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# A Comprehensive Definition of Technology from an Ethological Perspective

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**Abstract:** Definitions, uses, and understanding of technology have varied tremendously since Jacob Bigelow's Elements of Technology in 1829. In addition to providing a frame of reference for understanding technology, the purpose of this study was to define or describe it conceptually. A determination of dimensions comprising technology was made by critiquing historical and contemporary examples of definition by Bigelow and Volti. An analytic-synthetic method was employed to deconstruct both definitions spanning two centuries to derive aspects of technology. Definitions relying on an anthropocentric "how humans use technology" viewpoint failed to account for different perspectives that were found when an ethological perspective inquiring "how technology is used" served as a framework. Findings support qualification of insulin as technology according to the following comprehensive definition: something inherently intelligent enough to either function, be used to function, or be interpreted as having a function that intelligent beings—human or otherwise—can appreciate, something devised, designed (by primary intention), or discovered (by secondary intention) serving particular purposes from a secular standpoint without humankind creating it, or a significant beneficiary of rationally derived knowledge that is "used for" a purpose without itself necessarily being translated into something material that "does" autonomously, or dependently when used.

**Keywords:** definition of technology; science; philosophy; STS; science and the public; theory of technology

## 1. Introduction

Although the present article is an attempt to present a more encompassing understanding and definition of technology, there have been other efforts to define technology. According to Skrbina (2015), it is in the work of pre-Socratic Greek philosophers that we first glimpse the principle of (divine) ordering in the word "Logos," which implicates the principle of creation that was conveyed in the meaning of "Techne." Nevertheless, it was only over the last century and a half that the use of the word technology and incarnations of its meaning to describe various concepts became widespread. Such usage of the word is responsible for generating much interest in determining the core ideas that its use attempts to capture. Furthermore, it is only upon the determination of these fundamental aspects that any attempt to define technology is possible.

According to Brey (2009), although it is difficult to develop a definition for technology, people do indeed know what it is and can discern between things that are human-made and those that occur naturally. Analysis of the previous statement reveals the apparent relationship between knowledge of technology and one's ability to differentiate between that which takes place in nature and that which is created. That notwithstanding, this relationship may not be as obvious as one would think, due to the ambiguity of the statement by Brey. The lack of clarity in conveying what is meant by the declaration results from being able to interpret it in either of two ways, with regard to both knowledge and distinction:

1. Knowledge of technology allows one to distinguish between what is natural (i.e., not technology) and what is made by humans (i.e., technology), or
2. Knowledge of technology allows one to distinguish between what is natural (i.e., natural technology) and what is made by humans (i.e., technology made by man).

Interpretation one is what most would assert to be true. That is, to say, the reason for asserting so is that if one were to assume this is true, and accept that people know what technology is despite the lack of an adequate definition, because they know the difference between natural things and man-made things, then either what is not being explicitly stated, or what one is inferring, is that the knowledge allows them to distinguish between natural and man-made things, because technology is one and not the other. Furthermore, of the two choices, technology is inferred to be what is human-made, which is therefore unnatural. Thus, people know technology, people know that natural is different from human-made, and technology is human-made and, therefore, not naturally occurring.

Although interpretation one may seem to be obvious and straightforward, there are a few issues that plague this argument, the most important of which are the enthymemes. An enthymeme is a hidden or suppressed assumption relied on to make a conclusion (Boylan and Johnson 2010). Based on the acceptance that people know technology and can discern natural things from human-made ones, how it is that knowledge of technology allows one to do so, may only result from it being neither of the two, or being at least one of the two, but possibly both. In other words, technology must either be natural or be human-made (unnatural). Nevertheless, because unnatural is the negation of natural, it is impossible for technology to be neither unnatural nor natural because then it could not be at all. Thus, technology must be at least one of the two. That notwithstanding, there is no justification for believing that, of the two, technology has to be human-made, which introduces the possibility of interpretation two.

Unlike interpretation one, the distinction that is made possible through the knowledge of technology according to interpretation two, is between natural and human-made technologies, which makes technology the referent of both descriptors—natural and man-made (i.e., unnatural). In this case, both natural (technology) and human-made (technology) fall under the category of the superordinate of technology, which would make technology a class of which natural and human-made (i.e., unnatural) varieties consist. Although this interpretation is less likely to occur, given the original statement, other than a as suppressed assumption concerning technology, there appears to be no reason that it should be. Moreover, in the absence of reason, not only is interpretation two at least as valid as interpretation one, but the idea that people know technology to be a class comprised of both natural and unnatural human-made things should be given full consideration. As a legitimate potential alternative to the mainstream notion of technology, interpretation two's "technology as a superordinate" inference should reinvigorate discussion concerning philosophical conceptions of technology. It is under the assumption there is no justification for believing that technology is what people think. This paper proceeds with an awareness of the possibility that technology may not only be what people think, which will be accomplished by considering the origin of the word "technology".

As introduced in the text by Volti (2009), the word "Techne" is widely accepted to mean "skill" and "art." The reconciliation of both interpretations of the Greek word are facilitated by an appeal to the logical connection that exists between them: to create anything requires skill and art. Both skill and art may be considered as metonyms for creation. Nonetheless, as metonyms, they should not be misconstrued.

Skill and art both refer to, and describe, the same core concept under different circumstances, as though an artist were to approach the object of his or her work from dual perspectives to properly render a masterpiece. From one perspective, "skilled" may be understood to be a structured approach (to creation) whereby one executes something to completion, according to a prearranged plan, without encountering obstacles. Conversely, the artistic perspective as an approach, is one in which the ability to create in a pre-planned structured fashion is hampered by challenges or obstacles encountered, but one possesses the expertise to be guided by spontaneity, and unpredictably compensates to see the

process to fruition. Perhaps the difference is more readily understood from the perspective of control. Skillfulness may be interpreted as involving both having and exerting control throughout the entire process, to complete the creative undertaking, whereas artistry could be viewed as lacking control yet dominating the situation to complete the creative process. In essence, skill and art may be likened to two otherwise identical chiral molecules that are non-superimposable mirror images of one another. Similar to preparation and spontaneity, action and reaction, or offense and defense, both aspects of skill and art are necessary to capture the essence of "create" in "techne" completely.

### 1.1. Research Topic

The current research addresses the metaphysics of technology and may be considered an analytic and synthetic endeavor into the nature of technology that relies on how authors in the field, and related areas throughout the 20th century, have attempted to define it. As the starting point for the study, the schematic definition of technology, presented in "Society and Technological Change" (Volti 2009) was determined to be an unsatisfactory definition, that did not fully capture what technology truly is. One practical issue concerns instances of technology that man need not create for them to exist. Volti's definition does not allow for such examples of technology to be considered, nor do any of those we considered from the literature.

Through exploration and analysis of the two main definitions of both Volti, and Bigelow, as well as those of other authors for comparison, regarding the essence of technology through metaphysical, sociological, and scientific lenses, we found both the strengths and weaknesses, whose inconsistency is the at the root of why it is possible for legitimate examples of technology to fail to meet the stipulated criteria. From an ethological perspective, it is not that humans must create or use something in order for it to qualify as technology, it is that in order for something to satisfy the criteria to be considered technology, the requisite highly-organized structure and ability to understand or apply it, implies that it was created or can be used for a purpose by a human or other species. By critiquing some of the examples of definitions from the literature for comparison, we identified both deficiencies and commonalities that permitted us to not only synthesize the evidence accumulated, while compensating for deficiencies, but also to liberate the true nature of technology, to successfully construct a more thorough and comprehensive definition that will allow the identification of a greater variety of forms.

### 1.2. Research Significance

So as not to potentially detract from the importance of the present study, emphasis was placed on the tenets of credibility and confirmability, according to Lincoln and Guba's (1985) evaluative criteria, by establishing the level of overall trustworthiness, through the use and selection of sources from the literature (Crabtree and Cohen 2006). The significance of the present study is based on the use of both an existing definition of technology that is nearly 200 years old, which has been deemed only to be of historical significance, and a more contemporary schematic definition to obtain elements or aspects of technology that may not have been previously considered. Furthermore, this article proposes a definition of technology based on these elements or aspects, without relying on the ubiquitous presumption of the involvement of "human intelligence" or "human making" as obligatory for the creation of it, although humans may be involved. Also, comprehensively defining technology will facilitate the identification of a greater variety of forms that may never have been considered, which could broaden our understanding and accelerate the progress of technological advancement.

### 1.3. The Research Problem

The definition of technology given by Volti does not account for technology in all of its forms. Therefore, if we are to accept the currently used schematic definition of technology that he presents, then we will exclude many important ideas of technology, because the definition is not sufficiently comprehensive. Although there were a variety of perspectives, containing similarities and differences, I was unable to achieve the goal due, in part due to the existence of a significant number of theories

and opinions that were anthropocentric. Such theories neglect to acknowledge, or underemphasize the fact that both the making and use of tools does occur in animal species other than humans (Boesch and Boesch 1984). From an ethological perspective, in which the behavior or what is being done is considered, the manipulation or control of an environment to serve a purpose—in which humans engage and is deemed characteristic of their behavior—also occurs with chimpanzees, who transport hammers for the purpose of splitting nuts (Boesch and Boesch 1984). None of the individual definitions found took into consideration the ethology of technology that would account for the aforementioned non-human example displaying human-like characteristics, nor did they provide sufficient explanation or detail robust enough to account for all forms of technology made or used. The disappointment that resulted from the literature survey prompted the following research question: *Of what elements should a comprehensive definition of technology be comprised from an ethological perspective*?

## 2. Methodological Approach

The overall arrangement of this study was designed to achieve two main goals: the discovery of aspects and the invention of theory related to the definition of technology. The process of analysis leads to discovery, and that of synthesis leads to an invention (Beaney 2014). The method of analysis used was geometrical, in that, by working in reverse from the origin of the word as well as statements regarding conceptions of technology, I was able to discover some fundamental truths about its essence (Beaney 2014). After having discovered them, these truths were used as premises in the argument to justify synthesizing a comprehensive definition to capture the nature of technology more accurately.

### *2.1. Literature Research Strategy*

Since the research question concerned the nature or essence of technology, the task was twofold: to provide an understanding of what is meant by the idea embedded in the word, through examples (interpretational), and to develop a theory and comprehensive definition (conceptual). Therefore, the answer to the question (i.e., my thesis) is a combination of concept and interpretation requiring supportive documentation in the form of theory, opinion, or other statements regarding the essence of technology.

Acutely aware that there would be no way to gather every opinion or theory in existence, I attempted to locate a variety of primary and secondary sources, which included journals, books, websites, and encyclopedias that would provide a sampling of representative statements, themes, and ideas relating to the definition, theory, or philosophical interpretations of the meaning of technology, and were written during the twentieth century. I utilized several sources to find potential works to review for inclusion, beginning with The University at Buffalo University Libraries. Many titles were returned from online databases, such as the EBook Library, EBSCO Host, and ProQuest Ebrary. The keywords that I used to conduct the initial search were "definition of technology," and "theory of technology", along with "philosophy of technology" were entered as well. The most relevant result that contained the keywords in the title or subtitle consisted of an in-depth article on the Postmodernist Theory of Technology by Leitch (2004) that provided a high caliber starting point for important figures and theories in the field. An ancestral search was performed using the references in the article and the process was repeated until the same names appeared. Sources were then chosen from those for which I did not have to pay, those that were in English, and the ones that I felt represented a good variety for analysis, from the eligible cases.

### *2.2. Limitations and Criteria for Inclusion*

An effort was made to have a good representation of the definitions of technology, in terms of what is considered by many authors to be modern and postmodern periods, and from the utilitarian, anthropological, and constructivist perspectives (Leitch 2004). Nevertheless, given the purpose of the present article and the inability to include sufficient coverage of all the sources on which everyone agreed, I selected definition sources from a qualitative perspective and implemented a purposeful

sampling method, which is the most commonly used technique in qualitative research (Martella 2013). The case selection of definitions or theories, as sources of data, was based on the information that they provided, since according to Martella (2013), purposeful sampling is best for in-depth research.

I restricted the focus to definitions from the middle of the twentieth century until the present. A source was selected from those considered seminal relating to the topic, those addressing the origins of the topic, and those published by recognized authors in respected sources. The statements chosen consisted of unambiguous opinions, theories, or philosophies concerning the nature or essence of technology. Sources were not considered if they were published in a language other than English, or if the definitions or theories were not detailed, not relevant, or were not determined to be useful to the analysis.

### *2.3. Organization*

The approach to the research is reflected in the organization of this paper, beginning with the steps and procedures implemented during the literature survey, including selection criteria and the presentation of examples retrieved from the literature. Explanations of findings and rationale for claims are offered through the use of examples. An argument against Volti's and Bigelow's definitions is presented, according to the fundamental truths discovered concerning the essence of technology; this is followed by the development of a framework for defining technology that appropriates concepts from medicine and epidemiological research and is the foundation for advocating this paper. In consideration of the claim of concept, there is a section devoted to developing a philosophical framework for a definition that has been included, which details how information should be structured, to properly form a definition according to a foundation in adequacy. Next, examples are provided on how this comprehensive definition allows for a distinction to be made between technologies, as a result of primary and secondary intentions. Lastly, we formally conclude by synthesizing the aspects, to develop a comprehensive definition of technology, which may account for a greater variety of forms than are acknowledged currently and perhaps some that may not have been previously considered.

### *2.4. Framework and Epistemology*

The approach was made within the context of a philosophical framework, relying on principles and applications of logic, and reasons for interpreting the meaning and deriving conclusions through argumentation. Our vantage point included an ethological perspective that acknowledges—for purposes of comparison–the role of human characteristics as they relate to our ability to understand technology, without actually requiring that humans be the interacting animal species in order for something to be considered technology. I value governing oneself by logical reasoning and believe that consistency and coherence ultimately provide insight, regardless of the subject. Every effort to bracket biases has been made, but I have disclosed to the best of my knowledge any and all pertinent information that could potentially bias the findings, so that the reader may determine for themselves whether they are in agreement.

## 3. Technology and the Link between Art and Skill

Techne as a word-root is traditionally understood to refer to "art" or "skill" (Skrbina 2015). The contemporary usage of words incorporating this root imply that a certain amount of skillfulness or artistry must be involved in that to which they refer. Nevertheless, what is often overlooked is the fact that, while skill or art undoubtedly are involved, implicit in them is a common conceptual precursor, integral to that which the word may refer to, as well as the skill and artistry that are requisite themselves—the notion of creation.

### *3.1. Inferring the Core Aspects of Technology and a General Definition of Technology*

Skill is employed to create things in the same fashion that artists create their work. However, one need only to observe the results of skill and art to understand that something was "created."

The fact that something was created may be concluded from the overall organization; things were done the way they were so that every aspect of the work or object functions together with a purpose that can provide some benefit (aesthetic or otherwise). That is, if something discovered is organized, then it may be inferred from the function, purpose, and benefit, that it was created without the need to establish who or what was responsible for creating it. Therefore, these three are considered to be the necessary core aspects of any example of technology.

With regard to semiotics, the original meaning of the root Techne (i.e., create) and logos (i.e., ordering—words that are ordered consisting of letters that are ordered to make them; logic as in series of steps in order, and reasoning also in steps) when combined should be understood to refer to a "creation of order" (i.e., as in skill or art used to create order-yielding work), or that in which "order is created. In other words, from the perspective of making meaning, I interpret and define technology generally at its core to be either "something created through ordering exhibiting organization, whose aspects function with a purpose that can provide some benefit," or "something that is organized (implying creation of order) whose aspects function with a purpose that can provide some benefit."

### *3.2. A Contemporary Example of a Schematic Definition of Technology*

One way to understand technology is through the schematic definition presented in the text entitled "Society and Technological Change" (Volti 2009). In it, technology is defined as "*a system created by humans that uses knowledge and organization to produce objects and techniques for the attainment of specific goals*" (Volti 2009, p. 6). Examples that currently exist, such as the laser, the television, or the computer, all qualify as technology according to the criteria of this definition. Although it may prove exceedingly difficult to deny any of these examples—as mentioned earlier, a place among the pantheon of technology according to how Volti has defined it—there still are many other examples that would not be given full consideration for inclusion, regardless of the definition to which one compares potential examples of technology. Furthermore, there are also examples that would satisfy these criteria to be determined technology, but this example may be successfully proven through valid argumentation not to be technology according to the very same standards as the premises used to qualify it initially, which renders such definitions unacceptable. Irrespective of whether the definition gives rise to inconsistencies, such as was just alluded in the case of the criteria proposed by Volti, or whether a new definition is developed that preserves validity through consistency in determining that something is technology, it will be challenging to bar entry of valid arguments substantiating ideologies centered on the concept of technological determinism.

Technology is unlikely to have occurred by chance, without being created by intelligent beings—many presume to be mankind—given the inherent knowledge and requisite organization of technology as a system that allows it to produce objects and perform techniques to achieve goals. The schematic definition of technology presented by Volti, as well as other opinions, theories, or philosophies that exist in the literature regarding its essence, do not account for aspects of technology that address this from differing perspectives. I, therefore, claim that there should be a restructuring of the definition to more thoroughly reflect a variety of aspects and forms, both created by humankind and those that predate our existence. This task may be rather daunting, but it is possible, and should primarily rely on discovering the metaphysical aspects to achieve its end that are related to the subjective nature of experiencing and interacting with technology, that are shared by all individuals.

When I performed a cursory analysis of the text from sources used in the research concerning the definition of technology, the ten most frequently used words concerning technology—once we control for lemmatization and related words—in descending order were: science, Heidegger, knowledge, culture, social, human, material, system, process, and power. Based on selected documentation from authors, it is apparent that despite the disagreement concerning how to frame the definition of technology, science, philosophy (i.e., Heidegger), and knowledge are at the core of the concept we refer to as technology.

Technology has a certain material or physical component, as manifested by the plethora of commonly agreed upon examples that surround us in the physical world. Nevertheless, for as many examples about which there may be a consensus, there is at least an equivalent number about which there is disagreement. How we come to know about the physical (world) is a matter that is the primary concern of the field of science.

It is ultimately our success in arriving at such knowledge that may be attributed to the power of logic or reasoning, which itself falls under the field of philosophical inquiry. In addition to seeking knowledge, a philosophical inquiry may consist of abstract thinking and is commonly practiced in many areas of philosophy. Such thinking, especially when in the form of very highly organized abstraction that is from, or that extends beyond, another concept, is often conveyed by the prefix "meta" (Merriam-Webster 2016). Although metaphysics, as a branch of philosophical study, concerns the fundamental reality and the nature of what is real or outside of objective sensory experience (Merriam-Webster 2016), it may rightfully be said to have been the mindset I adopted when deciding to embark on this journey. The ideas and approach to the research question were motivated by the desire to uncover the appropriate criteria, according to which all forms of technology should be judged, which would provide a sound basis for adequately defining technology.

### 3.3. The Rationale for Defining Technology

Something that is definitive precisely specifies to provide a final solution (Merriam-Webster 2016). Accordingly, a definition of technology with which we are concerned is supposed to demarcate the territory that it covers, by distinguishing itself with sufficient detail to avoid ambiguity. Nevertheless, the definitions of technology considered have not proven to be sufficient, such that while explaining enough to allow only a portion of the available examples to qualify categorically as technology, others fail to meet the criteria and do not qualify, and yet more remain in limbo somewhere in between. Furthermore, proponents of the examples of technology, who feel a sense of injustice in them not having qualified when they should have been, begin to grow understandably unnerved, which ultimately leads to divisiveness. It appears as though the lack of comprehensiveness may render the overall process of definition counterproductive if not thoroughly done, which is a reason that the issue is being revisited with my research.

The rationale behind the effort given to defining technology, or anything as important for that matter, may be understood through the remarks of Dionisopoulos and Crable (1988), who have stated that the process of definition has been recognized for its persuasive and ideological potential. I would be remiss not to qualify the claim above with the word "successful" because the truth of the statement is contingent upon achieving what the process set out to accomplish. There can be no effective persuasion or ideology without success in definition first. In fact, when not done comprehensively, instead of bringing closure, the process of definition can sabotage, by creating a rift itself or exposing the presence and location of irreconcilable gaps in theory, that lead to the opposite of what the process had the potential to be, by leaving too much open to persuasive ideological misinterpretations by people in various fields of study.

### 3.4. Aspects According to the Historical Conception of Technology of Bigelow

Jacob Bigelow, who is often credited with coining technology in its present-day usage (Li-Hua 2009), was both a physician and Harvard professor in the early nineteenth century. In his book, entitled Elements of Technology (1829), Bigelow states that technology (at that point in time) was "understood to consist of principles, processes, and nomenclature of the more conspicuous arts, particularly those which involve applications of science, and which may be considered useful, by promoting the benefit of society, together with the emolument of those who pursue them" (Bigelow 1829). It may not immediately be apparent the abundance of information that was provided, so I encourage readers to take a second look to fully appreciate its complexity as a reflection of that of the technology itself.

Analyzing Bigelow's statement, if taken as true, reveals that technology, conceptually, was comprised of the following aspects: the physical (process), the metaphysical (principles), the sociocultural (nomenclature), the functional (application of science), the beneficial (considered useful), the purposeful (promoting societal gains), and the economic (emolument). Although the aspect of product was not expressly mentioned, it is implicit to the aspect of process, which is taken to mean action, change, or transition in some form, in that a process must either culminate with itself, or with something else that is not itself. At a subsequent point in time, the continuation of the process would be the process, whereas something other than itself at a later point in time would be a distinct product. Both alternatives, however, may be considered products and could explain why no explicit mention was made in Bigelow's definition.

While I do appreciate the care taken in constructing this definition, I do not completely agree with it, in that there exists at least one example of something that satisfies all of the required aspects of both Bigelow's and Volti's definitions to be considered technology, but does not necessarily meet any of the criteria and still exists: the hormone insulin. Based on the use of implicative reasoning for conditional statements assuming his definition as the premise for the argument, and given insulin may be viewed as a system of delivery for energy sources into muscles that is created by humans and uses knowledge (i.e., science) and organization (i.e., skill, art implying it was created) in order to produce objects and techniques for the attainment of specific goals (i.e., modulation and usage of glucose as energy source), then insulin is technology. Moreover, accepting as true Bigelow's definition as premises for the argument, and given that this substance has been created by mankind, involving a process consisting of the application of science, according to principles, has been given a name, and is considered exceedingly useful based on how it benefits society and those who create it, the substance, insulin, is technology.

### *3.5. Insulin and the Argument in Support of Technological Determinism*

According to both Bigelow's and Volti's definitions, insulin is certainly technology. However, there is a rather inconvenient issue with this technology because, unlike all other forms of technology about which there is consensus, insulin does not need to be created by humans to exist. So, either insulin is technology, or it is not; if insulin is technology and insulin does not need to be manufactured, then technology does not need to be created, and anything in existence that was not created could therefore be technology. On the other hand, if insulin is not technology, despite satisfying all of the aspects of the criteria of the definition, then it is not the case that there exists something that is technology, because insulin meets the criteria and is not technology. Therein lies the problem with the definition: either everything will be technology, or nothing will be. Such an absurdity renders the definition as it stands of no use and further substantiates the need for the present study.

Moreover, the case of insulin, regardless of the existing or any newly-developed definition, welcomes the corollary of technological determinism as an argument. I would not go as far as to claim that insulin is autonomous just yet, but conceding that insulin is technology that can be created, but exists without humans making it, implies that not only can humans not take responsibility for it as technology, but since it exists without mankind making it, either it simultaneously came to be with the creation of people, or this technology preceded them. It is unlikely to have entered into existence after humans, for this would imply—according to principles of causality—that humankind created it, which is obviously false. It is also unlikely to have spontaneously developed by chance factors after the existence of humans. Such a development would mean that there was a point in time at which insulin did not exist anywhere, yet it later not only came to be, it came to be made by a particular organ which is present in all animals, in addition to humans, simultaneously, with the same function. There is very little likelihood that this could be the case and this is difficult to accept.

If insulin is technology, and it came to be, simultaneous with the creation of humans, then at best technology would be considered to have a contingent reliance on humans, or at worst, it would be autonomous and coincidental to them, as well as being partially deterministic, in a sense that

there exists a dynamism between insulin and humans, where each influences and is influenced by the other. Nevertheless, if insulin as technology preceded humans, then at best technology would be both autonomous and completely deterministic. The only way to avoid technologically deterministic implications is to deny that insulin is technology, but that would be problematic, considering it satisfies the criteria of some definitions of technology, which also implies that there could be other examples that qualify that should be denied.

### *3.6. Technology and the Aspect of Reflexivity*

As we observed with the aspect of process, the term "product", involves aspects that are so inextricable as to have the presence of one imply the existence of the other, which obviates the need for both to be included in a satisfactory definition. This discovery is promising because there is potential to reduce the overall number of aspects expressly mentioned in a new definition to only those from which the other aspects may be logically derived. A total of eight aspects were discovered, that included the three core aspects we have previously determined. Nevertheless, there is yet another aspect that was neither directly expressed, nor easily determined from the content of Bigelow's definition, that deserves to be mentioned: that of reflexivity.

The aspect of reflexivity refers to technology having the ability to perform some function, purpose, or benefit, as well as be used to fulfill the same three core aspects. Perhaps it may be better understood in the following manner: If we assume Bigelow's definition is true, and having been able to derive the aspects both mentioned and implied, each aspect and the technology itself, not only require something prior to their existence, but also need that very thing after the technology and its respective aspects come to be, in order to be capable of understanding or appreciating its existence. That which is required is intelligence.

Intelligence is necessary when one creates technology, or technology is created, that is, when it is created by humans to do something in particular—for instance, technology requires intelligence to underlie the skill and art responsible for imparting purpose, function, and benefit (PFB). However, in the case of technology that has either knowingly been created for another PFB by humans, or has been discovered, but not created by humans to fulfill a different PFB, intelligence is necessary to determine what the technology is to be used to do. Thus, regardless of how, or by what, something that is technology comes to be, intelligence appears to be a requisite for both appreciating and understanding it. Furthermore, while it is this appreciation and understanding that allows for the creation of technology with specific PFB, this is also what leads to things encountered that are referred to as technology being applied to a set of different PFBs. Despite the importance of the aspect of reflexivity for understanding technology, it may only operate through the PFB of technology, which precludes it from securing a status among the core aspects

## 4. Categorically Diverging Definitions of Technology

From an anthropological standpoint, many views equate technology with things such as tools, like those utilized by humankind throughout history (Nelson 1932; Wissler 1926). Though rather incomplete relative to the attempt that we just analyzed by Bigelow (1829), or Volti (2009) previously, such a definition underscores the importance of the study of technology to anthropologists. Its study is quite promising because much may be learned about humankind from its use and reliance on technology throughout history. However, as noted by Bleed (2008), technology is poorly understood and ill-defined, with both material and nonmaterial aspects confused, or studied in isolation (p. 95).

Boas also echoed this sentiment, by adding that the study of technology is critical to understanding culture; he also made a distinction between technology as a custom of manipulating the world, and the products of this custom, which he called material culture (Herskovits 1948, p. 41). I interpreted both remarks as admonitions of sorts. One cautioned that there is more to technology than the physical manifestations to which we have become accustomed, but that lacking a proper definition is preventing progress in understanding. The other comment distinguished technology, as it was

understood, from that which technology produces. These statements were a considerable step in the appropriate direction toward a definition, but technology as customs is no less of a physical or material manifestation than the material culture they produce. Without a comprehensive definition, it would be rather unreasonable to expect anyone to keep aspects of technology straight, let alone to possess the know-how to study them together and efficiently. Therefore, in order to find the answer to the research question, we must begin by analyzing what figures have offered in the literature regarding the theory of technology in order to establish fundamental truths about its essence.

### *4.1. Technology as Predominantly Physical*

The theories and definitions of technology surveyed for comparison were from the latter half of the twentieth century and consisted of those found in works by authors that addressed technology in fields such as anthropology, communication, philosophy, sociology, feminism, and history. The rationale behind these, which included a variety of perspectives, was that by ensuring a diverse framework, comprised of independent authors and their respective opinions, as an analysis to find similarities, could potentially be viewed as more credible or valid in very much the same way that triangulation of sources lends itself to establishing this in traditional qualitative research (Martella 2013).

Claims were analyzed grammatically and hermeneutically to assist with the process of categorization. There was no question as to whether or not technology exists. However, beyond establishing a consensus that technology existed, it quickly became evident that everything else was subject to debate, according to dichotomous descriptors that would best distinguish the opinions. Some individuals claimed that technology is definable, while others were of the view that it is not. Some were optimistic about the prospects of defining technology and the potential for results, while others expressed pessimism. There were claims that implied that technology was subjective, while others felt it to be objective. Technology was interpreted as an issue of process based on some claims of definition, whereas the notion of product overrode others. Various mapping schemes were attempted, in order to determine how the definition claims presented themselves. As the analysis continued, while there were many differences, the theories seemingly began to diverge. Thus, of all the possible methods of categorization to use, it was divergent mapping (Machi and McEvoy 2016) that was used, because the definitional claims seemed to best support dueling perspectives with regard to the state in which technology exists. The main difference that each theory, opinion, or definition appeared to overtly state, imply, or acknowledge was that technology either consisted of primarily the physical (e.g., actions, machines, products) or primarily the metaphysical with secondary physical manifestations (e.g., ideas, thoughts, knowledge preceding machines or products).

Many significant contributions have been made by authors in the field, for example, Joan Woodward, whose work concerned technology as it pertains to industrial organization is widely recognized (Woodward 1970). Woodward's expansive definition, and others like it, though acknowledged as significant, were not considered well suited to the present study, due to specialization beyond a comprehensive general definition. Nevertheless, there were examples, such as that of Haraway (1997), who likened humankind to hybridized cyborgs, which intimates the existence of an inextricably fused human-machine organism. In such a world, the machine is metonymically representative of the technology that is inextricably part of us all; it is comprised of a duality where material and immaterial, the body and the mind and what creates and is created, co-exist interdependently.

Although not identical, the dual, yet contrasting, aspects of the different components of the cyborg ontology in Haraway's comments, are reminiscent of Descartes and dualism's adherents from the philosophy of mind. Haraway's is not the only view of technology that had dualistic undertones, however. The feminist perspective on the theory of technology, given by Wajcman (2009), exhibited similar traits. According to Wajcman (2009), scientific facts and technological artifacts have been treated as both semiotic and as material (p. 2), which may be understood as a fluidly-fixed hybridized duality, in which the active role of hermeneutics as a framework for general interpretation and the making of

meaning, exist alongside the relatively passive roles of observation and information-gathering of the traditional physical sciences.

This real or imaginary dynamism is dependent on how humankind interacts with or relates to, technology. Nevertheless, when this dynamism is taken as a premise for any argument, it leads to a variety of absurdities, which reveals a major inconsistency. For instance, it can be shown that if it is the case that technology is both semiotic and material, then the technology is neither one nor the other. Any definition, therefore, must be developed with consistency in mind, and be general enough so as not to catalyze further disenfranchisement of potential candidates, which are to be classified as technology, based on overt, implied, or perceived associations with gender, race, or other socio-cultural aspects.

### 4.2. Technology as Dichotomously Physical

A different author from the field of archaeology described technology as consisting of "distinct 'inputs', such as knowledge and labor, and 'outputs', referred to as material culture and modified environments" (McOmber 1999, p. 4). According to this definition, technology is divided into two categories and may be seen as a technological dichotomy of sorts. Such approaches to defining technology were certainly represented in the literature, where within the definition, there exists a division between the physical aspects, and what I refer to as the dichotomously physical aspects, in the understanding of technology.

The dichotomously physical definitions of technology are those that acknowledge or imply the existence of metaphysical aspects that are of either distinct or non-distinct (i.e., integrative) varieties. It is not surprising that even among the definitions of technology that are within the dichotomously physical category, there exist subdivisions that represent a contrast between definitions reflecting distinctive aspects and those that express technology as more of a conceptual mosaic of interwoven components. That notwithstanding, there are problems associated with how we are to reconcile the ability of both physical and metaphysical aspects to interact with one another; this makes it exceedingly difficult to accept any of the theories that have conspicuously material components of technology incorporated into the theories themselves, without simultaneously conceding the existence of those of the immaterial or metaphysical.

Another definition of technology provided from the viewpoint of the archeologist, White (1949), stated that technology was "composed of the material, mechanical, physical, and chemical instruments, together with the techniques of their use, by means of which man, as an animal species, is articulated with the natural habitat" (p. 364). White did acknowledge that humankind was an animal species and for that should be recognized. Nevertheless, while I concede that techniques could be immaterial in isolation (i.e., mental relaxation techniques, or focus), the phrasing of "techniques of their use" relegates this interpretation to the realm of the material, since it is associated with the use of stated material instruments. White's definition, therefore, fails to mention or imply the immaterial or metaphysical as an aspect, which I still find difficult to accept.

### 4.3. Conceptual Sensitivity and Conceptual Specificity

One could glean the aspect of material from both physical and material instruments and aspects of product; therefore, processes based on mechanical and chemical instruments being products—either having been constructed by way of technique in a process, or if already in existence, having to be used as part of a technique in a process. Perhaps it may be a viewed as reaching, but it could also be argued that articulation with the natural habitat may be interpreted as a benefit, purpose, and function, despite there being no economic aspect implied. Nevertheless, my approach, consisting of both scientific and philosophical methods, cannot ignore that there is an absence of any metaphysical aspect, which renders it inadequate and seriously compromises what I refer to as conceptual sensitivity and conceptual specificity. Borrowing the core concepts of sensitivity and specificity from the fields of medical and epidemiological research (Boslaugh 2014), I refer to conceptual sensitivity as the ability

of a definition (as a test) to identify cases of that which it purports to define accurately. Conversely, conceptual sensitivity is used to refer to a definition (as a test) that does not identify a case as that which it is to define when, in fact, the case is not.

Any comprehensive definition should minimize the occurrence of false identification of things as technology when they truly are not (i.e., type 1 error), as well as minimize falsely rejecting the qualification of things as technology that actually are (i.e., type 2 error). Therefore, the most crucial aspects of any adequate definition of technology, regardless of it expressing a primarily material essence or a dichotomously physical nature, are that it should both (a) be conceptually sensitive enough to allow for only valid examples of technology to be identified through meeting the criteria; and (b) for it to be sufficiently and conceptually specific to identify only valid examples of technology. These ideas will be elaborated upon when we build the framework for definition.

Additional statements attempted to be more all-encompassing, such as that found in Hyde (1986) in which it is suggested that perhaps all that we do could fall under the rubric of technology. Unfortunately, all that we do would be considered a theory, defined by action, which is distinctly physical in nature. Although from the physical aspect, aspects of process, product, function, purpose, and benefit could be derived, the metaphysical is still noticeably missing. In other words, if this were true according to Johnstone, solely satisfying the physical aspect without any corresponding metaphysical component would be sufficient to qualify as technology.

### *4.4. The Anthropocentric Standard for Defining Technology*

One prominent theme that was overt or implied in many of the statements regarding technology was that humans are either the benefactors or the creators who are inextricably and uniquely associated with it, which renders these perspectives anthropocentric. Noted author Carl Mitcham (1978) defined technology as "human making or using of material artifacts in all forms and aspects" (p. 232). Mitcham's anthropocentric view was joined by many others, including those who suggested that technology is not a practical implementation of intelligence, but one of human intelligence (Ferré 1995). Either attempt at defining technology as making and using, or a practical implementation does so through the physical without the metaphysical. Furthermore, that it was the idea that the human aspect qualified something as technology that was both widely and inappropriately accepted as truth for many years. Nonetheless, as previously mentioned in this paper, research would expose this anthropocentric misappropriation (Boesch and Boesch 1984).

Although it has been more than three decades since the evidence of chimpanzees, significant evidence does exist that should have decidedly shifted the focus away from subsequent definitions of technology that are qualified by human-making, yet there have been and still are many academics whose definition resembles that of Volti (2009), which has qualifying criteria that implies "human making." Many are reluctant to accept, or acknowledge, that humankind is not unique, concerning the use and fabrication of technology, no matter how rudimentary, and cannot abandon the anthropocentric framework. For instance, Pitt (2000) defined technology simply as "humanity at work," while Johnson (2006) has argued what Anderson and Anderson (2011) have similarly echoed: technology is the idea of things that are created or human-made. Nevertheless, it should be pointed out that if such a notion of technology is granted, then it must be acknowledged that it encompasses dichotomously physical components comprising that which humankind made use of and integrated, but did not necessarily create, such as systems of knowledge and other sociocultural aspects. Furthermore, according to Li-Hua (2009), "technology represents the combination of human understanding of natural laws and phenomena accumulated since ancient times to make things that fulfill our needs and desires or that perform certain functions," and that it "has to create things that benefit human beings" (p. 19). Although I concede that it may prove difficult to refrain from such human-centered tendencies for many, it does not mean that we should indulge them. The anthropocentric standard found in definitions of technology frustrates our efforts by obscuring the fundamental aspects and misdirecting attention away from the essence of technology.

### 4.5. Defining Technology through Essence

While understanding the essence of technology is crucial to defining it, there have been significant contributions made in an effort to define technology from Feenberg, Brey, Haraway, and Bunge, just to name a few. In addition, many others have attempted to go beyond a simple definition to propose a new conceptualization or technology, as Ihde has. There are also those who have contemplated determinism, autonomy, technocracy, or a dystopian society with regard to consequences of technology, which include Heidegger, Marx, Ellul, Pinch, Bijker, Marcuse, and Jonas, for example. Despite the presence of such contributions in the literature, it became very discouraging at times while researching definitions. Although many great ideas were available, none seem to truly capture or express what a sensitive and specific definition should. That is, despite the great ideas, philosophically substantive definitions, or novel conceptualizations, it remained unclear whether there was a fundamental definition that was consistent with them all. It was for this reason that I completely understood the remarks in the literature by those who expressed a sense of pessimism regarding the process of definition with respect to technology in particular, or the process as a whole in general. The categories of definitions of technology that have been proposed include technology being understood as a mere tool, as an instrument implying intentionality, as rationalization, or existing in a hybridized format with humans. According to McOmber (1999), "technology is a repository of overlapping, inconsistent meanings" (p. 149). In addition, the word "technology" itself was claimed to have been incapable of possessing any of the transcendent quality referred to as timeless essence (Wittgenstein 1958).

In the chapter entitled History of Technology, Misa (2009) remarked that no scholarly historian of art today would feel the least temptation to try to define art, "as if that complex expression of human creativity could be pinned down by a few well-chosen words" (p. 8). A similarly negative outlook was echoed by Bijker et al. (1987), who felt any effort given to the task of precisely defining definition was unnecessary (p. 3). Thomas Hughes would subsequently elaborate in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (1987) by suggesting that any definition would be a disservice to the conceptual complexity of technology and pose restrictions while obscuring it (Bijker et al. 1987). Hughes also commented that a precise definition would mean that one would be able to consistently compare and disregard that which does not meet the criteria, which we have seen is not the case.

While I concede that the word technology itself can have no essence due to the ever-evolving nature of contextual meaning, the concepts and aspects that comprise the essence of a particular technology are unalterable—regardless of what they may be—and transcend the terms ascribed to them. In other words, that which a word and its corresponding definition attempt to capture (e.g., technology) remain fixed, but subsequent words and corresponding definitions may be used to more appropriately reflect the referent.

For example, a term may be used in reference to a particular object or concept in a given context, and then it may be understood in referring to another; in this case, the essence of the referent has changed, even though the term meaning or its use may not have (e.g., the reader's spouse: use is the same, but the referent is contingent upon who the reader is and its essence is different). Furthermore, an instance where "the reader's spouse" is first used and taken to mean "the person to whom the reader is married," and subsequently another word (e.g., husband) is substituted for spouse, when we know he is male (i.e., the reader's husband), instead to refer to the same individual and relation, the essence of "the person to whom the reader is married" has remained unchanged, despite the usage of different words.

That to which technology refers today, comprises an unchanging essence that transcends terminology and word usage. Different words may be used to describe the same thing, and the same word may be used to describe different things; however, that to which the word does or did refer need not change at all. The only possible scenarios are either a modification of the word and corresponding definition that is used to define or describe a single referent that occurs, or a change in the referent to which a single word, and therefore, its definition, applies. Regardless of which is the case,

one point merits mentioning and should clarify what is meant. It is only the alterations that actually occur to the terminology used that account for the evolution. Although no structural changes affect spelling or pronunciation, given that words may only be identified by their spelling, pronunciation and meaning, a change in the meaning or interpretation of a word, which is inextricable from the word itself, may be equated with change occurring to the word. Semiotic changes, with respect to viewing a word as symbols and its interpretation, result from an applied linguistic transmutation. That is, regardless of whether a novel interpretation of a word begins to emerge initially, or through the situations in which and to which a word is applied, how a word is understood and used determine its meaning.

Unlike what may occur in the case of individual word changes, the "change in" the referent both involves, and does not involve, the referent itself. In fact, the "changes in" may seem somewhat ambiguously worded. By the "change in" of the referent statement, it should not be understood to mean that the change is one that is actually occurring to a single referent itself; the change is one that results in one referent replacing another. Given the potential for such alterations to occur to words themselves, it should be emphasized that it is irrelevant and unnecessary for a word to have an essence, because the referent of the word itself always does. Furthermore, the existence of an unaltered essence implies that there are aspects of characteristics that are in fact both consistent and identifiable, regardless of how conceptually complex they may initially seem.

Consistency may be accomplished through establishing what the essence of technology is. Moreover, the process of establishing the essence requires the ability to identify it reliably. Consistency is therefore achieved through identification, which itself makes comprehension possible, if so desired. Therefore, given both consistency and identifiability, technology should be amenable to definition, according to the aspects that have been mentioned throughout. These aspects include the three cores—function, purpose, and benefit—in addition to those extended ones of economics, socio-cultural, physical, and metaphysical (of timeless essence), which we have previously outlined in this paper. In other words, a definition of technology is both possible and necessary if we desire to understand what technology is, regardless of what any individual manifestations of it may be. An appropriate definition will be one in which the timeless essence is reflected and allows for all instances of technology, whether two hundred years old or yet to be actualized, to be adequately defined.

Despite what has been stated in the literature, it is not the process of definition that obscures the complexities, or poses restrictions on the essence of technology; it is approaching the task of defining by individuals grounded in this belief as a framework that will ultimately be responsible for any obscuring and posing of restrictions that result. Such opinions both reflect, and are further confirmation of, the tendency toward anthropocentrism, as well as humankind's need to dominate. This perspective implies that the process, and therefore the one who defines (i.e., humankind), are hegemonic with respect to that which is being defined, which cannot be possible if a timeless, unchanging essence of technology truly exists. Definitions and the process are descriptive and do no more to restrict, obscure, or otherwise, alter the aspects of anything one attempts to define than not trying to define it. Therefore, any effort given to define technology may potentially benefit society and formalizing my approach in doing so is where the next section will begin.

## 5. Developing a Philosophical Framework for Definition

In consideration of the analysis of the schematic definitions of technology that were presented by Volti (2009) and Bigelow (1829), as well as the additional opinions, theories, and definitions of a variety of authors from a range of fields critiqued, we concluded the following, regarding what is entailed in the process of defining technology. Unlike that suggested by Volti (2009), we have shown that there need not be a stipulation that "humans make" in order for the criteria of a definition of technology to be satisfied. Furthermore, there were eight aspects of technology that we derived from Bigelow's case: physical, metaphysical, process (therefore, product), functional, purposeful, beneficial, and economical. Despite the many aspects that are obvious and implied in his definition, there was at least one case

that I suggested as technology that would satisfy all but one aspect (i.e., economical), which reveals the inadequacy of the definition as it was. This exception in which a true example of technology failed to meet the criteria according to the test (i.e., false negative) is reminiscent of a type II error (Martella 2013) and is what we want to avoid or at the very least, control.

I was then prompted to slightly modify, then appropriate, the error classification concepts of type I and II (Martella 2013) for our purposes, as well as adopt the notion of philosophical adequacy, which is comprised of soundness and completeness (Garson 2013), based on concepts found in provability logics and the foundation of mathematics. As the most well-known of provability logics, Gödel's second incompleteness theorem essentially expresses that consistent systems cannot prove their own consistency (Garson 2013). Originally applied within the context of arithmetic, the axiom GL that concisely captures an important principle, is named after Gödel and Loeb, and expresses the idea that if a system could prove soundness (i.e., consistency: there is proof that if it can be shown that T, then it is true that T) for a given sentence (T), then T already has a proof. In other words, a system, such as that which defines technology, if truly sound, cannot prove its own soundness, because there may be a flaw in the system, which is what occurs when, according to the same supposedly sound definition of technology, there can be both proof of something as technology (i.e., insulin) and evidence of the same thing not being technology (i.e., insulin). Soundness is extremely critical for all systems, including argumentation, arithmetic, and definition, because from soundness we can develop a framework for our task.

### *5.1. Adequacy as a Foundation for Developing a Definitional Framework*

Interesting to note is that soundness is equivalent to what is referred to as its own contrapositive, which means that if it is not the case that T, then it is not the case that it can be proven that T (Garson 2013). The contrapositive is as important to our theory development as soundness itself. Simply because the definitions we have reviewed by the authors may be able to prove something is technology, it does not necessarily follow that what it proves is the case. Moreover, because something may not truly be technology, it does not imply that it cannot be proven as such by definition either, because it is possible that the system used (i.e., definition) is inconsistent, so that there may be both proof of truth and its negation.

Through a concept referred to as adequacy (Garson 2013) we may achieve our definition. By establishing the adequacy of a definition of technology, we can demonstrate that the definition of technology is both sound and complete. To claim soundness for a definition of technology, the definition of technology requires proof of instances of technology that would be valid cases of technology. Conversely, for completeness, it must be shown that valid instances of technology are the ones for which we could provide proof. If successful in demonstrating adequacy of the definition of technology, then we will be very close to having satisfactorily developed our definition.

The information contained within the case definitions we have assumed as valid will be our premises as we proceed and apply logical rules, also assumed to preserve validity. In order to satisfy completeness, if the definition is valid, then there is proof that it is. Proof that it is valid, for the purposes of our research, will be established when a definition consistently identifies (i.e., proves) examples of technology. Conversely, for soundness, the assumption is that if the definition is valid, then the definition has proof that it is. In this case, from the assumption of consistently identifying examples in the premise of this argument, we proceed to preserve validity, which means that there cannot be a case in which the premise is true and the conclusion that the definition is false. The definition is false when it does not consistently identify examples of technology. Having established the facts, according to the test for adequacy, neither Volti's, Bigelow's, nor any of the other definitions consistently identify examples of technology.

Although there will always be the risk of some error occurring because nothing is perfect, prudence requires that these occurrences be minimized as much in hypothesis testing (i.e., definition) as is reasonably possible. Since the main goal of our study and thesis is both interpretational and

conceptual, in that we aim to develop or define an idea and provide a framework for understanding, in order to be able to correctly discriminate examples of technology from those that are not, our definition as an experiment or hypothesis test, must essentially become a test whose power to identify only true examples of technology as technology, while not identifying those examples that are not is maximized as technology. Doing so requires consistency when both the definition's identification and the technology's truth-status are in agreement. This positive correlational relationship between the definition and that which it is to identify, is strikingly similar to the concepts found in medicine and epidemiological research, referred to as sensitivity and specificity (Boslaugh 2014). Sensitivity relates to the ability of a test to positively identify individuals who have a particular disease for which the test is designed to identify. Specificity, on the other hand, refers to the tendency for test results to be negative for a particular disease when individuals do not have that disease.

Ultimately, utilizing the notions of adequacy when considering the relationship between a definition and that which is to be defined by it, requires that we rely on the principle of soundness. The contrapositive of soundness we explained provides a logical equivalent that may be used to understand a sound relationship. By viewing the relationship between a definition and that which it defines as an argument, soundness may be considered proven when we assume that the definition is understood as proof and can consistently and correctly conclude that which is to be defined as technology is a valid example of it. Also, presenting an argument in which we assume that the term to be defined as technology is a valid case, we can consistently and correctly prove the definition of that which is being defined is valid and demonstrate completeness.

Taken together, both soundness and completeness comprise the notion of adequacy, which as a condition is satisfied, when the definition, as a test, correctly identifies technology, if, and only if, that technology is a valid example. Such a bi-conditional relationship between definition and that to be— defined is based on adequacy—I refer to this as conceptual sensitivity, which is a reflection of the power of the definition. Furthermore, if we take the contrapositive of soundness and its inverse, to be when the definition, as a test, does not identify technology—if, and only if, that technology is not a valid example this derivative bi-conditional relationship is referred to as conceptual specificity.

When a conclusion, based on the definition as a premise, is not valid, then the definition has incorrectly, or false-positively, identified something as technology that is not a valid example, which is a type I error. Conversely, when a definition fails to identify a technology that is a valid example, the definition has false-negatively identified something that is technology, which is a type II error. Together, all of these concepts were synthesized to develop a framework for definition. Once we began to consider additional cases in which authors provided their opinions regarding technology, we found that the definition often given, either overtly expressed an underlying negative sentiment (i.e., pessimism) regarding the possibility and benefit of giving an effort to define. Alternatively, there appeared to be those who believe defining technology was indeed possible (i.e., optimism). Of the cases in which definitions were attempted, there existed a categorical divergence of two prominent views regarding the definition of technology, which were comprised of theoretical positions that opposed one another: those that viewed technology as predominantly physical, and those that viewed technology as consisting of both physical and non-physical components, to which I refer as a definition of technology that is dichotomously physical.

Technology is not necessarily a creation of mankind; it is something that is itself always inherently intelligent enough either to perform functions or to be imbued with a purpose that only intelligent beings have the ability to comprehend; it is something devised, designed or discovered to serve a particular purpose from a purely secular standpoint without requiring that man be responsible for its existence, or it is a significant beneficiary of rationally-derived knowledge that is "used for" a purpose without itself necessarily being translated into something physical that "does" (e.g., instructional methodologies in education).

### 5.2. Technology by Primary and Secondary Intention

While it may not be obvious, wherever there is purpose, there is also intention. In other words, regardless whether it may be a human or a cat, the purpose found for some item of technology directly relates to how it is intended to be used. Nevertheless, I would like to indicate that neither the purpose nor the intention is necessarily embedded in the technology itself. As a pharmaceutical example, Minoxidil was a drug created to treat hypertension (Hair Solutions 2006). That is, the drug was used with the primary intention of controlling high blood pressure. However, one of the unwanted side effects was excessive hair growth. Eventually, the drug was approved by the FDA and marketed as Rogaine® to treat hair loss and was prescribed for the purpose of growing hair. In other words, Rogaine® was then secondarily used with the intention of hair growth. Despite the side effect and main effect existing as a result of using the drug, what it was used for depended on the purpose and intention that was required. It is in this manner that purpose is correlated with intention, without necessarily being tangibly embedded.

Accordingly, the purpose of a particular technology may be due to what I refer to as either primary or secondary intentions. Primary intention occurs by design or by devise, and is responsible for technology resulting from the initial intention in mind to make a technology to satisfy a purpose. Secondary intention occurs by discovery, when something that exists and is being used for another purpose first, and is found to serve a second purpose for which it may not have been intended initially (e.g., Rogaine®). The vast majority of entities considered technology also simultaneously satisfy both aspects of reflexivity with regard to function and purpose, which renders purpose directly implicit in function.

For instance, let us suppose that we have a Keurig®, a vacuum, and salt. A Keurig® is technology by primary intention, which both performs a function itself and is used (by man) to perform the same function (make coffee). It serves a particular purpose by design, devise, directly and inextricably related to its function. In the case of a vacuum, it performs a function only when used (i.e., suck debris). While it can generally function, or suck, aimlessly when plugged in, if not guided or directed toward dirt, then it will not serve a purpose; therefore, it is not performing a function. A vacuum meets the reflexivity of function criteria because it is used to do something or function, and may aimlessly suck if plugged into an outlet. However, a vacuum's purpose (and intention) is to suck dirt, which is directly linked to its function to suck dirt.

Salt is an exception, in that it satisfies the aspect of function through the reflexivity of its purpose. Nevertheless, its purpose is served in the absence of directly performing, or being used to literally perform, a function that is inextricably linked to a particular purpose. Regardless of the original purpose, and although salt does naturally occur, it also happens to elevate the boiling point of water. It is doubtful that salt was designed or devised to raise the boiling point of water. Furthermore, it cannot be said to directly perform the function of raising the boiling point, despite the fact it may be used to do so.

Because salt was likely discovered, as opposed to being designed or devised, to raise boiling point, it may be used to perform this function, since purpose and function are inextricable, but to speak of salt as having embedded the purpose of raising a boiling point would be misleading. Thus, understanding the relationships between purpose, intention, and function is essential to the definition of technology. Function and purpose are inextricably linked to one another in much the same fashion as each is related to the technology.

### 5.3. Synthesis of a Comprehensive Definition of Technology

According to the argument that was presented based on the analysis of evidence from the research, technology is exceedingly complex. The research question asked, "Of what elements should a comprehensive definition of technology be comprised from an ethological perspective?" An argument of authority was used to warrant the conclusion that addresses it, which I present as the claim of concept within the framework, suggested in the form of a comprehensive tripartite definition of

technology as follows: Technology is (a) something that is always inherently intelligent enough either to function, to be used to function, to be imbued with, or to be interpreted as having, a function that only intelligent beings (human or otherwise) have the ability to comprehend; (b) something devised, designed (i.e., primary intention), or discovered (i.e., secondary intention) that serves a particular purpose from a purely secular standpoint, without requiring that mankind be responsible for it, though he may be (i.e., the aspect of reflexivity through purpose in that salt doesn't inherently "elevate" or do anything deliberately, but it does "elevate" the boiling point of water, which it has been found to do and can be considered to serve a purpose); (c) a significant beneficiary of rationally-derived knowledge that is "used for" a purpose, without itself necessarily being translated into something physical or material that "does" (e.g., instructional methodologies in education, processes, ideas).

## 6. Conclusions

What we know or accept as science, ultimately determines what technology we devise, how we design it, or what purposes for it that we may discover and later rediscover. With new technology and new uses for old technology, many of the values that we held initially are guaranteed to transform. That notwithstanding, as our values transform, so does our perception of the technology that led to the change. Such dynamism requires us to continually reevaluate our positions regarding everything, while conceding that perhaps how we once thought about technology may not be the complete picture. Moreover, considering the existence of organized systems that either came into existence simultaneously with, or predated humans, it will no longer suffice to continue qualifying and referring to technology as that which is created by humankind according to the current schematic definition of Volti, nor will definitions like that of Bigelow be enough. Furthermore, the inadequacy of such definitions and examples of technology, such as insulin, provide a platform for the introduction of arguments substantiating either partial or complete forms of technological determinism.

There is no question that all forms of technology have significantly benefitted from knowledge gained from results obtained from research employing logic and scientific methods. When one considers the knowledge that has been obtained in, and benefitted, a variety of fields, there are occasions and examples where knowledge is not and cannot be converted into a physical form. Nevertheless, advancements benefiting sociological and instructional methods satisfy almost all criteria to be considered technology, but the lack of physical form precludes full qualification. That the results of benefits of derived knowledge do not exist in physical form, is not sufficient reason to exclude such examples from consideration, since the remaining criteria are met. Therefore, the requirement that technology be physical was removed, and the third aspect of the definition describes technology as a significant beneficiary of rationally derived knowledge that is "used for" a purpose, without itself necessarily being translated into something physical that "does."

We initially introduced a general definition of technology after deconstructing the word-roots, and claimed that technology is either understood to be: "something created through ordering exhibiting organization whose aspects function with a purpose that can provide some benefit," or "something that is organized (implying creation of order) whose aspects function with a purpose that can provide some benefit." We also considered an argument in support of why, in order to qualify as technology, it may not necessarily be required to have been a creation of humankind, as was the case of insulin.

Whether or not the reader agrees with the origin of whatever one may consider being an instance of technology is irrelevant. Regardless of the instance of technology, it is undeniable that any example of technology about which there is a consensus would exhibit organization, which implicates the fact that it was created without regard to that which created it. From the notion of creating, it may be inferred that both skill and art are required; this results in such a level of organization to exist. Thus, we deduced that the technology is comprised of the three core aspects of purpose, function, and benefit (PFB). which represent the (timeless) essence of technology. We also discussed the additional aspect of reflexivity, which is vital to the ability to appreciate and comprehend the notion of technology.

Nonetheless, as reflexivity only operates through the core aspects of PFB that comprise technology, it is contingent on their existence and could not be included among the core aspects.

Technology is something that is itself, always inherently intelligent enough either to perform, or to be imbued with, a function, purpose, or benefit, that only intelligent species, human or otherwise, have the ability to appreciate (e.g., nut-cracking). In addition, we explained that technology might result from primary or secondary intentions, depending on whether it is something devised, designed or discovered to serve a particular purpose from a purely secular standpoint without requiring that humankind be responsible for its existence. Qualifying the previous statement with the word "secular" was felt to be necessary; this was explained in anticipation of rebuttals attempting to introduce God as responsible for technology existing. The focus of this effort was to be placed more on the inherent qualities of technology itself and not that humans or God made it. Lastly, as a significant beneficiary of rationally-derived knowledge, we addressed an example of how technology may also be "used for" a purpose, without itself necessarily being in a physical form that "does." Once we established the definitional framework and developed it through the concept of adequacy, we were able to achieve the desired end of creating a comprehensive definition. It is hoped that the argument for general and tripartite comprehensive definitions that were presented as proposed, helps to establish and uphold the framework for definition that was developed in this paper. Furthermore, the present study may motivate others and assist in stimulating future research efforts into how best to reliably and consistently identify new examples of technology from which much may be learned.

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