
TECHNOLOGY, TECHNOLOGICAL INNOVATION AND HEALTH: A NECESSARY REFLECTION

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ABSTRACT: This article aims to systematize conceptual aspects regarding the terms technology and technological innovation, highlighting the implications for the health sector. The text was composed supported on selected authors from the fields of philosophy and sociology, and sought to contribute to a critical view of technoscience, debating on the beneficence and maleficence. The text addresses the development of a culture that sees technologies and technological innovations as the only source of satisfaction, and highlights the influence and implications that technological innovations have on the health sector, in which material technologies stand out. Furthermore, the text emphasizes on the need for a critical analysis of the phenomenon, using ethical criteria to avoid/minimize maleficence. The text concludes that the utilization of technologies should prioritize resolving the severe structural problems of humanity worldwide, thus contributing to making improvements in the health sector and to constructing a more dignified, fair, sympathetic, and sustainable society.

DESCRIPTORS: Science. Technology. Science, technology and society. Health sciences, technology and innovation management.

TECNOLOGIA, INOVAÇÃO TECNOLÓGICA E SAÚDE: UMA REFLEXÃO NECESSÁRIA

RESUMO: O artigo tem por objetivo sistematizar aspectos conceituais dos termos tecnologia e inovação tecnológica, destacando implicações para o setor saúde. O texto foi construído com suporte em autores selecionados, do campo da filosofia e da sociologia, buscando contribuir para uma visão crítica da tecnociência, incluindo suas beneficências e maleficências. O texto trata do desenvolvimento de uma cultura que vê nas tecnologias e inovações tecnológicas a única fonte de satisfação, e destaca a influência e implicações da inovação tecnológica no setor saúde, no qual se sobressaem as tecnologias do tipo material. Ressalta, ainda, a necessidade de uma análise crítica do fenômeno, utilizando critérios éticos para evitar/minimizar suas maleficências. Conclui que o uso das tecnologias deveria priorizar a solução dos graves problemas estruturais e globais da humanidade, contribuindo para melhorias no setor saúde e para a construção de uma sociedade mais digna, justa, solidária e sustentável.

DESCRIPTORES: Ciência. Tecnologia. Ciência, tecnologia e sociedade. Gestão de ciência, tecnologia e inovação em saúde.

TECNOLOGÍA, INNOVACIÓN TECNOLÓGICA Y SALUD: UNA REFLEXIÓN NECESARIA

RESUMEN: El artículo tiene como objetivo sistematizar los aspectos conceptuales de los términos tecnología e innovación tecnológica, destacando las implicaciones para el sector salud. El texto fue construido con el apoyo de autores seleccionados en el campo de la filosofía y la sociología, buscando contribuir a una visión crítica de la tecnociencia, incluyendo sus ventajas y desventajas. Aborda el desarrollo de una cultura que ve en las innovaciones tecnológicas y en la tecnología como la única fuente de satisfacción y resalta la influencia y las implicaciones de la innovación tecnológica en el sector salud, con especial énfasis en las tecnologías de tipo material. También destaca la necesidad de un análisis crítico del fenómeno con criterios éticos para evitar/reducir al mínimo sus maleficencias. Concluye que el uso de la tecnología debe dar prioridad a la solución de los problemas estructurales y globales de la humanidad contribuyendo para mejoras en el sector salud y la construcción de una sociedad más digna, justa, solidaria y sostenible.

DESCRIPTORES: Ciencia. Tecnología. Ciencia, tecnología y sociedad. Gestión de ciencia, tecnología e innovación em salud.

INTRODUCTION

Technology and technological innovation are current themes in the media and in the agendas of governments, companies, funding and research agencies, and several social organizations, with a strong influence in the health sector. There is a widespread idea that this is an era of unprecedented technological development, thus current society is deemed as the society of knowledge and technology.

It is now common for organizations, institutions and companies to establish permanent learning and the production of new knowledge and technologies as the core strategies for their survival and development. Families also consider it essential for their children to attend higher education and master knowledge and technology in order to guarantee a promising future.

Today, it is barely unimaginable to consider living without certain resources and instruments, such as electricity, automobiles, airplanes, computers, landline and cell phones, television, and the Internet. Just the same, it is apparently unthinkable to maintain and assure health without antibiotics, anesthetics, vaccines, prostheses, orthoses, bypasses, respirators, transplants, and radiodiagnosis examinations.

As early as 300 b.C., Plato already pondered that humans are the most vulnerable animals on the face of the earth, and they must turn to technical means in order to survive and achieve well being.¹ The permanent development of these means has permitted humans to multiply and the several historical periods to be shaped by the degree of knowledge development regarding nature and the discovery and construction of various equipment and technical resources.¹⁻²

It should be noted that the technical-scientific development of humanity has, unfortunately, found preponderant motivation in war and battles of domination between human beings. In the 20th century, two world wars triggered a race towards developing destruction technologies, but, ambivalently, they have served to improve people's lives.

This technological race has caused the degradation of nature and new inequalities, including the notion of three worlds – developed, developing and underdeveloped countries. However, this same movement has, dialectically, permitted a critical view of the current model to emerge. The paradigm of sustainability was formulated, which

has been increasingly gaining a central role, and become the reference in the 21st century, proposing to transcend the empire of economics, balancing the economic dimension with social justice, security and environmental recovery. This context mobilized the United Nations (UN), in 2000, to formulate eight millennium development goals to be achieved by 2015. They include: eradicating extreme poverty and hunger; reducing child mortality rates; combating HIV/AIDS, malaria and other diseases; ensuring environmental sustainability; and promoting gender equality and empowering women. This demonstrates the potential of using knowledge in the society.

Science and technology are important tools to improve health and treat diseases, as it is to construct a civil movement for peace and a dignified and decent life for all.

In this setting, taking into consideration the terms of technology and technological innovation and their importance for the health sector, the aim of this article is to systematize the conceptual aspects of the aforementioned terms, highlighting some implications for the health sector. The manuscript composition was supported on selected authors from the fields of philosophy and sociology, presenting some theoretical-conceptual considerations with a view to contribute in the debate in the health sector. Different from the literature review, systematization refers to the intellectual process of the logical articulation of concepts and elements contributed by different authors, so as to synthesize those considered pertinent to the rational appropriation of references and broadening the understanding about the theme in the health context. Therefore, the author selection is intentional, and the analysis involves a thorough reading and critique of the articles, highlighting conceptual elements and elaborating a reflexive text, conducted by the interpretation of the authors.

TECHNIQUE AND TECHNOLOGY

From a philosophical view, technique and technology can be considered inherent to human life in society. Historically, technology is identified as knowledge that derives from techniques that human beings use to survive the natural phenomena. Technology has produced both scientific theories for its explanation and support – pure science – as well as pure science derivatives that produce applicable knowledge – applied science, which is the origin of techniques to solve practi-

cal problems.³ The term technoscience has gained common usage as it is a clear expression of this close relationship between science and technology.

Technique, in its most general meaning, comprises a set of rules established to effectively guide a specific activity.¹ Therefore, it is extended to all fields of human activity. Techniques can be ranked into two large areas: the rational and the magic and religious. Rational techniques can be subdivided into:

- a) Symbolic: (cognitive or esthetic) "regarding science and fine arts".^{1:1106}
- b) Behavioral: "of one man in relation to another man", includes a broad field, "from erotic techniques to those of advertisement, economic to moral, legal to educational". These also comprise the "organizational techniques, that aim at finding conditions to obtain maximum performance with minimum effort in every domain of human activity".^{1:1106}
- c) Production: "concerns man's behavior towards nature and aims at the production of goods".^{1:1106}

There is a relationship between contemporary technology and the technique of past epochs and cultures, with experimental science being what differentiates them. Through the articulation of different contributions⁴, the highlight is on the understanding of technology as a "scientifically-based technique". Technique and technology consist of the activity of producing something artificial ("art-fact"). It involves the planning, rules, instructions, search for an efficient product (as cost-effective as possible) and can be something material, a good, or a service.⁴

Technology can be defined as the field of knowledge referring to designing artifacts and planning their implementation, operation, adjustment, maintenance and monitoring, under the light of scientific knowledge. In summary, it is understood as the scientific study of the artificial.⁴ It is also defined as the "typically modern way of man interacting with the world, a 'paradigm' or 'pattern' characteristic and limiting of existence, intrinsic to everyday life,".^{4:499} Technology is identified as a basic phenomenon, evidenced through the existence of devices that provide products, that is, goods and services. Devices that alleviate efforts and solve difficulties.⁴ "Most technological innovations only exist thanks to scientific advancement and its application to practical ends, but science,

per se, cannot define the path to achieve scientific advancement, nor can it explain the causes for technology becoming a lifestyle".^{4:501}

"The device world is one of mere means, with no ultimate ends, which consists of a novelty in human history",^{4:502} and this allows for understanding the difference between traditional technique and technology. In technique, "every mean-end relationship was part of a context (social, cultural, ecological) while in technology the mean-end relationship is universal, regardless of concrete contexts".^{4:502}

Many people understand technology as machines, equipment and devices. For others, technology and technique are synonymous. Yet others see technology as a tool. Technology is understood as a process, comprising certain knowledge built for the generation and utilization of products and for organizing human relationships.⁵⁻⁶

Technology can be unfolded into products/material "things" (such as products to meet specific needs) and in non-material "things" (work processes, certain knowledge specifically developed for product generation and also for organizing human actions in the production processes including work relationship technologies).⁷⁻⁹ Technology is a term that comprises both material and non-material technologies.¹⁰

From the sociological approach of the term, technology "involves all forms of production technique",^{11:357} including hand and intellectual labor and is not synonymous to machine, as conceived in the general sense. In fact, technology also addresses the physical organization of production, the ways how machines are organized in the work sites and how the work is divided and organized. Production techniques and organizations are social products, consequences of human decisions, hence technology can be analyzed as an outcome of social processes.¹¹

Recently, in the debate on technology, the concept of "Social technology" emerged, which originated in India, in the works of Mahatma Gandhi (1869-1948) in the first half of the 20th century.¹² This concept values local techniques while implementing their amelioration by adapting modern technology to the environment and the real conditions of the location.

For Gandhi, the challenge consisted in that "the production should be by masses and not mass production".^{12:13} Therefore, besides the pacifist ideals and practices that rendered him worldwide

fame and acknowledgement, Gandhi defended a view of self-generated development, empowering communities and social inclusion.¹² This movement produced the idea of Social technology.

In 2004, in Brazil, under the leadership of Fundação Banco do Brasil, the Social Technologies Network (Rede de Tecnologias Sociais - RTS) was created, which aims at "mobilizing society around the Social Technology theme, and engage in discussion on the theme as an instrument for social inclusion and improving quality of life",^{12:15} contributing with the development of the country. RTS inspires and supports community projects, particularly involving poor populations and from small cities, in association with the strategy of local development, and, in 2008, the Financiadora de Estudos e Projetos (FINEP), an organization of the Brazilian federal government devoted to funding science and technology in the country, created a project for the Social Technology category.

According to the actors involved in the RTS, Social Technology "comprises a replicable technique or methodology, developed through interaction with the community, and promoting an effective solution of social transformation".^{12:12}

TECHNOLOGICAL INNOVATION

Innovation involves more than merely making changes to the current technology. "It involves connections, interactions and influence between and from many various degrees - including company-company, company-research center, company-government relationships. Effective innovations depend on all connections being effectively established and operational".^{13:sp.}

Likewise, authors¹⁴ state that innovation is not limited to manufactured goods or industrial products. Innovations exist in services and in the public and private sector, e.g. Internet-based businesses, which have changed the way of selling products by using the technological innovation introduced by the Internet. These authors register two forms of innovation: radical and incremental. The former is understood as the development and implementation of an entirely new product, process or form of organizing the production. This type of innovation can characterize a structural rupture with the previous technological pattern, originating new industries, sectors and markets, while reducing costs and increasing the quality in existing products.

Incremental innovations refer to any type of improvement that is made to a product, process or organization of the production within a company, without necessarily changing the structure.¹⁴ There are uncountable examples of incremental innovations, many perceived by consumers, generating improvements in technical efficiency, productivity, quality, reducing costs, and making changes that allow for broadening the application of a product or process. The optimization of a production process, product design, or the reduction of material and component use in the production process are considered incremental innovations.¹⁵

The Brazilian Law of Innovation defines innovation as "the introduction of novelties or improvements in the production or social environment resulting in new products, processes or services".¹⁶

In the 1980s, with the production restructuring process ongoing at the time, the expressions "new technologies", "high technology or high-tech", state-of-the-art technology, and technological innovation were highlighted, generating a debate on what is understood by technological innovation. The discussion was on the current common sense, which associates "technology" with new machines and equipment made available in the market and production. However, technological innovation in the process of production restructuring was never associated only to new machines, despite their significant role in transforming the production process and in the changes made to the factory floor. Technological innovation "involves a socio-technical process" that can be understood from a dynamic perspective, as any technology is determined by a "complex number of inter-relations- at the social level as well as in companies".^{17:6} New technologies comprise machines, equipment, the various devices, the companies' working organization model (including innovation in management and work relationships) and in a social-historical context. It involves the level of the company, industry, or institution in the service sector, but also the relationship with the macro-social level and the State policies that are effective in the different historical societies.

In the production restructuring process, the highlighted technological innovations were micro-electronics and its products, robotics, automation, new materials, the changes in the work organization, breaking with the traditional Taylorism and Fordism models, changes in the structure of companies and in inter-companies relationships. Innovations caused extensive changes in the work

activities and in the socio-professional categories. Competencies were exchanged, creating new demands, new compatibility issues, technical translations and law adjustments, and institutional and economical problems. These transformations, therefore, imply the need for knowledge regarding production functioning and technique, work regulations, and the formulation of norms, all of which require adaptations, inventiveness, new studies, and more debates.¹⁸⁻¹⁹

INNOVATION TECHNOLOGY AND IMPLICATIONS FOR THE HEALTH SECTOR

Health is a good or value that holds the top place in the priority pyramid. A common popular saying is that "with health, everything else in life is solvable". Therefore, in current society, which faces an accelerated scientific and technological (technoscience) development and a true frenzy for novelties (innovation), one would expect the health sector to be strongly affected by this process particularly because it deals with biological bodies marked by finitude, and because human beings relate between each other and with nature. A dream or desire of prolonging life to a maximum is nourished, of curing diseases and incapacities, of esthetical procedures determined mostly by culture than by functional feasibilities. On the other hand, the contemporary and globalized world also, and always, poses new threats, risks and signs of vulnerability, such as pandemics.

The investments in technoscientific advancements and discoveries in the health area are overwhelming and on the rise. New drugs, vaccines, prostheses, orthoses, exoskeletons, machines and equipment for diagnosis and interventions, surgical robots, instant information and communication, a single national electronic record unified for international accessibility, implants, transplants, as well as the artificial production of human cells, are examples of the fields of investment and work of thousands of technicians and scientists.

Healthcare technologies comprise drugs, equipment, technical procedures, organizational, educational and support systems, and healthcare programs and protocols through which care is provided to the population. Health technologies can be studied from a historical perspective, identifying the knowledge, explanation and techniques utilized in the various historical times, from early human history until today.

All forms of healthcare interventions or technologies have always been associated with an explanation about the diseases, their causes and effects. Therefore, disease was associated to supernatural causes, system and mood unbalances of the body and the influences from the weather conditions and the atmosphere, with emphasis on nature's capacity of curing, associated with eating habits⁹. Unquestionably, today an idea predominates that disease is the dysfunction of a part, organ or system of the body, with single or multiple causes, which focused the look on the individual (on the affected part of the individual's body), the diagnosis, and the treatment of the "illness", using the hospital as a place for privileged services. Hospitals and clinics are the setting for major advancements of common modern science, where increasingly sophisticated techniques and technologies are used both for diagnosing and treating diseases.

Today, there is also a clear influence from technological innovations, whether in terms of equipment made available or new healthcare techniques, in different fields of expertise in the health sector. Therefore, knowledge is affected in areas such as clinical, epidemiological, mental health, as in the cultural dimension of the health-disease process and the organization and work management models.

The health sector, strongly affected by the positivist science paradigm, has been sensitive to the incorporation of material technologies for the purposes of treatment, diagnosis and life support, using informatics knowledge and products, new equipment and materials³, though being less aggressive in using non-material innovations, particularly innovations in the field of work organization and relationships.

Along in its process, industrialization has generated the modernization, technological advancement and valorization of science. In the health area, these advancements are expressed by the introduction of informatics and the advent of modern and sophisticated devices, which add benefits and speed to the diagnosis and treatment of diseases. This man-made, modern technology has made a large contribution to solving problems once considered insoluble, and, thus, can now be reverted into better life and health conditions for people.¹⁰

Studies in specific scenarios, such as Intensive Care Units and professional nursing care, show that these professionals are constantly chal-

lenged by complex clinical situations that demand careful attention and control and, for this same reason, a consistent, accurate and safe integration of technological innovations to the system of bedside care. It is obvious that these innovations must be assessed in terms of their impact on professional practice and patient safety.²⁰

One study made a metaphorical comparison between the historical phases of technology construction in nursing and the cyclic phases of the moon, considering the current time as a 'full moon, marked by the presence of records, patents in the National Institute of Industrial Propriety (*Instituto Nacional de Propriedade Industrial* - INPI), and the development of research proposals involving the production of nursing technologies, supported by funding agencies, in addition to theses and publications with growing visibility. However, the author questions if the use of information technology is resulting in more time to generate new sensitivities in nursing care, promoting the explicitation of the art underlying the practice.²¹

Brazil is still highly dependent on other countries in the health technology arena. The identification of this issue mobilized the recent formulation and implementation of a National Public Strategy for Science, Technology and Health Innovation.

IN CONCLUSION

To close this reflection, some philosophical and sociological aspects should be highlighted with the purpose of contributing with a critical view on the theme of technoscience. To do this, it is pertinent to associate the view of technologies regarding their beneficence and maleficence, recalling what was addressed in the introduction section.

In the early 21st century, there was an unprecedented supremacy of economy and technology in human history. Economy surpassed politics, religion and even law. More than a means, technology has become, in itself, an end. There is an empowerment of technology, human being lose control over technique and become highly dependent on technology.

The culture that has been developed associates satisfaction, security, dignity and quality of life with the access to modern technology and everyday 'novelties (innovations). The need to consume what is 'new' involves a vast range of goods, from drugs, to automobiles, to the latest

television model. However, this goes without questioning the conditions of accessibility or the brutal inequality regarding the usufruct of the socially produced goods.

Technological developments promote many benefits and this fact appears to be a consensus. Not only did technical capacity make humans the dominant species on the planet, but the stage of the technique/technology now drives human existence in its various moments in time, including in the dimension of subjectivity. With capitalism, technique/technology shifts from its value of use and becomes merchandise, gains identity, dissociates from its immediate end and from any specific or determined sociocultural context.

Man is, at the same time, natural and extra natural. Man's true being is extra natural and life is a form of project or program of existence that must be permanently executed². Humans are beings whose existence consists not in what already is, but on is yet to be, different from others beings or things. Man is an assumption of being 'this' or 'that'. To exist means having to realize the assumption that we are one specific circumstance, and that we are not given the chance to choose beforehand the world or circumstances in which we must live. In the past, men divided life into two areas, leisure (*otium*), which means engaging in occupations of being the human aspect of man, interpreted as demand, organization, social skills, sciences and arts, and business (negotiations - *nec-otium*), which referred to the effort that humans had to make in order to meet the bare necessities and which made leisure possible.²

In the field of philosophy, thinkers recall the transformation of the desire for a less burdensome and richer life into a culture that is exclusively aimed at an increasing consumption of technological products. Because of this distortion of meaning, within the 'technology paradigm', life now has no direction but, yet, is imposing and frivolous.⁴

Has the exacerbation of the *nec-otium* dimension, with technique/technology as the flagship, imposed on today's human beings the sensation of not knowing what to be, or a lack of argumentation for one's own life? This question should be drawn upon when the purpose is to avoid extremist views, both apologetic as well as fatalists.

There is reasonable consensus that technologies do not always result in benefits and that there is no such thing as neutral technology. Considerable complex maleficence is involved, such as the use of technology for war, human destruction and

the degradation of nature. We have also seen that the technology empire causes aspects regarding the existential voids and new questionings about the meaning of human life. There is a feeling that life is being 'outsourced' and a relative loss of what could be referred to as the human aspect of man.² The radical attitude towards instrumental rationality (technology) weakens or eradicates the ends, while, on the other hand, it triggers a needs for a reenchantment of the world, of returning to the meaning of sacred, of exploring the potential of subjectivity.

In health, one of the main concerns is with the collateral effects of drugs and the medicalization process of several dimensions of life to a level much beyond the acceptable limits of control over the disease. Technological incorporation implies new risks in its application, with unforeseen effects or effects that have not been thoroughly assessed, increasing the chances of iatrogenesis. Some ethical problems exist in applying technologies to prolong life, such as the appearance of highly resistant bacteria due to an indiscriminate use of antibiotics, or the development of research with human beings, among many others. As never before, it is relevant to consider the aspect of injustice, due to the unequal access to technologies and innovations, increasing the already existing inequalities due to social determinants in the health-disease processes. However, economical differences will never culminate in social security differences of vulnerable individuals to the procedures of scientific research, as supposed in the flexibilization of international norms, which aim at justifying the double standard.

It is necessary to develop, strengthen, apply and demand that technology and technological innovations be permanently subjected to ethical criteria in order to avoid and/or minimize any maleficence they may cause. It is urgent to further the reflection in the field of bioethics and improve the application of ethics codes by health professionals and others from specific fields, such as ethics in business and environmental ethics. Essentially, the incorporation of technology should respond purposes based on improved healthcare for all; care that is more resolute and more accountable.

Finally, science and technological innovations must be conducted in a way that the priority is to solve the serious structural problems of humanity worldwide, in an effective commitment towards making a significant contribution towards a more dignified, fair, sympathetic, and sustainable society.

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