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Reflections on Practical Otherness: Peirce and Applied Sciences

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1. Introduction

By *practical otherness* I mean a special case of Peircean category of secondness given in the realm of phenomena of applied sciences, the kind of sciences that according to Peirce have practical ends. In general terms, the experience of otherness is one of the most important for the growth of knowledge being, at the same time, the phenomenological basis for a *relevance criterion* for the choice of the theory that can better represent some sort of phenomena.

An applied science like engineering, particularly when dealing with design and monitoring of physical objects, shows in its activities how *practical consequences* – the famous expression of the *pragmatist maxim* – can be understood totally based on the possibility of *practical otherness*. Furthermore, pragmatism is a way not only for reading the connection between theory and experience but, above all, for demanding an essential commitment between both. Peirce's theoretical system also furnishes the ground for reading indeterminacy as much in theories as in real objects. This *conceptual symmetry*, let me here adopt the expression, is in fact a consequence of the symmetry of Peircean categories, and established epistemologically by *Fallibilism* and ontologically by *Tychism*. This indeterminacy can be estimated with experimental data, and decisions can be taken despite the congenital uncertainty that rules all sciences.

Regarding the experiential ambience, it is important to remark that applied science has some advantage over theoretical sciences: its experimental field is entirely open to observation, as its objects need to work anyway. They are practical objects with practical ends and, being so, they continuously are tested by their users. Despite being designed by men under well-known theories and technology, they potentially keep, nevertheless, their *practical otherness*: the theory prediction must be harmonious with their observable performance or, otherwise, be denied by it. Their performance affects theories, and even *normal technology*, as extended from *normal science*, here and there deals with surprising facts, demanding an effort to guess what is going on with the possible disagreement between prediction and experimental data. Under the point of view of Semiotics, the practical scientist keeps a dialogue with the objects of design through the analysis of its performances. To call the interaction between theory and experience a *dialogue* is possible mainly due to Peirce's realism, reflected, of course, in pragmatism as a spreading rule for meaning, viz., surpassing the domain of mere subjectivity.

Let us take for granted that all the assumptions of Peirce's epistemology are deeply connected with his conception of science. This conception brings somehow an ethical commitment that cannot be surprising to anyone who is aware of his classification of sciences. The three steps of inquiry, namely, abduction, deduction and induction, will be effective as if they could work by themselves, if some ideal condition could be filled out. The main condition will be a sincere search for truth, free from other interests potentially strange to this aim. Science taken generally, therefore and consequently, shall have one basic aim, namely, to represent the best it can the universe of a dynamical and evolutionary reality. This being the case, no other goal should interfere in the science path throughout its main end, viz., to achieve truth.

2. Reflecting on Peirce's considerations of applied sciences

My concern here is to reflect on the following questions: would the epistemological dimension of science be free of that ethical commitment just mentioned in the latter item, as the three steps of inquiry seem to be indistinctly applied to any kind of object? In this case, could this application of the method of inquiry not be called a science? In other words, science would be such if only it really follows a sound ethical end? These interesting questions seem to require, first of all, what distinctions could be made between *Pure* and *Applied* Sciences, as the latter, given its own nature, could not obey that demand of being only a disinterested search for truth.

Other subsidiary questions will also appear along this investigation, such as 'could Applied Science be equivalent to Technology?' and 'what is the difference between Technology and Technique?' Such secondary questions regarding the main ones will deserve clarification in order to refer our reflection to a univocal terminology, despite the fact that they are far from a conceptual agreement among researchers.

2.1. The nexus with Peirce's pragmatism

On the one hand, Pragmatism, in its function of clarifying concepts, could be, we believe, the proper criterion to make the retro-mentioned concepts clear and distinct. On the other hand, the steps of inquiry, exactly as formulated by Peirce,[1] also seem to be an interesting basis for reflection. We know the complexity of the concept of Science in Peirce, not only for its conceptual scope, but also for its ethical dimension, for its bond with Esthetics, for the means through which it outlines itself under the logical forms of reasoning – in sum, for its dependence on the Normative Sciences – besides its interlacing with the Categories and with the fundamental concept of Community in his philosophy.

Conversely, given this complexity, which has certainly required much of Peirce's attention, it seems to me that he concentrated less on the clear formulation of the concept of Applied Science and even Technique. Only exemplarily, it's worth remembering that the word *technique* appears only twice in the eight volumes of the *Collected Papers*. The word technology, not once.[2] Certainly it had no highlighted meaning in his time, nor the same power and importance it acquired later or today. The rapid pace of post-war industrialization was a historical phenomenon Peirce did not experience the mass production of objects, directly linked to technological development, nor was it the object of his reflection. However, it was quite clear to him that the Applied Sciences' goal was to serve human needs. In Beverley Kent's classic work, there are interesting passages on the Practical Sciences in Peirce:

[1] As already mentioned, abduction, deduction and induction.

[2] According to Harper (2001), the term technology was coined in 1615, and it means "discourse or treatise on an art or the arts," from *Gk.* tekhnologia "systematic treatment of an art, craft, or technique," originally referring to grammar, from techno + logia. The meaning "science of the mechanical and industrial arts" is first recorded 1859. High technology attested from 1964; short form high-tech is from 1972. Tech as a short form of Technical College (Institute, etc.) is American English, attested from 1906.

> While the practical sciences do seek to discover truth, they differ from the heuretic sciences because their investigations are directed towards satisfying some definite human want. Kent, 1987, p. 82

and,

> Practical sciences seek to satisfy human desires. They take the systematic statement of discovery, supplement it where necessary, and make it available for application to areas in which it is expected to have some utility... Although he formulated a very considerable classification of the practical sciences, he regarded it as one of his failures.
> Kent, 1987, p. 131

Kent (1987, p. 189) furnishes a good synthesis of Peirce's considerations concerning the Applied or Practical Sciences:

The task of the third major division of the sciences is to discover truth for some defined human need, although the researchers themselves may not be involved in the practical application of their investigations. Peirce noted that this group of sciences attracts significantly more scholars than the previous groups. While these disciplines primarily involve reasoning and related operations, an enormous number of facts not previously assembled, must be collected also. These facts concern either the want that is waiting to be satisfied or the physical means for its implementation. Although they are bound to make their own observations and amass their own data, the practical scientists are quite dependent on the discoveries of the heuretic science.

There is, in Peirce's thought, a care for distinguishing Heuretic Sciences from Applied or Practical ones, and, on certain occasions, he seems to cherish a kind of disdain for the latter, in such a manner that their *vital ends* characterize a channeling of the research for the solution of man's current problems (see Hookway 2002, pp. 21–22, 228). Unlike these interests, Pure Science ought to be based, according to Peirce, on the instinctive impulse toward the truth, freed from the practical character of its results. Concerning this aspect, we will comment on it in the conclusion of this paper.

From an epistemological point of view, we will point out further on the utmost importance of these practical purposes in Applied Sciences for human needs, especially regarding the speed of incorporation of new theoretical models and diffusion of knowledge.

It is important that we give, here, a more accurate and detailed definition of Applied Sciences, Technology and Technique, for these concepts are, oftentimes, deemed alike.

It seems proper to say that Practical or Applied Sciences, doubtlessly directed to human needs, involve the research of theoretical models and the retroanalysis of experimental data and, for this very reason, constitute reflexive intellectual urging in the Peircean pragmatic sense, which, as we know, cannot be confined merely to the realm of particular objects. Concerning this issue, it is worth referring to two classical passages of Peirce's Pragmatism:

> Action wants an end, and that the end must be something of a general description, then the spirit of the maxim itself, which is that we must look to the upshot of our concepts in order rightly to apprehend them, would direct us towards something different from practical facts, namely, to general ideas, as the true interpreters of our thought. CP 5.3

and,

> Pragmatism is a correct doctrine only in so far as it is recognized that material action is the mere husk of ideas... But the end of thought is action only in so far as the end of action is another thought.
> CP 8.272

The expression *practical consequences*, present in the Pragmatism maxim embodies, in light of this reflexivity concept, the need for the *continuum* to configure itself as *discontinuity* for a subsequent return to its genuine eidetic realm. Well then, seen from this vertex, *Practical* will mean passing through the discontinuous, where the otherness required for the improvement and growth of the representation effectively lies.[3]

It is also interesting to point out that this passage through the discontinuous is the manner through which the theoretical sphere *appears*, that is, has phenomenologically experienceable consequences. The semiotic dialogue, needed for the establishment of semiosis, i.e., of the cognitive function, requires the *practical* as experienceable aiming at the universal validation of the theoretical instance.

Technology, in turn, can be considered, parodying the Kuhnian concept of Normal Science, as a Normal Applied Science, that is, that activity that, through a technique, puts into practice theoretical models that have already been tested or parametrically reformulated in a reflexive manner from experience.[4] Lastly, Technique would comprise all practical proceedings that enable technological knowledge in the form of the creation of

[3] In Ibri (2001) I considered this point in detail.

[4] It is left for us to clarify what constitutes experience in technology. We will return to this question.

objects. Technology and technique differ: while the former is theoretical-practical knowledge, the latter is confined solely to practical knowledge. Technological activity possesses theoretical models for the reading of experience and, thus, can always see it under a more general view, shaping its conduct in light of these models. Technical activity is the upshot of successful practices and, for this very reason, possesses a reduced power of generalization. When its habits are broken by failure, it can hardly mobilize resources for a reflexive analysis; all it can do is simply exclude that failed case from the list of successful samples it has and which it always seeks to imitate.

Technique accomplishes; technology plans such accomplishment and knows how to justify it in light of already tested theoretical-practical models. Applied Science solves the problems brought by technological practice in its normal activity, proposing new interpretants to be tested.

2.2 What, after all, is experience in applied sciences?

According to Peirce, as we know, Applied Sciences have practical ends, which are to produce objects for human utilization. Its ground, according to him, is in the Heuretic Sciences or Sciences of Discovery. In Civil Engineering, for example, the last theoretical basis of part of its models is to be found in Rational Mechanics, the general science of the equilibrium of solid systems.

As Applied Sciences, such as engineering particularly, aim at producing objects for human purposes, and since such objects once built are submitted, not to the experience imposed by those who have conceived it, but by those who will use them, we may say that the experimental field of these sciences is constituted by the performance of the objects it creates. The verification of the truth of its theories is not constituted by experimental results only, but by performances. The objects will *speak* for themselves, when inquired by a technological activity to monitor their performance. However, not only so: those who utilize them *will tell* whether they do or do not serve their purpose. It is worth mentioning that this objectual field is, due to its very nature, *public*. Nevertheless, it must be highlighted that it will not be of any interest for the retro-analysis of the Practical Sciences all that, out this human testimony, refer solely to variables that effectively concern market sciences. This retro-analysis, of an exclusively epistemological nature, aims at proposing new theoretical-practical models – or reparameterizing old ones – thus endowing technology with new efficient procedures.

We may say that Applied Sciences are, for the reasons stated, intensely dialoguing, evidently semiotic, demarcating its growth and learning in this circulation of signs that causes the intense and pragmatically reflexive interaction among its particular and general instances. We ought to bear in mind that the truth of the theories that are practical in character is made patent in a much faster pace than that of the merely Speculative Sciences or those without practical purposes: in the latter, often, the experimental field is extremely complex and burdensome, and many theories remain, for years, strongly hypothetical, due to the difficulty of their experimental verification.

In the realm of technology, the conception of a new object will begin with a project. But what is a project? It is, in fact, the most genuine semiotic kind of knowledge in its '*esse in futuro*', namely, in its predictive expression. We could say that a project is a virtual object described according to laws that will rule the real object in the future. Keeping its general symbolic character, it bears the icon of its replica as Secondness in the form of a hypoicon. The designer has high hopes for his project and knows that it will only be possible if the laws provided in it according to the best theories, represent, in an approximately true manner, on the one hand, the laws that rule the behavior of the material components, and, on the other, those that rule the performance of the object that will be built. Incidentally, one must decide many times during project design, which theories must be chosen among those available for each case. There is, here, evidently, a tacit realism adopted by the designer. From this Realism depends all the possible justification of the prediction success. This is a key point among Peirce's arguments in favor of his Realism: the conditions for the future representability of the sign in relation to its object lie, simply, on the reality of the *continua* of Thirdness, viz., on the hypothesis of a realism of the laws. It is not only the case of adopting a theoretical stance here, but to answer factually for such stance, once the objects of the Applied Sciences are right here and will be, in their most genuine Secondness, in their *practical otherness*, as a *consequence* of how it has been represented. Furthermore, we believe such conditions to be valid not only for the project of a bridge but also for a piece of furniture, for a machine or for medicines.

We must consider, then, this potential *continuum* of the insistence of the object against the set of presuppositions with which we conceived it. The generalized and generalizing evidence of Thirdness that rules it, typical of Applied Sciences, is in fact the most plausible justification of the naturally regulating Realism of the scientists' expectations.

The object, once made, though it might have been according to the project, will be judged in light of three basic parameters: its structural performance, directly related to its safety, its durability and functionality. Such parameters constitute the continuity of the phenomenical field, according to laws in Applied Sciences, and will be, according to their performance, permanently defying a theoretical retro-analysis. Much to the contrary, in a Science of Nature, especially those whose objects are difficult to access experimentally, it is important to notice that such objects are not apt to directly affect our human conduct.

There is a field of pragmatic meaning in Applied Sciences within which a semiotic dialogue is drawn between the interpretants of the scientist, of the users of the object, and of the objects themselves – these *interpret* the actions they will be submitted to, according to the laws that rule them. The users are, in turn, those who will *interpret* the efficacy of the purposes those objects ought to serve. Both, objects and users, constitute the *practical otherness* with which the scientist will have to permanently confront himself. Practical otherness is forcibly experimented as the upshot of the Applied Sciences activity. In non-applied sciences it is presupposed as the necessary theoretical requirement for the logical truth of theories – the otherness of its objects will only be able to manifest itself as the investigation proceeds.

We do not deem it proper to consider this tacit realism assumed by Applied Sciences as naïve. It is not the case of a scientist who, unconscious of the vicissitudes of philosophical skepticism, would assume a metaphysics of the universals without any criticism since, while inquiring on a natural object, would not even think how impossible it is to infer the need of the space-time continuum for the properties he has discovered. On the contrary, he believes that he will be submitted to the semiotic criticism of a future *practical* otherness coming from the performance of the object and the judgment of its users, concerning the efficacy of the purpose.

One may think that, once the objects have been devised by means of projects, they somehow impose their form, along with their behavior and according to laws and targets, such that the general instance is only in the sphere of language, characterizing the most common kind of nominalism. Much to the contrary, since practical otherness imposes, as we have mentioned before, a constant dialogue with the object of these sciences, characterized by the continuous reflexive activity of retro-analysis, the scientist expects his actions – through technology and technique – to be efficient according to laws which rule the conduct of the objects. *Tense* Secondness, so to speak, needs to be represented so that its impending *brute force* is overcome by mediation. Such *tension* is immediately reflected in the Thirdness of Science: a mistake in the diagnosis, be it, for instance, medical in nature, or concerning the real safety state of a civil engineering structure, may cause the most undesirable consequences. Here, the *telling* has an ethical commitment with the *doing*. And such responsibility can only be undertaken in light of a Realism that allows the efficiency of the semiotic dialogue of the physician with the symptoms of the body of the patient, or of the engineer with the symptoms of a structure. In both, behind the indexes of factuality, there must be *real* symbols that mediate the conduct of the object, making that dialogue possible. The hope of the scientist is, always, that the object of his investigation also *speaks* his language. In fact, such hope only seems to consummate itself under the hypothesis of Realism.

2.3. The implicit fallibilism in applied sciences

Besides the mistaken supposition that the practice of the Applied Sciences is nominalistic, it would be natural, also, to think that the objects must behave *without deviation* in relation to what a project proclaims. Let us not forget, however, the *tense* practical otherness constituted by the performance of the objects, many times far removed from what was thought of it. In civil engineering, for example, the theoretical models for design are probabilistic or semi-probabilistic, owing to the probabilistic behavior of the materials, structure and actions that affect it. Structures are designed by adopting the so-called *safety* ratios whose purpose is to minimize the risks of a possible, although scarcely probable, incidence of random variables in simultaneous combination with rare events. Besides this evident admission of chance acting in the sphere of the object, there is, in these models, the implicit acceptance that human action, be it during the project design, or in the making of the objects envisaged, may fail, due to the inadequacy of the immediate object to the dynamic one, characterizing the project, thus, as a bad representamen of the real object.

For this very reason, many of these structures, after having been built, are permanently monitored, in a manner of confrontation of the theoretical premises that have guided the design with the real behavior of the object.

Exemplarily, it can be mentioned that large structures conceived with new theoretical premises are frequently monitored through highly precise electronic and mechanical instrumentation. The theoretical curves of the predicted structure behavior, based on the premises adopted by the project, are confronted with the experimental data of displacements and deformations obtained through the instruments. In an applied way, this is what Peirce means by the *esse in futuro* of the theories: the confrontation of the prediction with experience as a validation criterion of these very theories.

As an analysis criterion, when the theoretical curves are very close to the experimental ones, one may conclude that the structure was correctly built, according to the project, and, mainly, the theoretical premises represent the real behavior parameters. What is worth noticing is that the differences between the theoretical and experimental curves, despite the fact that they indicate the same tendency of behavior, and this is enough to support the interpretants of the monitoring process, are due to chance factors that affect the real object, thus undeterminable in the ideality of the theoretical model. The awareness of scientific fallibility is able to accept the natural and expected dispersion of experimental results. For no other reason, Fallibilism, under an epistemic bias, and Chance, through an Ontological one, are correlate concepts.

3. Conclusion

The semiotic dialogue with the designed object is only possible if general logical structures guide its performance. In this case, the common language between sign and object is constituted by general systems of relations: on the one hand, theories; on the other, laws, in a form of necessary acknowledgment of Peirce's Realism, as mentioned before. Thirdness needs to be symmetrical, and under this hypothesis, it is feasible to explain the reason for the affection of theoretical symbols by experimental indexes. I believe that Realism finds itself in a more comfortable logical situation to justify why the last word is given to the particular, when it comes to validate, or not, the general.

As aforementioned, the fact that an object has the *geometrical form* predicted in the design does not mean that it possesses the same *logical form* of that project. Parametric variables associated to a proper dispersion of the used material will influence in the structure behavior, as well. Major discrepancies can and often occur. The performance of the object will show its practical otherness, its Secondness, which will allow the recalibration of the parameters or refinement of the models. The continuum of the future performance will show, or not, the correction of the new adopted model, in a process of improvement of the interpretants of that science.

As all sciences, applied ones grow and assimilate new knowledge thanks to the anomalies of behavior. In the occurrence of unexpected behavior of the object, and even in accidents with harmful consequences, opportunities for great learning arise. Area-scientists seek plausible explanations in processes involving the raising of hypotheses, which must be tested for confirmation. All kinds of research need a theoretical model as a criterion for relevance. That is why every research ought to start with Abduction.[5] Applied Sciences evolve under the same reasoning processes that guide Heuretic Sciences, according to the nomenclature bequeathed by Peirce, and, as abductions are abundant and extremely necessary in Applied Sciences, it seems to us that they should also be reconsidered under their tremendous heuretic power.

For this reason, some questions that demand reflection posit themselves. All the supposed inferiority of Applied Sciences – in relation to Heuretic Sciences – lies, it seems to us, on the meaning of the word *practical*, still carrying the stigma of *useful* – a *practical* end would be a *utilitarian* end – while, as a matter of fact, practical ought to mean *experienceable*, in such a manner that one may consider the maxim of Pragmatism as a valid rule for meaning also within Applied Sciences, in tune with Peirce's criticism of the improper appropriation of this maxim by the utilitarianism.

Yet, to us, the question seems to be an ethical and not an epistemological one. What to do with knowledge and how to be faithful to the truth of the facts to the detriment of interests foreign to Science itself, whether practical or not, is a problem concerning what conduct to adopt in light of certain values one considers communitarily admirable, free from sectarian interests. From this point of view, it seems false to us to impose a connate distance between Heuretic and Practical or Applied Sciences, regarding its logical structure and the sound ethicity of its ends. To condition scientific investigation, regardless of its nature, whether theoretical or practical, to the purposes intended, reveals an interference of power instances foreign to scientific procedures, misrepresenting them as such.

Under this prism, the philosophy of Peirce enhances a rereading of the misunderstandings of our culture, of our relation with Nature, of our anthropocentric tradition, which stimulates asymmetric, dualistic stances, whether from the point of view of knowledge or from an ethical vertex. Reforming our worldview should imply, pragmatically speaking, reforming our conduct, and, thus, judging Practical Sciences under their potential

[5] Abduction is emphasized as the starting point of every inquiry in connection with deduction and induction in Ibri (2006).

nature for epistemic discovery, distilling, from scientific activity, those decisions that are ethical in character.

The recent awareness in the community of man concerning the need to save our Planet, as a vital undeferrable goal, has provoked, along with it, reflections on the aggression of our civilization to Nature, an awareness of this asymmetry of rights to which, for centuries, we have related. Would not this asymmetry have a conceptual debt with anthropocentric philosophies, and with what Peirce named an *ethics of greed*? In this vital mission, it is clear that one cannot do without Applied Sciences and their twin sisters, Technology and Technique. I believe that philosophy owes them better epistemic justice, aware, also, of the necessary separation between *knowledge* and *uses of* knowledge, between the meaning of power as a verb, and the meaning of power as a noun.

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