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 DOES THE A PRIORI BELONG TO SCIENCE AND TECHNOLOGY?

SUMMARY: In this paper, I intend to support a currently controversial approach to the a priori -- the one that respects its fundamental role in science, and I furthermore suggest the relevance of the a priori may be expanded to technology. I shall address the following three issues: a priori in scientific and technological methodology, a priori and the essence of science and technology, and a priori in the assessment of science and technology.

KEYWORDS: A priori, method, science, technology.

It is a truism to say that the concept of the a priori has always been controversial; I entirely agree with Albert Casullo’s claim that the a priori proved to be exceptionally divisive, especially in the recent history of philosophy:

The major divide in contemporary epistemology is between those who embrace and those who reject the a priori. The importance of the issue, however, extends beyond the boundaries of epistemology to virtually every other area of philosophy. To a large extent, one’s views about the a priori determine how one goes about answering other philosophical questions. Current opinion is deeply divided and radically polarized. Proponents of the a priori frequently allege that rejecting it is tantamount to rejecting philosophy as a respectable intellectual discipline. Opponents respond that no intellectually respectable theory of knowledge can accommodate the a priori (Casullo 2002 3).

It indeed seems that most philosophers tend to strongly disagree over what role the a priori plays in the acquisition of truth and knowledge. Let me add that this controversy does not pertain solely to contemporary philosophy; the controversy spans at least the last century and a half. To illustrate this, one might consider looking at several philosophers belonging to the so-called Austrian philosophy movement at the turn of the 20th century, who believed that a priori ought to be taken quite seriously and that the very possibility of scientific realism assumes a priori knowledge. There are many proponents of this school of philosophy worth
mentioning; Franz Brentano is generally considered a forefather of the school and Anton Marty, Kasimir Twardowski, Adolf Reinach, and Carl Menger are some of his notable followers. This school of philosophy, which recently began attracting substantial interest in the analytic tradition of philosophy, provided some unique possibilities for alternative approaches to realist ontology.

The Austrian school spanned diverse intellectual backgrounds including natural sciences, law, and economics, and it included intellectuals from an empire that ruled over Poland, Hungary, the Czech Republic, and various other countries. The Austrians attempted to integrate the unity of science in their philosophical method, and in light of that unity the members of that school often adopted a holistic, rather than reductionist, methodology. They also firmly believed that the Kantian approach to the a priori, prevalent at the time, turned out to be too relativistic for their purposes. Barry Smith, in his influential book Austrian Philosophy, traces the nature of the a priori in the Austrian tradition of philosophy, and especially the way in which the Austrians sought to find an alternative to the Kantian approach to the a priori:

The realm of what is knowable is thereby seen as embracing not only contingent regularities knowable a posteriori (by experiment and induction) and analytic truths knowable a priori (by analysis of words and concepts) but also truths synthetic and a priori which reflect corresponding structures or relations in the world. These structures are universal or multiply exemplifiable, and they are typically a matter of how simple elements are bound together in intelligible ways into larger wholes…. Such structures are ‘intelligible’ in the sense that they can be grasped immediately and without experiment or inductive inference, in much the same way we grasp, for example, the validity of a mathematical proof (Smith 1994 307).

Some philosophers, especially those belonging to the movement of Positivism, strongly rejected the above approach, and insisted that empirical science ought to be viewed as the sole enterprise entitled to conduct the business of knowledge acquisition. Science, according to the positivists, many of whom exemplify the so-called radical empiricist tradition, pursues purely a posteriori methods. To this day, in the wake of Positivism, most philosophers maintain strong naturalistic tendencies (whether or not they admit to have been influenced by Positivism). In light of the latter tendencies, most philosophers, when they permit the a priori to play any role in their overall theory of knowledge to begin with, tend to see the a priori as either idle or vacuous in the acquisition of knowledge.

In what follows, I intend to support the former approach to the a priori; the one that respects its role in science and I furthermore suggest the relevance of the a priori may be expanded to technology. I shall address the following three issues:
• A priori in scientific and technological methodology
• A priori and the essence of science and technology
• A priori in the assessment of science and technology

Before I proceed, I need to briefly characterize my understanding of the a priori. Admittedly, my approach to the a priori is both methodologically loose and non-exhaustive: I take a priori knowledge to be knowledge which does not depend on experience to be justified and which is also gained independently of experience. I should admit, right from the outset, that my approach is going to fall short of Albert Casullo’s strong requirement for establishing a priori knowledge: “Establishing the existence of a priori knowledge, however, requires more than revealing deficiencies in radical empiricist theories of knowledge. It requires supporting evidence for the claim that there are non-experiential sources of justification (Casullo 2003 148).” As well, the drift of this paper does not support my participation in the rich and intricate discussion of a priori justification. I hope it will suffice to remark that I am aware of some of the deep conceptual problems both radical empiricists and apriorists have faced hitherto in respect to a priori justification. (The terms “radical empiricists” and “apriorists” are normally used in the literature to refer to philosophers who deny the existence of a priori knowledge and those who support the existence of such knowledge.) This is how Casullo sums up the aforementioned problems:

With respect to the existence of a priori knowledge, I argued that the leading arguments are inconclusive. The conceptual arguments, both for and against the a priori, involve implausible conditions on a priori justification. Supporting criterial arguments involve false epistemic premises, whereas deficiency arguments fail to show that radical empiricism has unacceptable consequences that are avoided by apriorism. Radical empiricist accounts of knowledge of propositions alleged to be knowable only a priori do not establish that those propositions are not known a priori. Finally, neither philosophical nor scientific naturalism supports the claim that a priori knowledge is incompatible with epistemic naturalism (Casullo 2003 147).

To return to my much more modest goals, I wish to ask the following: are there at least some components of science and technology that appear to be a priori? I believe we do not have to look too far to find a potential answer to that question. The answer can be found in the very heart of the methodology of science; more specifically, within a version of the theoretical framework of that methodology, propounded by Sir Karl Popper. It is widely known that Popper, inspired by Hume’s skeptical attitude towards induction, doubted that induction can ever secure the grounds for its justification. Even a novice in the domain of philosophy of science
knows that Popper envisioned a unique and daring view of science, where knowledge should always be an outcome of risky predictions. The value of a scientific hypothesis, according to Popper, is ultimately measured by testing its corresponding set of empirical and observable implications. As soon as the latter implications are found inadequate, the hypothesis faces revisions or a wholesale rejection. Even in light of this fallible and probabilistic approach to scientific reasoning, Popper still believed his model of science ought to be based solely on deductive certainty. Yet that deductive certainty turned out to be a form of negative reasoning, basically involving the application of *modus tollens*. I believe the following question remains legitimately asked: could Popper’s deductive certainty be ultimately based on anything else except *a priori* grounds?

What emerges as the most important consequence of my brief discussion of Popper’s thought is that Popper maintained that scientists who choose to be guided by reason cannot possibly appeal to induction. What is their guidance then? I am keenly aware that, even before the very mention of the a priori playing a role at this junction, it will be immediately objected that the *outcomes* of Popper’s falsification method in science are strictly empirical. However, one needs to keep in mind that the *ground* on the basis of which the hypothesis-implication projection is *formulated* is not, and cannot, be empirical in nature. The thesis that Popper’s deductive logical configurations (i.e. the coupling of a hypothesis with a suitable implication) reject any intrusion of empirical knowledge since their purpose is to become the only vehicles of scientists’ empirical corroboration appears to fit Popper’s methodology very well. This is what Popper writes in *The Logic of Scientific Discovery* on what he terms the “quasi-inductive process”:

The quasi-inductive process should be envisioned as follows. Theories of some level of universality are proposed, and deductively tested; after that, theories of a higher level of universality are proposed, and in their turn tested with the help of those of the previous level of universality, and so on. The methods of testing are invariably based on deductive inferences from the higher to the lower level; on the other hand, the levels of universality are reached, in the order of time, by proceeding from lower to higher levels (Popper 2009 276).

Surely we have to ask about the source of such universality. It might be offered that the “some universality” Popper refers to could be a matter of an arbitrary starting point, and it could be reduced to an outcome of blind guessing. Yet the minds of scientists do not function as black boxes and no matter how random their guesses might happen to be they always take place within some sort of a range or some kind of a structure. Popper attests to this very persuasively:
We do not stumble upon our experiences, nor do we let them flow over us like a stream. Rather, we have to be active; we have to ‘make’ our experiences. It is we who always formulate the questions to be put to nature; it is we who try again and again to put these questions so as to elicit a clear cut ‘yes’ or ‘no’ (for nature does not give an answer unless pressed for it) (Popper 2009 280).

How do we best explain this process of formulating our questions and shaping our experiences? Where does whatever level of universality enter the picture in this process? In my opinion, it does not take a great leap, even within the context of Popper’s philosophy, to allow at least some room for the a priori in his methodology.

Does what I have said so far, at least at first blush, allow the a priori to assert itself in the methodology of science? I suggest there is more to be said on the conjunction of science and technology and the a priori. First of all, does not every technology incorporate formal sciences? Are not some of the most far reaching technological advancements in the 20th century ultimately based on abstract and bold thought experiments? In fact, the 20th century is arguably the century that can be labeled “the century of the a priori” more than any other century. Let me point out to a couple of examples to illustrate this claim, which I believe is much less controversial than it appears. Albert Einstein’s work illustrates the giant leaps between what was once considered pure (and in many cases a priori) based reasoning and technological improvements and solutions directly or indirectly based on the former reasoning. It goes without saying that the greater these leaps became the less time was necessary to close the gap between what occurs in the laboratory of the mind, based on a priori methodology, and what occurs in the scientific and technological laboratory.

However, there are even more philosophically pertinent reasons to inquire into Einstein’s reliance on the a priori. In his essay “Einstein, Kant, and the A Priori” Michael Friedman argues that even though Kantian synthetic a priori had to be rejected in the wake of Einstein’s work, a “relativized” constitutive a priori principles had been instantiated in the creation of special relativity. Friedman’s argument relies on a careful historical analysis of the relativized a priori, which Friedman attributes to the work of Hans Reichenbach. The relativized a priori, Friedman further argues, can be traced in the subsequent scientific work of Helmholtz, Mach, and Poincare and, of course, Albert Einstein. It turns out Einstein’s special relativity can be plausibly interpreted as informed by aforementioned constitutive a priori principles. A prime example of this type of a principle is Einstein’s principle of equivalence:
Because Newtonian gravitation theory involves an instantaneous action at a
distance (and therefore absolute simultaneity), it was necessary after special
relativity to develop a new theory of gravitation where the interactions in
question propagate with the velocity of light. And Einstein solved this prob-
lem, via the principle of equivalence, by defining a new inertial-kinematical
structure wherein the free falling trajectories in a gravitational field replace
the inertial trajectories described by free particles affected by no forces at all.
The principle of equivalence, in this sense, replaces the classical view of
inertia holding in both Newtonian mechanics and special relativity. But the
principle of equivalence itself rests on a well-known empirical fact: that
gravitational and inertial mass are equal, so that all bodies, regardless of their
mass, fall with exactly the same acceleration in a gravitational field. In using
the principle of equivalence to define a new inertial-kinematical structure,
therefore, Einstein has ‘elevated’ this merely empirical fact (recently verified
to a quite high degree of approximation by Lorand von Eotvos) to the status
of a ‘convention or definition in disguise’ – just as he had earlier undertaken a
parallel ‘elevation’ in the case of the new concept of simultaneity introduced
by the special theory (Friedman 2008 108).

Whether or not we agree with Friedman; i.e., whether or not Einstein’s usage
included these constitutive, relativized (and essentially Kantian) a priori principles,
Friedman certainly helps establish a place for the a priori in Einstein’s thought.
What about the process of visualization used by some scientists in the recent
history of science? The type of visualization I am referring to seems to be both
independent and prior to experience. Even the technological skills used by the
scientists in these visualizations seem to be independent from experience. Are we
that far off when we speculate such skills have an a priori grounding? Perhaps the
best example of the former type of visualization can be found in the fascinating
scope of imaginative probing and mental experimentation done by Nikola Tesla.
This is how Tesla describes his process of visualizing his experiments:

Then I observed to my delight that I could visualize with the greatest facility.
I needed no models, drawings or experiments. I could picture them all as real
in my mind. Thus I have been led unconsciously to evolve what I consider a
new method of materializing inventive concepts and ideas, which is radically
opposite to the purely experimental and is in my opinion ever so much more
expeditious and efficient. The moment one constructs a device to carry into
practice a crude idea he finds himself unavoidably engrossed with the details
and defects of the apparatus. As he goes on improving and reconstructing, his
force of concentration diminishes and he loses sight of the great underlying
principle. Results may be obtained but always at the sacrifice of quality.
My method is different. I do not rush into actual work. When I get an idea I start at once building it up in my imagination. I change the construction, make improvements and operate the device in my mind. It is absolutely immaterial to me whether I run my turbine in thought or test it in my shop. I even note if it is out of balance. There is no difference whatever, the results are the same. In this way I am able to rapidly develop and perfect a conception without touching anything. When I have gone so far as to embody in the invention every possible improvement I can think of and see no fault anywhere, I put into concrete form this final product of my brain. Invariably my device works as I conceived that it should, and the experiment comes out exactly as I planned it. In twenty years there has not been a single exception. Why should it be otherwise? Engineering, electrical and mechanical, is positive in results. There is scarcely a subject that cannot be mathematically treated and the effects calculated or the results determined beforehand from the available theoretical and practical data. The carrying out into practice of a crude idea as is being generally done is, I hold, nothing but a waste of energy, money and time (Tesla 2011).

One could object to the previous account of Tesla’s visualization by pointing out that Tesla’s imaginary experiments appear to be extrapolated from experience, after all. Even if one grants that this objection stands to reason, there is still no way of providing an empirical account of Tesla’s discovery of properties hitherto unobserved and unrecognized in nature. How would Tesla glean his inventions from experience, especially when we know that several of his ideas are so far reaching and ahead of his time that they still await practical application? Take for example his invention of the alternating current; he did not even test any features of his new invention in his shop. By his very account, the invention inextricably emerged, simple and complete, in the laboratory of his mind.

Finally, let me briefly discuss a possible usage of the a priori in the process of assessing a wide range of societal impacts of science and technology. It goes without saying that the rapid growth of science and technology and their tremendous range of current and projected applications makes it necessary for humanity to engage in constant monitoring, reflection and assessment of that growth and range. What can we say about the slippery slope argument, which has become indispensable, especially in regard to assessing the impact of science and technology on society, in the philosophy of technology? Slippery slope arguments say, roughly, that if one thing happens then something else will also happen, and if that other thing happens, some kind of a disaster or at least a highly undesirable consequence will occur. Since we do not want that final disaster perhaps we should not make that first step. Even though there have been efforts to elucidate slippery slope
arguments, particularly in the critical thinking literature, I believe there are still many aspects of slippery slope arguments that are not sufficiently understood. Let me provide a small example of the kind of dominant role slippery slope arguments seem to be assuming, especially when it comes to discussions of the future directions of technology. McNamee and Edwards address the phenomena of transhumanism, medical technology, and slippery slopes in a recent essay published in the *Journal of Medical Ethics*. Transhumanism is a relatively recent intellectual movement that became prominent because of an increasingly pressing need to redefine the boundaries of humanity. This movement is interdisciplinary in nature, and it strives to assess the technological challenges and opportunities that arise in the process of enhancing the human organism. The authors define transhumanism as “a quasi-medical ideology that seeks to promote a variety of therapeutic and human-enhancing aims (cf. McNamee and Edwards 2006).” There are many possible applications of slippery slope when it comes to possible uses of medical technology. One approach may involve the Sorites paradox,

[w]here taking a grain of sand from a heap does not prevent our recognizing or describing the heap as such, even though it is not identical with its former state. At the heart of the problem with such arguments is the idea of conceptual vagueness. Transhumanists may well seize on this vagueness and apply a Sorites argument as follows: as therapeutic interventions are currently morally permissible, and there is no clear distinction between treatment and enhancement, enhancement interventions are morally permissible too (McNamee and Edwards 2006).

Needless to say, slippery slope arguments do not necessarily involve vagueness; as a matter of fact, they might take the form of the domino effect, “foot in the door argument,” “show ball” or “genie in the bottle argument,” and so on and so forth. Even though the previous example involves medical technology, the reader is certainly aware that the usage of slippery slope is extremely prevalent in the philosophy of technology.

Could it not be argued that the slippery slope argument may ultimately be a matter of a priori reasoning? It turns out in the search for what appears analogous to slippery slope argument in philosophy one often turns to abstract phenomena found in physics and mathematics. For example, in physics, the phenomenon of momentum may be considered analogous to the structure of slippery slope arguments. Momentum is usually accounted for by referring to a process that involves some sort of causal relationships among intermediate events. Even though the connection between the a priori and slippery slope reasoning may appear rather tenuous at first glance, I am convinced this junction is not properly understood and it merits further inquiry.
I hope this brief discussion has helped reveal the extent to which the a priori can be discovered not only in scientific and technological methodology but it can also be argued that the a priori belongs to the very essence of science and technology and that it plays an important, and yet not sufficiently understood, role in the assessment of the effects of science and technology.

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mentalnu ulogu u nauci, a dodatno predlažem da relevantnost a priori može da se proširi na tehnologiju. Razmotriću sledeća tri pitanja: a priori u naučnoj i tehnološkoj metodologiji, a priori i suština nauke i tehnologije, a priori u proceni nauke i tehnologije.

KLJUČNE REČI: A priori, metod, nauka, tehnologija.