous other means of connecting things in the physical world to virtual networks are proliferating at an astounding pace. Smaller, cheaper and smarter sensors are being installed in homes, clothes and accessories, cities, transport and energy networks, as well as manufacturing processes. Today, there are billions of devices around the world such as smart phones, tablets and computers that are connected to the internet. Their numbers are expected to increase dramatically over the next few years, with estimates ranging from several billions to more than a trillion. This will radically alter the way in which we manage supply chains by enabling us to monitor and optimize assets and activities to a very granular level. In the process, it will have transformative impact across all industries, from manufacturing to infrastructure to healthcare.[19]

Object tracking is another application of IoT: using compact sensors placed in objects in a network coverage area together with intelligent algorithms has the potential to transform the logistics and supply business.

Another disruptive technology is the blockchain-based technologies, such as the cryptocurrencies, which have been attracting the interest of banks, companies, and governmental organizations. It allows to document electronic transactions reliably without the need for a central authority to validate them. Thereafter, any modification made to the original version as well as new applications are tied to the blockchain. This technology in conjunction with object tracking will enable document reliability without the need of an authority to authenticate them. In this sense, Schwab illustrates some possibilities in the field of governmental documentation:

> If, at the moment, blockchain technology records financial transactions made with digital currencies such as Bitcoin, it will in the future serve as a registrar for things as different as birth and death certificates, titles of ownership, marriage licenses, educational degrees, insurance claims, medical

[19] Ibid., p.22.

> procedures and votes – essentially any kind of transaction that can be expressed in code. Some countries or institutions are already investigating blockchain's potential. The government of Honduras, for example, is using the technology to handle land titles while the Isle of Man is testing its use in company registration.[20]

McFee[21], claim that the worldwide phenomenon of the cryptocurrencies frightens governments: "It will eventually frighten every nation state, but it doesn't matter what they do, there's no way you can create a law or to legislate something that will stop Bitcoin or any cryptocurrency because technically, you cannot.". The main reason is taxation, which becomes very difficult without a central entity issuing or controlling the validity of these cryptocurrencies, on which McFee[21] makes the following consideration: "Our income taxes are the greatest source of revenue, but if everybody's using Bitcoin, the government doesn't know what your income is. They can't tax it, and if you choose to say I didn't have anything, they cannot prove otherwise".

Technology platforms such as Uber and Airbnb demonstrate the exponential capacity of expansion by allowing a chain of trust between the consumer and the service provider at a very low cost, enabling services ranging from laundry to home sharing. Schwab argue that:

> "This enables the effective use of under-utilized assets – namely those belonging to people who had previously never thought of themselves as suppliers (i.e. of a seat in their car, a spare bedroom in their home, a commercial link between a retailer and manufacturer, or the time and skill to provide a service like delivery, home repair or administrative tasks)."[22]

As technology platforms reduce transaction costs, there are economic gains for all parties involved. After the cost of

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[20] Ibid., p.23.

[21] MCFEE, John. *'Worldwide phenomenon' Bitcoin frightens governments*. Available at: https://calvinayre.com/2017/10/09/bitcoin/john-mcafee-worldwide-phenomenon-bitcoin-frightens-governments-video/ Accessed in December, 2017.

[22] SCHWAB, op. cit., p.23.

creating the digital platform, the additional cost of each transaction is minimal and costs are concentrated in the increase of facilities or services in the technology platform.

3.2.2. AUGMENTED REALITY

Augmented reality (AR) devices traditionally connect to the human senses through vision and hearing, and show reality with additional information embedded in it. Schwab explains that "with direct access to internet applications and data through vision, an individual's experiences can be enhanced, mediated or completely augmented to provide different, immersive reality."[23]

Augmented reality enhances one's current perception of reality, whereas virtual reality replaces the real world with a simulated one. Google Glass is an example of AR device.

Augmented reality can be used to support human decision as well as to draw the human operator's attention to situations that might be going unnoticed. The visual sensors can perform the identification of people and already present their name in the AR glasses, or even information about professional activity, sports, among others existing in social networks.

In a surgery, the doctor may use an AR goggles that identifies the major bodily organs or other relevant information wished and set for viewing at the time of surgery, or even request by voice command. It could for example through sensors of temperature, movement and pressure identify some eventual hemorrhage or anomaly, or even visually enlarge the place where the incisions will be made, among the innumerable possibilities in the visual support.

3.2.3. BIG DATA

[23] Ibid., p.114.

Big data is a term that describes the large volume of data that inundates a business on a day-to-day basis. This large volume of data makes it difficult for human analysts to realize significant swings and moves that could lead to actions to maximize business results, like cost and time reduction, new product development and optimized offerings and detecting fraudulent behavior before it affects the organization.

Care should be taken with respect to information privacy as well as with responsibility in creating the algorithm in order to generate reliable data to make a decision. A statistical analysis is advisable to verify if there is a gain of performance with the use of the algorithm and its improvement.

Schwab argue that governments may realize that their data collection techniques are expensive, slow, and inefficient, and thus adopt a big data system for their information gathering for decision-making.[24]

3.2.4. ARTIFICIAL INTELLIGENCE

The artificial intelligence (AI) study is evolving rapidly, due to the exponential increase in the processing capacity of

[24] More data exists about communities than ever before. And, the ability to understand and manage this data is improving all the time. Governments may start to find that their previous ways of collecting data are no longer needed, and may turn to big-data technologies to automate their current programmes and deliver new and innovative ways to service citizens and customers. Leveraging big data will enable better and faster decision-making in a wide range of industries and applications. Automated decision-making can reduce complexities for citizens and enable businesses and governments to provide real-time services and support for everything from customer interactions to automated tax filings and payments. The risks and opportunities in leveraging big data for decision-making are significant. Establishing trust in the data and algorithms used to make decisions will be vital. Citizen concerns over privacy and establishing accountability in business and legal structures will require adjustments in thinking, as well as clear guidelines for use in preventing profiling and unanticipated consequences. Leveraging big data to replace processes that today are done manually may render certain jobs obsolete, but may also create new categories of jobs and opportunities that currently do not exist in the market.
SCHWAB, op. cit., p.133.

computers, the enormous amount of data available on the internet and the software that allows the computer to relate the data and to elaborate a case analysis according to the criterion requested.

One of the problems of AI researchers is the so-called "deep learning", a process that requires tiered data processing, something the machines still do not works well, searching for the ability of a computer to apply its knowledge in other areas, such as humans currently do, is the ultimate goal of AI.

AI has been used to teach computers to learn the skills of humans and, in many cases, to overcome human achievement in such skills as playing chess. There are other well-developed skills such as speech recognition, language translation and navigation.

> Artificial intelligence (AI) is all around us, from self-driving cars and drones to virtual assistants and translation software. This is transforming our lives. AI has made impressive progress, driven by exponential increases in computing power and by the availability of vast amounts of data, from software used to discover new drugs to algorithms that predict our cultural interests. Many of these algorithms learn from the "bread crumb" trails of data that we leave in the digital world. This results in new types of "machine learning" and automated discovery that enables "intelligent" robots and computers to self-programme and find optimal solutions from first principles.[25]

In the legal area, the use of AI divides the experts on the effects of automation in the profession. "Recent advances in Artificial Intelligence, such as the IBM Watson-based Ross Intelligence System, and a recent Australian innovation, AILIRA (an AI tax law research system), have created a stir. These systems use Natural Language Processing to enable answers to legal questions in natural language"[26].

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[25] Ibid., p.15.

[26] *The Rise of Machines and the Future of Law Part I.* Available at: https://www.the4thindustrialrevolution.org/the-rise-of-machines-and-the-future-of-law-part-1/ Accessed in December, 2017.

Adrian Cartland has a unique view of the law and sees that there are many aspects of the law that are ripe for disruption through technology: "Law in a way is like coding, except what you have is you can create a program, but instead of running it, people just look at it and discuss how you would actually run it. So that is what a legal document is, that is what legal advice is. It's essentially a program".[27]

The possibility that through AI the machines can understand the laws is something revolutionary in the science of law because it would be the first nonhuman entity able to understand the legal directives and probably even execute its commands, which is basically what a software does. The difference is that instead of a static code with pre-determined commands, AI can modify the code it executes in order to comply with legal directives, resolving conflicts of laws in time and space, thus performing the integration of the ordering legal.

In this sense it should be very useful to resolve logical conflicts between laws, including considering the hierarchy of constitutional norms and principles. The use of such an AI tool should also improve the quality of legislative output by realizing all the implications that the new law will introduce into the legal order.

The possibility of a machine using the AI to understand and comply with legal text, and even contribute to the legislative process with a prior control of the validity of the new law, in an anthropocentric perspective is something that can frighten. The legal consolidation of manners can even be questioned by some really intelligent machine.

3.3. BIOLOGICAL

[27] *The Rise of Machines and the Future of Law Part II.* Available at: https://www.the4thindustrialrevolution.org/the-rise-of-machines-and-the-future-of-law-part-ii/ Accessed in December, 2017.

3.3.1. GENETICS

The genetic sequencing of the Genome Project took more than 10 years and cost $ 2.7 billion, currently in 2017 a genome can be sequenced in a few hours and for less than a thousand dollars. Schwab points out that "With advances in computing power, scientists no longer go by trial and error; rather, they test the way in which specific genetic variations generate particular traits and diseases."[28]

3.3.2. SYNTHETIC BIOLOGY

Evolution has spent billions of years via natural selection to reach the current picture of biodiversity. Mutations in the genetic code, which have sometimes generated species with greater capability of adaptation and survival, who have left more descendants and had their genetics spread throughout the planet. This process led to the emergence of the human species, which, with the scientific knowledge reached, now has the possibility of personalizing organisms by modifying the genetic code of all species, which is called synthetic biology.

Schwab argues that this will have a profound impact on medicine, agriculture and biofuels[29]. The combination of genetic

[28] SCHWAB, op. cit., p.24.

[29] Setting aside the profound ethical issues this raises, these advances will not only have a profound and immediate impact on medicine but also on agriculture and the production of biofuels. Many of our intractable health challenges, from heart disease to cancer, have a genetic component. Because of this, the ability to determine our individual genetic make-up in an efficient and cost-effective manner (through sequencing machines used in routine diagnostics) will revolutionize personalized and effective healthcare. Informed by a tumour's genetic make-up, doctors will be able to make decisions about a patient's cancer treatment. While our understanding of the links between genetic markers and disease is still poor, increasing amounts of data will make precision medicine possible, enabling the development of highly targeted therapies to improve treatment outcomes. Already, IBM's Watson supercomputer system can help recommend, in just a few minutes, personalized treatments for cancer patients by comparing the histories of disease and treatment, scans and genetic data

sequencing with AI systems that process large volumes of data (big data) will make it possible to discover new genetic diseases and synthetic biology can develop its cure, and also, "3D manufacturing will be combined with gene editing to produce living tissues for the purpose of tissue repair and regeneration – a process called bioprinting. This has already been used to generate skin, bone, heart and vascular tissue. Eventually, printed liver-cell layers will be used to create transplant organs".[30]

Scientific progress in this area has been so rapid that limitations are becoming less technical than legal, regulatory and ethical. The list of possibilities is virtually infinite "ranging from the ability to modify animals so that they can be raised on a diet that is more economical or better suited to local conditions, to creating food crops that are capable of withstanding extreme temperatures or drought".[31]

Natural biological processes, which have taken billions of years to reach the current stage of genetic evolution, may now be enhanced by genetic engineering, aided by big data systems and AI, leading to possibilities that are still unimaginable and that will lead to profound ethical issues. Schwab points that "we are confronted with new questions around what it means to be human, what data and information about our bodies and health can or should be shared with others, and what rights and responsibilities we have when it comes to changing the very genetic

against the (almost) complete universe of up-to-date medical knowledge. Ibid., p.24-25.

[30] Ibid., p.25-26.

[31] The ability to edit biology can be applied to practically any cell type, enabling the creation of genetically modified plants or animals, as well as modifying the cells of adult organisms including humans. This differs from genetic engineering practiced in the 1980s in that it is much more precise, efficient and easier to use than previous methods. In fact, the science is progressing so fast that the limitations are now less technical than they are legal, regulatory and ethical. The list of potential applications is virtually endless – ranging from the ability to modify animals so that they can be raised on a diet that is more economical or better suited to local conditions, to creating food crops that are capable of withstanding extreme temperatures or drought. Ibid., p.25.

code of future generations".[32]

4. SOCIAL AND ECONOMIC ASPECTS

The economic and social impacts of 4IR can already be noticed. Impacts related to work and employment have garnered increasing press attention due to the commotion they cause. Companies such as Uber, which created innovations that have shaken the people's transportation market, end up by being much criticized by competitors, who were affected by the changes they promote, as well as for their acting in the gray zone of the sector's regulations, which may foster disproportionate competition with those working by the rules of the sector.

The possibility of digital platforms, with their offer of products and services, to connect consumers and suppliers directly thus reducing or eliminating intermediaries, in addition to reducing transaction costs, has led to the creation of a database of users, which allowed for identifying consumptions and behavior patterns when purchasing those products and services. This information makes it possible to maximize the results of the operations performed by such digital platforms, aspect that also leads to ethical debates.

The gradual replacement of human labor by expert robots and algorithms should increase inequality in the labor market, and according to Schwab "the winners will be those who are able to participate fully in innovation-driven ecosystems by providing new ideas, business models, products and services, rather than those who can offer only low-skilled labour or ordinary capital".[33]

For decades banks have been replacing human labor by computerized systems such as ATMs, remote terminals in supermarkets and districts for withdraws and deposits, internet

[32] Ibid., p.26.
[33] Ibid., p.87.

banking, and more recently, mobile applications. Conducting business in an electronic environment has enabled the gradual elimination of paper money in the electronic - or online - payment system.

Governments are concerned with cryptocurrencies because they lack the need for intermediaries to confirm the currency's validity, making it very difficult to tax, especially with regards to the international market of intangible products, such as software, content, information, and other products digitally traded.

Schwab advises that governments must adapt to the fact that state power is now shared with non-state actors and institutional influence:

> It would take a book dedicated to this subject alone to explore all the multifaceted impacts of the fourth Industrial revolution on governments but the key point is this: Technology will increasingly enable citizens, providing a new way to voice their opinions coordinates of your efforts and possibly circumvent government supervision I see possibly because the opposite might just as well be true with new surveillance technology has given rise to all-too-powerful public authorities.[34]

4IR opens up a number of possibilities for rethinking the role of several of our major institutions, as well as of their way of acting. In this sense, Schwab has concerns over the ongoing social and economic transition, and considers that:

> First, I feel that the required levels of leadership and understanding of the changes underway, across all sectors, are low when contrasted with the need to rethink our economic, social and political systems […] Second, the world lacks a consistent, positive, and common narrative […] that is essential if we are to empower a diverse set of individuals and communities and avoid a popular backlash against the fundamental changes underway.[35]

From a human rights perspective, the 4IR might speed up desired achievements such as economic gender parity, as smart

[34] Ibid., p.67.
[35] Ibid., p.13.

machinery replaces manual labor, and skilled labor becomes more and more valued. From Sen's point of view, the introduction of technologies that allow people more possibilities of converting their *capabilities* into *functionings* expand their freedoms and consequently enhance human development, as he exemplifies:

> A person's "capability" refers to the alternative combinations of functionings that are feasible for her to achieve. Capability is thus a kind of freedom: the substantive freedom to achieve alternative functioning combinations (or, less formally put, the freedom to achieve various lifestyles). For example, an affluent person who fasts may have the same functioning achievement in terms of eating or nourishment as a destitute person who is forced to starve, but the first person does have a different "capability set" than the second (the first can choose to eat well and be well nourished in a way the second cannot).[36]

The technological possibilities arising from 4IR will allow the reduction of what Sen called informational monism[37], which means decision-making based on a single variable, limiting the predictability of accurate results and planning. Big data systems are going to be able to recognize correlations and patterns in a database too huge for human beings to analyze. This should contribute to all branches of science, but especially to human sciences, where correlations and patterns depend on many variables. The academic community has traditionally carried out high simplifications in order to achieve results with consistent correlations, which is what Sen criticizes when analyzing the "'*well-being as informational foundation' or WAIF".*[38]

Sen argues "against the identification of well-being with utility (in any of its forms: happiness, desire fulfillment, choice), and against treating sum ranking as trivial and equality as having no independent force. More positively, I have argued for seeing

[36] SEN, Amartya. *Development as Freedom*, p. 75.
[37] SEN, Amartya. *Well-being, agency and freedom: the Dewey lectures 1984.* The Journal of Philosophy, v. 82, n.4, pp. 169-221, abr. 1985, p.186.
[38] Ibid, p.185.

well-being in terms of functioning vectors and the capability to achieve them".[39]

These considerations are relevant for the remodeling of society to contemplate the innovations introduced by the 4IR, broadening the concept of human motivation and undertaking the modification of the institutions[40] so as to include new customs and regulations.

According to Schwab, "individuals, civil society groups, social movements and local communities"[41] should never be stripped of their relevance, and in this way the values and customs of a society must be taken into account, especially with regard to work.

This change is most likely just around the corner and it seems to us to have potential to cause profound social and economic transformations, as presented. Hence the importance of governments and society to devote special attention to this change process in order to minimize the social impacts and on the economic organization, through study and analysis, adapting the existing models to those required by the new reality.

5. ANTHROPOCENTRISM

"The last century of human existence has marked a very successful period for population and economic growth. […] Based on the human experience to date, no one seems to seriously doubt the ingenuity of humans to meet the growth challenges. […] Yet, from an Earth systems perspective, the human success story is not so positive."[42]

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[39] Ibid., p.202-203.

[40] NORTH, Douglass Cecil. *Institutions, institutional change and economic performance*. Cambridge University Press 1990.

[41] SCHWAB, op. cit., p.90.

[42] *Harnessing the Fourth Industrial Revolution for the Earth.* Available at: http://www3.weforum.org/docs/WEF_Harnessing_the_4IR_for_the_Earth.pdf Accessed in December, 2017.

The World Commission on the Environment presented in 1987 the Brundtland Report,[43] considered the first document to use the term 'sustainable development,' defining it as: '. . . sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations . . . it is one that meets the needs of the present without compromising the possibility of the future generations to meet their own needs,' and then related the concepts of development to sustainability.

More broadly, 'sustainable development' could be understood as 'the conditions needed to sustain a process or system that is developing over time.' In the anthropocentric view, the ideal environment would be that one which is suitable for the preservation of human species and its natural habitat, including everything needed for the preservation of human life in the course of time.

Amartya Sen argues for a new rationality of development, directed to serve the human needs, focused on the provision of opportunities and quality of life for the people, so that they can develop their capacities and not just aimed at increasing their income

> The analysis of development presented in this book treats the freedoms of individuals as the basic building blocks. Attention is thus paid particularly to the expansion of the "capabilities'' of persons to lead the kind of lives they value-and have reason to value. These capabilities can be enhanced by public policy, but also, on the other side, the direction of public policy can be influenced by the effective use of participatory capabilities by the public. The two-way relationship is central to the analysis presented here. […] The success of a society is to be evaluated, in this view, primarily by the substantive freedoms that the

[43] *RAM. Revista de Administração Mackenzie*; Available at: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1678-69712011000300002. Accessed in December, 2017.

> members of that society enjoy. […] Having greater freedom to do the things one has reason to value is (1) significant in itself for the person's overall freedom, and (2) important in fostering the person's opportunity to have valuable outcomes.[44]

In this sense, Martinez and Mamed[45] explain that Sen "argues that to be sustainable should not only refer to the concept of the Brundtland Report, [...] according to him, this view is somewhat "narrow" about humanity, for 'we are not only patients, whose needs require attention, but also agents, whose freedom to decide what our values are and how to seek them can extend far beyond the satisfaction of our needs.'" (See SEN and KLINGSBERG, 2010, p.65).[46] The free interpretation of Sen's vision of sustainable development could be that this is a procedure of generating capabilities that will enable future generations to acquire more capabilities.

The Brazilian constitution adopts this anthropocentric perspective when addressing the economic and financial order in its art. 170, VI, which determines that the defense of the environment must be observed, seeking a harmonious coexistence between the economy and the environment. Scherwitz argues that in this "anthropocentric view, the human person is the recipient of the constitutional norm, and man is the only one capable of protecting and preserving the environment. According to this view, the environmental good is directed towards the satisfaction of human needs, protecting other forms of life only 'indirectly." [47]

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[44] SEN, Amartya. *Development as Freedom*, p.18.

[45] MARTINEZ, Sérgio Rodrigo; MAMED, Danielle de Ouro. *Economia e Meio Ambiente: Contribuições de Amartya Sen à Ética do Desenvolvimento e Sustentabilidade*. Available at: http://www.publicadireito.com.br/artigos/?cod=126c2da128e5b044 Accessed in December, 2017, p.13.

[46] SEN, Amartya e KLIKSBERG, Bernard. *As pessoas em primeiro lugar:* a ética do desenvolvimento e os problemas do mundo globalizado. São Paulo: Companhia das Letras, 2010.

[47] SCHERWITZ, Débora Perilo. *As visões antropocêntrica, biocêntrica e ecocêntrica do direito dos animais no Direito Ambiental*. Available at:

This seems to be due to the fact that the human species is the only one presently capable of understanding and developing scientific knowledge in order to prevent the success of its evolution to hinder its own future. In this sense, the social sciences, including the legal sciences, can help understanding the constraints of needed attitudes and the creation of a convergence in human actions directed to achieve sustainable development.

In this sense, the emergence of a more elaborate artificial intelligence (AI) brings a new perspective to anthropocentric optics, since it is going to be the first non-human entity to understand and obey ethical and legal concepts, which until then only humans were capable of. A machine, even with advanced AI, follows principles of logic and values, which can collide head-on with those commonly used. The question of anthropocentrism versus ecocentrism can therefore be analyzed by an AI, and not by humans, and new perspectives may arise from this approaching scenario.

In this sense, a criticism of Amartya Sen's work might be that two decades ago, at the time he wrote some of his works, it might have not been possible to apply empirical science to decision-making as it is today, enabling to conduct non-invasive scientific research in the brain in order to analyze human's decision-making process. This information can help develop a more elaborate and comprehensive AI regarding human motivations, so that in a rational way and taking into account human emotional aspects, more effective decisions can be made. Anthropocentrism will be confronted with issues that today may not even be possible to enunciate.

6. FINAL CONSIDERATIONS

Schwab concludes his work with a focus on "the human

<http://revista.zumbidospalmares.edu.br/images/stories/pdf/edicao-3/visoes-biocentrica-ecocentrica.pdf>. Accessed in December, 2017.

being", and on humanity's "identity, morality, and ethics," and this leads to a reflection on the foreseeable, and on those yet unthinkable changes and innovations that lie ahead. Each innovation and advancement in technology implies impacts on the individual, which validates the need for human well-being and dignity.

The 4IR is already helping the world experience a better quality of life, at work, regarding the efficiency of energy resources, and it must be seen as an evolution, according to the understanding of Amartya Sen, in that it brings more opportunities to transform human capabilities into functionalities. It can provide a redesign for humanity of its economic and social modeling, in our pursuit of full realization as intelligent and creative beings.

Utopian quests such as the possibility of intelligent robots to produce alone all inputs for humans, so that the latter could direct their time for more pleasurable tasks only, once, in theory, there will be no scarcity of resources, and restrictions will be only regarding environmental and energy sustainability. This would have profound implications in the economic models based on competition and scarcity of resources.

Even philosophical issues, such as anthropocentrism, can be re-discussed with a nonhuman interlocutor, through a sophisticated AI that must someday be achieved.

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