Technology and Its Social Implications: Myths and Realities in the Interpretation of the Concept

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Abstract—The concept of technology as well as itself has evolved continuously over time, such that, nowadays, this concept is still marked by myths and realities. Even the concept of science is frequently misunderstood as technology. In this way, this paper presents different forms of interpretation of the concept of technology in the course of history, as well as the social and cultural aspects associated with it, through an analysis made by means of insights from sociological studies of science and technology and its multiple relations with society. Through the analysis of contents, the paper presents a classification of how technology is interpreted in the social sphere and search channel efforts to show how a broader understanding can contribute to better interpretations of how scientific and technological development influences the environment in which we operate. The text also presents a particular point of view for the interpretation of the concept from the analysis throughout the whole work.

Keywords—Technology, conceptions of technology, technological myths, definition of technology.

I. INTRODUCTION

BECAUSE there is too much confusion when trying to discern what comes to be science and technology, a brief review of history is needed to enrich our understanding of these two concepts. Even knowing that nowadays it is impossible to separate both, it is expected that, with a brief review of some historical moments, it can be shown that both science and technology are two major branches of human knowledge and that; furthermore, there are some important aspects that fit each of them inside of their respective particularities. To do so, it is necessary to emphasize that the initial intention is to show how the various facets constructed in the course of history are constituted of different interpretations for the term "technology". However, the intention is not to exhaust all content, since the history of

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technology is closely connected to the history of mankind, and so it is quite complex, with numerous ramifications. A more comprehensive and detailed study would be excessively long and tiring and would run away from the purpose of this work. Another reason for conducting a historical approach is the fact that the many divergent conceptions that we find today, about what comes to be technology, may be the result of simple ignorance of the socio-cultural evolution of man [1].

A. Objective

The present study aims to analyze the different ways of interpretation of technology, in order to contribute to future work that seeks the social relationships of scientific and technological implications in society.

To do so, this paper will:

i.   present a historical survey of the evolution of technology,
ii. show how technology is interpreted in the academic, social or popular level;
iii. present particular points of view on how to interpret sociological studies the concept of technology;
iv. classify the different interpretations of the concept of technology from a qualitative content analysis approach;
v.   use the results obtained, in the attempt to bring a specific contribution to the studies that seek to relate the implications of science and technology in the social context.

II. THE ORIGIN OF THE KEY TERM TECHNOLOGY

The history of mankind began with the history of techniques, with the use of objects that have been transformed into different instruments, evolving in complexity along with the construction process of human societies [2]–[5].

Through a study of the historical evolution of the techniques developed by man, placed within the socio-cultural contexts of each age, one can better understand the active participation of the man and technology in the development and progress of society, thus enriching the concept that we have regarding the term technology [5]. In this way, it becomes notable knowledge that the technique and technology words have a common origin in the Greek word *techné*, which consisted much more in changing the world in a practical way than understand it. Initially it was a process where scientific contemplation almost not exerted influences [6]. In the technique, the main question is how to transform, how to modify. The original meaning of the term *techné* has its origin from one of the variants of a verb that means to manufacture, produce, build, give birth, the verb *teuchô* or *tictein*, which meaning came from Homer; and *teuchos* means tool,

instrument [7], [8]. The word technology comes from a junction of the term *tecno*, from the Greek *techné*, which means "know how to do it", and logia, from the Greek *logus*, reason. Therefore, technology means the reason of know-how [45] or, in another words, the study of technique, the study of the activity in modifying, to transform [5], [9].

At different times, the history of technology is recorded along with the history of the techniques, with the history of work and production from the human being. So, it is important to attempt to present a landmark to show the fine line that separates technique from technology. It should be made clear that the history of techniques and technologies can not only be understood as a successive description of the artifacts discovered by builders and engineers but, also, the sequence of the major social circumstances sometimes favored, sometimes undermined the human effort in developing their artifacts and change the world around them, thus guaranteeing them better living conditions.

III. The First Steps

Primitive humans were already using objects found in nature as instruments that guarantee them an extension of the body; however they showed no intention to modify or improve them. The technological potential of the man was present, yet it still lacked the spark of the intellect so that significant changes began to be carried out.

Only with the Homo erectus arose the carved stone and the beginning of the intention to use an object as a tool and also transform it to better take advantage of it [10]. The Paleolithic period, as it is called the first phase of the Stone Age, was characterized generally by the formation of social groups where the man was essentially collector and hunter [11].

About two million years ago, the *Australopithecus africanus*, after getting off the trees, faced with two specific problems that need to be solved immediately: the first was part of a vital need; a matter of survival, the second problem was essentially a social order [12], [13]. His vital need was strictly related to his eating habits, based on meat, that needed to be torn apart for later ingestion, and its social need was based on the defense of territory.

Only through the use of his primitive intellectual capacity is that man was able to establish fundamental relationships that would help to modify the environment, employing a technique previously nonexistent. The man appeared only at the exact moment that the thought teamed up with processing capacity. The use of bones of other animals as instruments initiated the modification of the environment, in addition to starting a process of modification of the hominids themselves who used them. Man still not modified the nature building a new artifact, but, as important as this, was the discovery of new functions for bones. Modifying the role of these objects and redefining them, the man forever changed the social relations established thereafter. According to studies, is to believe that bones have been used in its raw state from the earliest times, although its systematic improvement has occurred at a later time [14].

The technique appeared, therefore, along with the man thanks to the manufacture of the first instruments and the manifestation of human intellect in the form of wisdom. According to Anthropology there is no man without instruments, even the more rudimentary. They are entities that complement each other, so that it one is eliminated, the other also disappears completely [5].

It is with the man that the techniques begin their development, because he becomes a prodigious inventor of new mechanisms, too much different from what is conceived by nature. What distinguishes man from animals is that the first has found that not only your body is an instrument; instead, the man learns that it is capable of creating new extensions so that its members can act in the environment in a more efficient way.

The same process would have a similar nature when those "nearly" men and women designed and produced the first stone tool. Accidentally, they may have realized that the two stones, clashing, could be chipped yielding a new instrument that would replace the bone in its investees hunting. The strength of this invention reached such magnitude and proportion, so that for a million years it did not change significantly. This fabrication of the first instruments of chipped stone already corresponded to a know-how: a technology, that developed by our ancestors, made a real "industry Blades" arise, improved as time went by [15], [16].

We may call these early artifacts of technological instruments, because they represent the community organization to meet a particular purpose: survival could be guaranteed through the interference of the hominid in the environment hunting and defending their territory against the attacks of the beasts. One of the main factors that mark the onset of our primitive ancestors, according to researchers, is the use of tools. However, this assumption is incomplete, because it is not only the use of tools, but the entire development process, including the invention, the design and production of the same, that consists in the real achievement. The strategies and other forms of organization developed by our prehistoric ancestors confirm the technological potential of mankind [16].

It was not only the design of weapons and tools of chipped stone that marked the rise of techniques in our remote ancestors. The vestiges of housing and prepared and excavated soils, found in archaeological studies, show signs of fire. Remains of meals, bone charcoal, ashes of primitive homes are proof that man learned to master fire since the beginning of its rise. The spark that emerged through the strokes in stones may have been used as the primary source of fire. Or even the friction between materials such as wood, result of the first technical experiences, may have produced the same effect. With the fire, the man was able to cook food for the first time, as well as ensure another form of shelter in relation to natural forces. His nights became warmed since then, and wild animals could be driven out of the old shelters of our ancestors [15].

While fire and tools manually developed gave the man the key to material transformations, the word gave him the inner

domain of his actions and his thoughts. Thus, the development of language should also be seen as one of the earliest arising techniques, or intellectual technology according to [17].

The word should have been developed primarily for the transmission of orders, evolving naturally to the analysis of work in space, later to describe facts in time, establishing itself as a primitive collective memory [18].

With these three major conceptions – chipped stone, fire and language – the human species gave a very big jump towards the great inventions and discoveries that would eventually form part of the history of society as we know it nowadays [15], [16].

However, many historical transformations were advancing, at first, very slowly. The earliest stone tools are considered the more ancient artifacts that we have news, and are at the beginning of a series of products developed through the efforts and creative and intellectual capacity of the human being, involving learning, knowledge, skills and abilities that do not require prior existence of organized scientific knowledge. The technology existed long before scientific knowledge, long before men, based on theories, could begin the process of transformation and control of nature. In addition to being older than the science, technology, unaided by science, was able to, several times, create complex structures and instruments. Our ancestors creators succeeded because experience had taught them that certain materials and techniques produced acceptable results, while others do not [15].

Nowadays, technological production is inherent to man. This one became a thinking creature because of its ability to build and, in turn, the product made the man a thinking being. By consequence, in the last million years, mankind has introduced significant changes in instruments, products of the evolution of the hand and enhancement of the brain. The subject became a biological creature and culturally more refined and, due to this, the products of his talent were becoming more and more functional and earning quality, from which we have conclusive evidences that allow reaffirm the technological capacity of prehistoric men and women.

Historical knowledge of the development of techniques and technologies produced by man since the beginning of time contributes significantly to ensure we understand the creative process of humanity and, essentially, better understand the technology as a source of own knowledge, in continuous transmutation and with new knowledge being added every day, each time faster and dynamically.

Finally, it is important to emphasize that, often, when talking about technology, we immediately think in more sophisticated products that are earning the market right now. However, technology is not only that. We must remember that our technological history began with the first man when he discovered that it was possible to modify the nature to improve the living conditions of their group. When man discovered that he could modify the bone, establishing a new use for it, gave the initial step towards the conquest of the atom and space [15].

IV. METHODOLOGY

All the developed literature review passed by a systematic process of analysis and classification for the construction of the research instrument. The values obtained were the result of a process of content analysis.

Starting at articles, books, national and international documents, this study aimed to collect information provided in each text, classifying all existing conceptions about technology. The gathering of information that could classify the various sectors of society was also prioritized.

By choosing a content analysis of the theoretical material, it was taken into consideration that this would be the best way to understand the message conveyed by the authors, because this approach, according to [19], allows us to go beyond the appearances of the text, allowing that, in addition to raising the concepts analyzed and / or presented by the authors, it also be possible to get hidden conceptions present in the studied texts. Thus, the content analysis enriched the exploratory attempt, increasing the propensity to discoveries.

A. Organization Analysis

The organization of the analysis was done based on three distinct poles and was supported by the theory of [19]:

i.   Pre-analysis: organization of the collected material and an initial reading to provide a categorization of the obtained data, i.e., the first activity is to establish a contact with the collected data, allowing commenting the first impressions. Gradually, the analysis becomes more precise, in the light of the emerging hypotheses and projection of the adapted theories about the material.

ii. The exploration of the material (or analytical description): if the different operations of the pre-analysis were conveniently completed, the phase of the analysis itself is nothing more than the systemic administration of the decisions taken. Thus, this phase has already started in the previous one and must contain a more careful reading to start the encoding process, classification, discount or enumeration according to rules previously formulated.

iii. Treatment of the results and interpretation: it also starts in parallel to the previous, but must combine reflection, intuition and grounding in the empirical data, as a way to establish relationships about the studied object. In this way, we seek results from raw data, in order to become meaningful and valid.

B. Codification

To treat the material means to encode it. When the intention is to analyze a data set, it must be known how to fit them within a theoretical frame of reference. Therefore, the encoding used corresponded to a transformation – performed according to precise rules – from the raw data of the texts by clipping (choice of units), aggregation (choice of the categories) and enumeration (choice of counting rules) allowing to reach a representation of the content, or its expression, susceptible to clarify about the characteristics of the collected data [19]. Thus, the chosen texts were analyzed and coded from what the Anglo-Saxons call fishing

expeditions, which means exploratory analyzes to see what is there. In this case, the content analysis starts the job from the simple and crude survey of the data implicitly or explicitly contained in the studied texts.

C. Categorization and Results

The categorization is a structuralize process and involves two stages:

i.   the inventory: isolate the elements;
ii.   the classification: split the elements and, therefore, seek or impose a certain organization to the messages [19].

V. DATA ANALYSIS

From the methodology presented previously, the literature was consulted and data were organized according to [19]. The presentation of results and the categorization of the material are presented in sequence.

Like this, it is not difficult to recognize the importance that technology has today, in all spheres of our society. And, due to this, it is surprising that the study of the technological phenomenon has not raised the deserved academic interest over many years. Perhaps this is due to the different ways in which technology has been interpreted around the world, generating a confusing and obscure atmosphere around his conceptualization.

The diversity of ways in which the technology was and is developed and studied over the years shows that this structures itself in a proper field of knowledge concerning other aspects such as cultural, of the society where it develops and organizational [20]. The technology requires a deep knowledge about why and how its goals are achieved, constituting a set of human activities associated with a system of symbols, instruments e machines, and thus, aims the development of works and the manufacture of products, according to theories, methods and processes of modern science.

However, before diving into this discussion, it is important to conduct a critical analysis of some anachronistic and distinct conceptions of technology. These are not well articulated theories about the nature of technology, but popular images ingrained in the public in general. According to what is presented in [21], it is considered that these pictures, with their pre-assumption of autonomy and neutrality of S&T, has favored an image of technological evolution that keeps the wrong dilemma of the internal efficiency versus external interference, giving place to a certain conception of technology assessment that supports, in turn, a technocratic model of political order [21].

A. Intellectualist Conception of Technology

This conception includes technology as a practical knowledge derived directly and solely from the development of scientific theoretical knowledge through cumulative and progressive processes where increasingly broad theories replace the previous.

From this perspective, technology is a practical knowledge (at least since the late nineteenth century) derived directly from the science. The theories, sets of statements that try to explain, using causal arguments, the natural world, are objectives, rationales' and free from any external value apart from science. The development of scientific knowledge is conceived as a gradual and accumulative process, articulated through increasingly broad and accurate theories that are replacing the past sciences. The theories may, in some cases be, applied to obtain technologies; however, pure science has no relationship, at least in principle, with technology. All the theories precede the technologies, so that there is no technology without theory, but the reverse may happen: it is conceivable the existence of theories without technologies [21].

This, it is a hierarchical model [3], [12], [21]–[24], where many tend to associate technology as a mere subordinate of the sciences, being several times conceived as a simple application of scientific knowledge through the practical activity, with particular reference to the various procedures for the transformation of raw materials into products for use or consumption, reaching even defining it as the science of applying knowledge to practical purposes. Since the "explain" and "theorizing" are, even today, wrapped in a more coherent and structural atmosphere, Science has always had the status quo of "first class" field of knowledge, while technology was restricted to a "niche" of application and consequence of that [12].

B. Utilitarian Conception of Technology

This conception considers technology as being a synonym of technique. That is, the process involved in its preparation is not related with technology, only its purpose and use are points taken into consideration. [23].

Osorio [24] emphasizes that technology must be accurate and efficient (more or less like the Greek technique) and should not be concerned to observe theories, because if this were done, would be too poor for not presenting robust assumptions that sustain it. Thus, the technological results can be considered much more satisfactory when the efficiency increases.

Note that, according to an elementary feeling, it may be considered that technique is a set of efficient knowledge (skills and competencies) that man has developed over time to improve their practical way of living. However, thanks to the development of Western civilization came the time when the purely practical dimension felt the need to know the proper reasons. Thus, the search for explanations joined practice with logic, starting historically what we know as technology [25]. Even having similar backgrounds, both represent different concepts. However, they are understood as synonyms by the common sense, creating great confusion [15].

C. Conception of Technology as a Synonym of Science

Understands technology as Natural Science and Mathematics: with the same logic and forms of production and design [1], [12], [13], [26]. This is another very common association [1], [13], [22], [23], [27].

D. Instrumentalist Conception (Artifact) of Technology

Is the point of view more ingrained in our daily life and predominant in commonsense. It is the myth of the machine that reigns as sovereign form of opinion in our society [8], [22]–[24], [28]. Understands technology as merely tools or artifacts built for a variety of tasks. Sustain this picture means to say that there is no essential difference between the stone tools of ancient age and the modern technological artifacts [21].

This point of view generates great confusion by believing that the technological production consists of only the equipment generated from the same. This can make you believe that simply knowing how connect the equipment, know the acronyms that manufacturers create and use it, to be an expert in technology.

E. Conception of Technological Neutrality

States that technology is neither good nor bad. Its use is that it may be inappropriate. It would be like saying that the technology is free of any kind of particular interest both in its conception and development as the final results [24], [29], [30].

The idea of neutrality of scientific knowledge has its origin in the own conditions of its emergence as such, since the fifteenth century, as an objection to religious knowledge. For many, science and religion would share the same purpose: the truth. The difference would be that science admits only the authority of reason and experience. Age of Enlightenment was the first major movement that questioned the religious thinking and adopting a neutrality conception. Positivism, from the late eighteenth century, based on the thought of Bacon and Descartes helped to enforce it.

If considered as independent of any political or social system, the technology could be transferred from one country to another without any difficulty. This reductionist vision of technology prevents its critical analysis and ignores the social, economic and political intentions and interests of those who idealize, finance and control it. We know that technology is not neutral; an apparently innocuous device can be loaded with political interests [31]. Technology, far from being neutral, reflects the plans, purposes and values of our society.

Scientists, engineers and politicians usually defend the neutrality of science and hide themselves behind their authority to justify certain actions. Pure science, with its criteria of rationality and objectivity, is out of the influences of a value judgment, cultural losses or political interests, and do not relates, under any circumstance, to the possible uses which someone may make of it [21].

F. Conception of the Technological Determinism

Considers technology as being autonomous, self-evolutionary, following, in natural way, its own inertia and logic of evolution, deprived of the control of human beings. One of the areas where this idea is more influenced is science fiction. The image of the autonomous and beyond human control technology, self developed according its own logic, is associated to a deterministic conception of the relationship between technology and society, the technological progress follows a fixed path, and even if political, economic or social factors may exercise some influence, it cannot change the powerful domain that technology imposes on social transformations [24], [29], [30], [32].

According to [21] there is no denying that technology determines the type of society we live in and can influence the configuration of the modern way of life. Some technologies are better suited to a way of life than others, but that does not mean that all changes processed in our ways of life are inevitably predetermined the technological development. To say this is to decontextualize technology and ignore the social interest networks crucial for choosing one or another technology. Undoubtedly, the technological development will have a social impact, which will may change our patterns of life and coexistence coming to generate other completely different, but this development is supported by a series of external interests and values and does not act on its own logic.

G. Conception of Universality of Technology

Understands technology as something universal; the same product, service or artifact could appear anywhere and, therefore, be useful in any context. Thus, the universal character of scientific laws leads to a conception that technology does not require a social context, nor should be considered the evaluative character, considering that technology, as a result of scientific development, is neutral [18].

So, we can say that this conception shows that the results obtained from the technological development are valid independently of the cultural, political, social or economic context of place where it was generated. This gives the idea that even technology has not changed its use if inserted in another context [30].

H. Technological Optimism and Pessimism

This conception considers science and technology as entities seeking the progress and welfare of mankind. Man will be able to ensure the survival of the species and the planet, taking advantage of natural resources, since it is done in a sustainable way. There are present two small phrases that have generated several controversies in our society.

The techno-catastrophist and techno-optimists attitudes can be interpreted in a dual form. For the techno-catastrophist, the threat that an autonomous technology presents presupposes a tragic apocalyptic end to humans that at the end, will be completely subdued and dominated. The only alternative to a technology out of control is to destroy it, so that society once again becomes more humanized. For the techno-optimists, the "causal powers" of technology have a very different meaning because they can bring all the possible improvements that the environment and men need for their wellbeing and survival [21].

Here are some brief comments about these two considerations.

Technological Pessimism

According to the German philosopher Martin Heidegger technique is a typically modern phenomenon, responsible for a technological progress that is the cause of all the ills of mankind, by contributing to extend the social inequalities, thanks to discrepant accumulation of wealth and power. That who defends this point of view says that the tendency is always to get worse [33], [34], [37].

Even knowing that Heidegger referred to the technique, we can transpose this viewpoint to technology. And, using this vision as North, many people today believe, or defend the thesis, that technological progress is and will be responsible for the extinction of life on Earth and / or destruction of the planet [33]–[37].

Technological Optimism

This conception faces technology as a way to ensure the progress and welfare of mankind. Francis Bacon stated that with science we could initiate the *Regnum hominis* (kingdom of man), which consisted in understands the nature and applies this knowledge to their domination with the purpose of improvement of human life. Times have changed and this point of view has been adapted. With the rise of the concept of sustainability, today many claim that there are mechanisms able to ensure the development solving environmental, social and material problems, without degrading the environment and without threatening the survival of the planet [25], [38]–[44].

I. Socio-System: A New Concept of Technology

This conception understands technology in an alternative way. A new concept allows relating the social demands and the technological production with politics and economy. The development of a technology is an open process whose course is determined by the interaction of the different relevant social groups (given the interpretative limitations imposed by the characteristics of the artifact involved and its cultural and economic form of selection). At each stage of the development of a technological artifact, especially when it consolidates as a product, there is a real political charge [3], [15], [16], [22]–[24].

The STS conceptual renovation and the new perspectives embedded within the social studies of technology reflect changes in the definition of the concept of technology.

As seen, the basic element of the traditional conception of technology was its instrumental character. Thus, technology was conceived as the result of applied science and was no stranger identifies it with artifacts. Nowadays, within academic fields, there is a great emphasis on prioritizing the process that leads to the generation of results and technological development. Thus, according to [28] it can be considered two definitions of technology. The first, which makes reference to the technical aspect (knowledge, skills and techniques, tools, machinery and resources), include the intellectualist and instrumentalist conceptions, while the second incorporates, besides the already mentioned features, the organizational aspects (economic and industrial activity,

professional activity, users and consumers) and the cultural aspects (goals, values and ethical codes, behavioral codes). Technical changes can produce adjustments in cultural and organizational aspects, just as innovations in organizing can lead to technical and cultural changes. The technological phenomenon can be studied, analyzed, evaluated and managed jointly, i.e., as a social practice, making explicit the cultural values underlying it. According to the conventional conceptions of technology, solutions to the problems demanded by society are exclusively technical. Pacey [28], in another way, believes that often the solutions that most resemble the desires and hopes of citizens depend on changes in the organizational sphere.

Other authors, emphasizing the social aspects about the technical, have characterized the technology as a form of social organization [21]. It is interesting to observe how this type of conception explains the question of public participation. In face of the traditional instrumentalist image of technology (which includes social agents and processes), defends itself in these conceptions a new image of technology as an interactive complex of forms of social organization that implies in production characteristics and use of artifacts, as well as the management of resources. Thus, the internal logic of the artifacts is replaced, as the relevant primary factor of technology; by the way that involves the interaction of different actors and social processes. Thus, priority is given to the organizational and cultural aspects upon the technical aspects [28].

A limited vision of technology, reduced to its technical characteristics, tends to exclude potential users of the process management of R & D and thus, becomes an inefficient vision because it produces the social infeasibility of technology. In the same way, the exclusion of people possibly affected, also results in inefficiency, because it prepares the ground for the social resistance. Thus, science, is clearly not an obstacle to the technological development, but is constituted as a vital necessity for its viability, since it must takes into account that the social component is crucial to any form of technology [21]. It is a mistake to present as opposites "foreign participation" and "internal efficiency" when talking about technology, since this is not an appropriate point of view for science nor for democracy. Thus, it is interesting to develop a new conception of technology as a form of social organization that involves different social segments, plus expert opinion and, often, the use of the production of artifacts and the resource management.

Therefore, this alternative image of technology allows taking into account the interpretative flexibility of technologies (as social processes) and political charge of technologies (as social products).

Technologies, as forms of social organization that involve the use of artifacts or certain ways of resources management, integrate the environment by establishing bonds of functional interdependence with other technologies and various types of socio-economic and cultural parameters. Technology, therefore, is not autonomous for two reasons: firstly it does not develops with autonomy from social forces and factors and,

secondly, is not separable from the system where it takes place and on which it operates. Technology, therefore, belongs to a medium, acts on it, molds and is influenced by the same. Thus, just as the introduction of new species into an ecosystem, the inordinate transfer of technologies can result in the appearance of more negative impacts to society (with undesirable disturbances in social and economic areas) than desired. However, differently of the ecosystems, a technology developed in a given environment, could eventually destabilize it.

The criteria for categorization was based on theoretical benchmarks and this sorting strategy was adopted for a simplified representation of the raw data in a way that it could be cataloged for later go through an analysis process. The result is shown in Table I.

TABLE I
CONCEPTIONS OF TECHNOLOGY

Conception of Technology	Understanding the Concept
Intelectualist	Understands technology as a practical knowledge derived directly from the development of scientific knowledge through progressive and cumulative processes [3], [12], [21]–[24].
Utilitarist	Considers technology as being a synonym of technique. In other words, the process involved in its elaboration has no relationship with technology, only its purpose and use [15], [23]–[25].
Technology as a synonym of science	Faces technology as being a Natural Science and Mathematics, with the same logic and the same production and conception methods [1], [12], [13], [22], [23], [26], [27].
Instrumentalist	Considers technology as being simple tools, artifacts or products, generally sophisticated [8,] [21]–[24], [28].
technological neutrality	Understands that technology is neither good nor bad. Its use is that may be inappropriate, not the artifact itself [21], [24], [29]–[31].
Technological Determinism (autonomous technology)	Considers technology as being autonomous, self-evolutionary, following naturally its own inertia and logic of evolution, devoid of the control of human beings [21], [24], [29], [30], [32].
Universality of technology	Understands technology as something universal; the same product, service or artifact could appear anywhere and, therefore, be useful in any context [18], [30].
Technological pessimism	Considers technology as something harmful and pernicious to the sustainability of the planet, responsible for the degradation of the environment and expansion of social disparities [21], [33]–[37].
Technological optimism	Understand technology as a carrier of mechanisms to ensure sustainable development and to remedy environmental, social and material problems [25], [38]–[44].
Socio-system	Believes that technology is determined by the interaction of different groups through social, political, economic, environmental, cultural, and other relationships [3], [15], [16], [21]–[24], [28].

VI. DISCUSSION OF RESULTS

Supported the considerations presented above, we will show how we understand technology. Considering that in our society it is common the confusion when we talk about technology and knowing that several contradictory associations are established, there is an evident need to try to find a precise definition.

Instead of trying to get fragmented representations, we must consider technology as a solid body of knowledge that goes

far beyond serving as a simple application of scientific concepts and theories, or the recognition and management of modern artifacts. We must make it clear that technological knowledge has a very broad framework and although formal, technology is not a discipline like any other we know, neither can be structured in the same way. Technological knowledge is not something that can be easily compiled and categorized in the same way as scientific knowledge. Technology could be presented as a discipline, but we know that it is better to described it as a form of knowledge, and therefore acquires specific forms and elements of human activity. Thus, we can say that the character of the technology can be defined by its use.

In order to try to eliminate the existing confusion between the definitions of science and technology, we use an approximation of the ideas of [20] that can be summarized in Table II [15], [16].

TABLE II
DIFFERENCES BETWEEN SCIENCE AND TECHNOLOGY

SCIENCE	TECHNOLOGY
Understand the natural phenomenon	Determines the need
Describes the problem	Describes the need
Suggests hypotheses	Formulates ideas
Selects hypotheses	Selects ideas
Try it	Make the product
Fits assumptions / data	Prove the product
Explains the natural	Manufactures the artificial
Analytics	Synthetic
Simplifies the phenomenon	Accepts the complexity of need
Generalizable knowledge	Particular object

In this sense technology is distinguished from science also in their modes of evaluation. The value of research and technological activity is the utility and effectiveness of the inventions and the efficiency in the production process [45]. Therefore, it is also not a simple invention. While an inventor works in the world of his ideas as an artist, the professional in technology generally works in a team with certain goals.

We must recognize that, currently, technology uses systematic methods of research similar to those in science, but not limited to borrow the ideas to meet certain human needs, it goes beyond this, combining theory with production and efficiency. The concepts of science are used in technology, however, after already having reduced the level of abstraction of individual concepts [22]. The concepts of the various areas of science combine with each other to cover the needs of the problems that solve the technology, and redefine the individual concepts to address the contexts of the same [26]. Nevertheless, just as technology uses elements of sciences, the sciences also benefit from technological concepts and creations.

We must also consider that technology is conceived based on new social requirements and demands and ends up changing a whole set of customs and values and, finally, aggregates to the culture. And, although being part of the artifacts and products that surround us, technology is knowledge that is behind this artifact, not only the result and

the product, but the conception and the creation [31]. And this involves much more socio-cultural elements than one might think. What substantially distinguishes the human species from the rest of living beings is its ability to create systematic and representative schemes of action, improve them, teach them, learn them and transfer them to distant in space and time groups, with the objective of evaluating the pros and cons factors, so we can take decisions of convenience that will point out which direction we must follow. And this does not apply only to the ability to develop utilities, appliances, tools, etc., but also the ability to develop symbolic technologies – or intelligence technologies according to [17] – such as language, writing and the most different systems of representation and thought. In this sense we can say that technology is a fundamentally human production [27].

Technology should not be reduced to any limiting vision, since it is not an autonomous actor, separated from society and culture. Quite the opposite both techniques as technologies cover in inseparable way the interactions among living and thinking people, among materials and artificial entities and, yet, among ideas and representations [17]. Each society creates, recreates, thinks, rethinks, wishes and acts upon the world through technology and others symbolic systems. Technology is unthinkable without admitting the relationship between man and society [8]. The development of new technologies embedded in products, artifacts or information and communication systems, constitutes one of the key factors to understand and explain all the changes that take place in our society. And, in this way, we can say that technology is intrinsically linked to human values [26].

In its totality, technology covers not only the artificial products manufactured by mankind, as well as the production processes, involving machinery and the necessary resources in a socio-technical system for manufacturing. In addition, it also includes the methodologies, skills, abilities and knowledge required to perform productive tasks and, of course, the proper use of products placed within the socio-cultural context [26]. Therefore, we cannot say that technology determines the culture or the society of men. The true relationships are not created between technology (which would be of the order of cause) and culture (which would suffer the effects), but among a large number of human actors who invent, manufacture, use and interpret in different ways the techniques, technologies and, also, the science.

Technology, once available to the society or to the market, starts having its value determined by the way how it will be acquired and used, and who sets this value is the own society under development [35]. Once development is an element inside a culture, technology becomes a product from the society that creates it. Hence the fact that, when imported, it can lead to a cultural domination, because it brings with it evaluation and efficiency values created in other society.

As far as it changes standards, technology also creates new routes of development. Therefore, to work with technology is to work with something dynamic. What today is considered innovation, tomorrow will be something obsolete, requiring new procedures, concepts and attitudes to innovate.

Technology is part of the cultural heritage of a people, therefore exists in the form of accumulated knowledge, and for this reason is in continuous production. Technology constitutes itself as a form of knowledge and all technologies are products of all forms of human knowledge produced throughout history [15], [16].

Thus, placed the different ideas and conceptions that we have about technology, in this work we assumed the idea that technology is a set of knowledge resulting from the development and design of instruments (artifacts, systems, processes and environments) created by man throughout history to meet your needs and requirements.

Technological knowledge is knowledge of how to make, know how to make and improvise solutions, and not just a generalized knowledge scientifically grounded. For technology, it is necessary to know what is needed to solve practical problems (know how to do it for what), and thus, develop artifacts that will be used, but without neglecting all the socio-cultural aspect where the problem is inserted [26].

VII. FINAL CONSIDERATIONS

Face of all that has been discussed so far, we can conclude that technology embraces also its cultural aspect, which includes goals, values and ethical codes, as well as it has an organizational aspect, covering economics and industrial activities, professionals, and also users and consumers [26]. Technology is not a commodity that can be bought and sold, it is knowledge that is acquired by the theoretical and practical education and, especially, by the technological research [10].

In summary, this brief overview about the conceptions of technology allows us to highlight some recurring and perhaps essential points in a broad conception of technology. Man, culture, knowledge and needs, work and instruments, are somehow mentioned in the conception of technology, where invention is a key factor and creativity represents both an individual as a social activity [12].

It would be plausible to claim, in a broader sense, that there are many specific technologies as there are types of problems to be solved, or more, if we consider that every problem presents more than one possible solution. We could say that technology includes an organized and systematized set of different knowledge, scientific, empirical and intuitive. Therefore, it allows the permanent reconstruction of the space of human relationships.

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