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## THE WORLD AS IT IS VERSUS HOW IT SHOULD BE: EPISTEMOLOGICAL DIFFERENCES AND CONVERGENCES BETWEEN SCIENCE AND DESIGN

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### ABSTRACT

The purpose of this essay was to critically discuss whether there are and what are the epistemological differences between scientists and designers. These two characters are worked out in the form of extreme stereotypes. The scientist is the ultimate representative of a traditional and positivist view of science, which seeks to explain in a value-free way how the world is. While the designer represents all those who act guided by proposals of value to transform the world, not just explain it. In these two different ways of acting and creating knowledge, Peirce's three types of logical inference would play a fundamental role, induction and deduction being the central tools for the scientist and abduction of the designer's own thinking. Throughout the work, we present a critique about this split, demonstrating that this is an artificial and inadequate division, since both characters work with the three types of inference. In this way, both would be, contrary to what the literature defends, epistemologically very similar.

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## INTRODUCTION

This essay aims at discussing whether there exist and what would be the differences and similarities between an epistemology of science and a possible epistemology of design. Epistemology is usually concerned with questions such as: What is knowledge and its nature? How does a field create knowledge and come to know? The discussion of the ways of knowing, its specificities and its relation to the scientific knowledge is a theme that is object of study in the 'design and knowledge' dimension, one of the six dimensions of reflection towards a philosophy of design proposed by Beccari, Portugal and Padovani (2016). Before advancing the discussion, it is important to delimitate the understanding of the term design used here. Far from being constrained by the areas of praxis that are associated with design here in Brazil, such as graphic design or product design, the working concept of design for this essay is rather broader and encompassing, going back to what Simon (1996) defines as sciences of the artificial, also known as sciences of design. For Simon, any person who projects ways to transform an existing situation that contains a problem into a better future situation is acting as a designer. Therefore, regardless of specificities and differences in the object of study and practice of multiple diverse areas that run the gamut from architecture, engineering, medicine, informatics to business, among other creative disciplines, all of them, by proposing new objects, new artefacts, physical or otherwise, have a point in

common: the final goal of re-shaping the artificial environment that surrounds us. This construction of a world that doesn't exist yet, according to Simon, is the praxis of designers; a definition that includes, therefore, multiple areas and professions. It is precisely this construction of a world that doesn't already exist, guided by values capable of qualifying what there is wrong in the current world and what would constitute a better world that would place the epistemology of design in a direct opposite stance from science, at least from a standpoint for a traditional and positivist view of science. For science, the scientific investigation cannot be guided by moral values, and should be neutral and capable of identifying impartially the 'truths' that exist in the world. In other words, science investigation should describe the world as it is, and should not speculate with hypothesis on how the world should be or not. When we justify this opposition in epistemologies, we will later show that multiple authors point to a difference in the form in which knowledge is created in each of these extremes. Science would work just with inference types of induction and deduction; abduction would be the working tool of design. In this discussion, the theory of abduction from Charles S. Peirce plays a central role, considering that this mode of inference - supposedly the only one capable of proposing new ideas - would be considered the central dimension of an epistemology of design. However, throughout this essay, there will be some questions about whether designers may claim a supposed exclusivity

on this form of reasoning. Accordingly, there will be some discussions on the extent to which it is possible for a scientist to conduct research in a neutral form, without values, by just impartially reading the world for its 'truths' using induction and deduction, without creating something new using abduction. The remainder of this essay presents some thoughts on epistemologies and the three types of inference (abduction, induction and deduction) as proposed by Peirce. Then, the alleged differences between the epistemologies of science and design are discussed. Next, we argue that both epistemologies are rather closer than they seem. As a case study, the essay presents an analysis of a science fiction piece to demonstrate allegorically an example of the inadequate interpretations of the types of inference. Finally, the conclusion points to some possible ways to reconcile the differences and propose a convergence, as well as pointing out some of the real differences.

## DISCUSSION

**Epistemologies:** Epistemology is usually concerned with questions such as: What is knowledge and its nature? How does a field create knowledge and come to know?

Underlying the questions about epistemologies, there are layers of worldview and assumptions about the nature (organization, form, access, praxis) of the domain in which knowledge is created and acquired: some may say that the world is discrete (a concept hold dear in the computational field); others will advocate that the world is a social construct (more to the liking of the humanities field); specific groups may view the world as something that is built (an assumption that is very strong with engineers, and to some extent, designers) and so on. Pintrich (2002) tells us that researchers are biased by world hypotheses, whether consciously or not. These world hypotheses are reflected in the subject of research and the instruments used to create and acquire knowledge. Such different worldview and assumptions influence the way the epistemological tools are chosen and used. This will determine the nature of epistemologies:

What form do they take? Do they reside mostly within the individual's cognitive structures - the world is already an interpretation; or do epistemologies reside in a context that is social and historic? Do they search for more general knowledge or for context-driven constructs?. How are they organized? Are there epistemological dimensions that can be isolated? Then the epistemology could be more direct in verifying hypotheses. Or are they entwined? Then ethnographic research tools: open-ended and non-directive approaches would combine factors. Are epistemologies ingrained, static and difficult to change - such as epistemological beliefs? Or are they dynamic, co-created in the relations that occur in the process?. How are they accessed? Are people able and willing to see themselves in epistemological terms - thus being explicit in their search for knowledge? Or are they more likely to keep to themselves?

Although this essay opposes science and design, it is interesting to review Cross's point of view where design separated from humanities. Cross (1982) summarizes broad aspects of sciences, humanities and design cultures: regarding the phenomena of study, science is concerned with the natural world; the humanities embrace the human experience and the design acts on the man-made world. As for the methods, the author says that sciences value-controlled experiment, classification and analysis; the humanities use analogies, metaphors, critique and design build models, form patterns and make synthesis. When it comes to values, the sciences tend to be used more objectivity, rationality, neutrality and the search for "truth"; the humanities are more subjective, use imagination and search for "justice" and design values practicality, ingenuity, empathy and search for "appropriateness".

**Three types of inference: abduction, induction and deduction:** In his studies, one the question to which Charles S. Peirce (b. 1839 - d. 1914) devoted his attention was related to the "logic of discovering", a subject regarding the issues of how new scientific knowledge could

in fact be created. For Peirce, the two know types then - induction and deduction - were not entirely sufficient to explain how new scientific hypotheses were proposed, because those two types did not allow for the introduction of new elements to the already existing premises. For this reason, Peirce developed the idea of a third type of inference, known as abduction, which accepted new propositions that were not present before in the observed facts and in the logic premises stipulated. According to Fann (1970), the presentation and discussion of abduction in Peirce's work do not occur in a complete and single instance, but they were rather dispersed, with multiple changes throughout his work. The author suggests that Peirce's theory could be divided in two moments, the first of which cover the period from 1859 to 1890, and the second from the latter date up to 1914. During the first period, Peirce did not use the word 'abduction' to name his new proposed mode of inference, using 'hypothesis' instead. The three types of inference are relatively independent, and each one of them will be explained here using the examples from Peirce. The first type, named deduction, is the logical reasoning that starts with a general rule to conclude a specific case, inferring its result. In this case, the result is necessarily derived from the premises, and it is the only type of inference that can, provided that all the premises are true, come to an equally true conclusion. An example from Peirce:

*Rule: All the beans from this bag are white*

*Case: These beans are from this bag*

*Result: These beans are white*

As for induction, it is a reasoning that starts with cases and infers the general rule. This inference is not necessarily true and is only acceptable based on probability given that a single false instance is sufficient to refute it.

*Case: These beans are from this bag*

*Result: These beans are white*

*Rule: All beans from this bag are [probably] white*

Finally, the hypothesis is the inference of the case considering a rule and a result. When a surprising result was found, for which there was no known explanation, this type of inference would consist of the search to find this result as a case of a certain general rule.

*Rule: All the beans in this bag are white*

*Result: These beans are white*

*Case: These beans are [possibly] from this bag*

In other words, if you know that the bag contains only white beans and you take one out, you can, by deduction, infer that the bean is white. If you don't know the color of the beans in the bag, and you take one out and it is white, then you can infer that the beans in the bag are white by induction. As for abduction, suppose you find a white bean around a bag of white beans, then you can infer that the beans are from the bag. Although Peirce himself didn't clearly state this, the type of reasoning of hypothesis seems not only to involve the inference of the case, but also the arbitrary selection of a rule that might explain it. In this first period of his theory, Peirce considers both the induction and the hypothesis as forms of amplifying inferences, that is, ways of reasoning that amplify rather than to explain that which is defined in the premises, and as such, they are the only types that would be able to introduce new ideas in our "deposit" of knowledges.

However, according to Fans (1970), after 1891, Peirce begins to add significant changes in his theory, thus characterizing a second period in his work. The hypothesis term is abandoned, and the term abduction is henceforward used. Induction loses its status of amplifying inference capable of introducing new ideas and becomes just a way of a hypothesis verification. Hypotheses are suggested only via abduction. Additionally, the types of inference that were once considered independent, they now are seen as related and comprising parts that form the three steps of any scientific investigation. To explain this relation among the three steps, Peirce points out that when surprising facts emerge, an explanation is necessary. For that, a

hypothesis that predicts the observed facts must be adopted: a process named abduction that characterizes the first step of the scientific investigation. Such adoption occurs only temporarily given that, logically, there is no guarantee that adopted hypothesis is true. The next step, therefore, consists in testing it to investigate its veracity - deduction is to be used to explain the hypothesis, deducing from it the consequences that must be tested. The third and last step consists of performing the experiments and comparing the predictions derived from the hypothesis with the facts found in the experiment. Each subsequent test whose results confirm the predictions, then the hypothesis is increasingly confirmed by the induction process. As can be seen, abduction becomes the only type of reasoning capable of creating new propositions. Even in situations where multiple observations of particular cases suggest a general rule for all the cases of the same class - previously recognized as an inductive generalization - Peirce sees it as a hypothesis suggested by abduction and only verified by induction. On this new relation between these two types of inference, the author says:

*The induction adds nothing. At the very most it corrects the value of a ratio or slightly modifies a hypothesis in a way which had already been contemplated as possible. Abduction, on the other hand, is merely preparatory. It is the first step of scientific reasoning, as induction is the concluding step... They are the opposite poles of reason, the one the most ineffective, the other the most effective of arguments. The method of either is the very reverse of the other's . . . Abduction seeks a theory. Induction seeks for facts. (PEIRCE, 1956 apud Fann, 1970)*

Whereas abduction was a way to infer the case from a general rule and a result, it now is also used to infer a general rule. For Habermas (apud ROOZENBURG, 1993), Peirce combines two different processes under the name of abduction, without providing a clear distinction between them. In an attempt to differentiate them, Habermas proposes two classifications: the explanatory abduction and the innovative abduction. The explanatory abduction is that related with the first period of Peirce's theory, where an inference of a case (p) from a general rule ( $p \rightarrow q$ ) and a result (q). According to Roozenburg, this can be logically denoted as:

Premise  $p \rightarrow q$  IF x is made of aluminum THEN x does not corrode

Premise q x does not corrode therefore

Conclusion p x is made of aluminum

The innovative abduction is that related to the second period of the theory, and incorporates the inference of both the case (p) and the rule that explains it ( $p \rightarrow q$ ) based solely on one premise - the result (q):

Premise q X does not corrode  
\_\_\_\_\_ therefore

Conclusion  $p \rightarrow q$  IF x is made of aluminum THEN x does not corrode

Conclusion p X is made of aluminum

It is important to understand the differences between these two periods of the theory because it seems to us that the separation between science and design resides on a selective interpretation of Peirce's work. In this selective interpretation, those who defend a unique epistemology of design adhere to presumptions mainly from the first period of the theory and seem to ignore important points of the second. We talk further about this on section 4. Next, we present the alleged differences between an epistemology of science and an epistemology of design.

**The scientist and the designer: epistemological differences according to literature:** Before delineating the epistemological differences attributed to a scientist and a designer, it is important to contextualize and better define the meaning expressed using each of these terms. In this essay, the use of these labels is purposefully

reductionist, aimed at creating extreme categories that explain two different views of how to act in the world.

The first label - the scientist - refers to research from the natural sciences field, math or even social fields that are committed to the "standard vision" of science, as defined by Robson (2002). For this author, this traditional view of scientific research derives directly from the positivist philosophical approach, and, albeit well known criticisms, it is still embraced by many scientists and it is the predominant trend in multiple areas and fields of research and knowledge creation. In this approach, the goal of science is to propose universal laws, that are developed by the investigation of empirical regularities - in which two or more variables are correlated in a certain sequence - thus creating a causality relation. Knowledge is obtained by direct experience and observation in a way that all scientific propositions are found in facts, and the hypotheses are tested against those facts. Science as such is supposed to be neutral, and it presupposes the separation of facts and values, being, therefore, value-free. As for the second label - the designer - it is not limited to those professionals who act in the sector that usually go by this designation, thus, expressing in this essay a broader connotation. The choice of this term aims at grouping those individuals - professionals and researchers - who are related to some extent to that which Herbert A. Simon defined as the science of the artificial, or science of design. For Simon (1996), design is a large field of human action, and it encompasses any activity that aims at altering the current state of things into a desired one. Therefore, just to name a few, design can refer to architecture, medicine, engineering, education, business and, logically, product design, fashion design, graphic design and all the other emphases. About this, the author says:

*Everyone designs who devises courses of action aimed at changing existing situations into preferred ones. The intellectual activity that produces material artifacts is no different fundamentally from the one that prescribes remedies for a sick patient or the one that devises a new sales plan for a company or a social welfare policy for a state. Design, so construed, is the core of all professional training; it is the principal mark that distinguishes the professions from the sciences. Schools of engineering, as well as schools of architecture, business, education, law, and medicine, are all centrally concerned with the process of design. (SIMON, 1996, p.111)*

According to these views, it is possible to see the first important difference between the traditional scientist and the designer. For Simon (1996), historically, it falls on science the role of teaching, explaining, investigate the nature and the functioning of natural things, while it is the role of the designer to investigate and advance the knowledge of artificial things and the way to project them. Scientists are, therefore, concerned with how things are, while designers look and how things should be. For Glynn (1985), science tries to understand the existing phenomena and submit them to general laws and theories, whereas designers try to propose alternative states that conform to the theories and laws. Additionally, while science starts with observations of particular facts and derive general theoretical hypotheses, design starts from the knowledge of such general rules to the innovation practice of individual concrete alternatives. For March (apud GLYNN, 1985), science investigates that which is somewhat permanent, and design creates new forms. Eekels and Roozenburg (1991) defend that the scientist looks at the world allegedly with a regard most lacking value as possible, collecting empirical data with the purpose of understanding how the real world is. Emphases is put on the truth, and, when there are discrepancies between the facts and the theories, the latter must be altered. The designer, for his turn, aims at imagining how a preferred and possible world looks like, guide by value propositions. When there are discrepancies between the facts and the value preferences, the facts must be altered. In this context, apparently, March (1976) was the first to indicate parallels between this creating and transforming practice of design with Peirce's theories of the logic of discovering. For the author, the rational process of design is composed of three

tasks: create new compositions using abduction reasoning; predict the behaviour of this artefact using deduction and accumulate new knowledge using induction. As can be seen, the author maintains the valorization, integration and relation between the three types of inference. However, some authors who came later, aim to value the abduction type of reasoning as the main dimension of an epistemology of design, above the other two types. For Glynn (1985), it falls on the epistemology of design, descendant from the epistemology of science, to inherit the task of developing the logic of creativity, the innovation in hypotheses and the invention - tasks that were hard to come by for science philosophers. For Roozenburg (1993), the innovative abduction is the main type of reasoning in design and it is an aspect that is highly characteristic of its praxis. Eekels and Roozenburg (1991) trace an opposition between empirical research, based mainly on induction and deduction, and design, which would use the logic structure of abduction. Dors (2011) also points to the same direction, considering induction and deduction as central within the context of scientific discovery: the inductive reasoning informs discovery, while induction supports the justification. As for design, the logic is of a different kind: it begins with a search of solving a problem and generation of value (result) by inferring a principle and a case (the design artefact), that is, an abduction logic of innovative kind. Finally, Dresch, Lacerda and Antunes Jr (2015) tell that in traditional sciences the methods commonly used are induction and deduction, as opposed to design, which uses abduction to propose solutions to the issues being studied. However, as the authors point out, induction and deduction could be used later to evaluate the proposed solution.

Based on the observations above, a possible conclusion is that there is a stream of thought that defends an epistemology of design in which, focused on creating artefacts that do not yet exist, would use abduction as its main tool. In this view, the designer is the creative individual who acts to create knowledge that recreate the world, bringing it closer to what it should be. Even the authors who consider the presence of induction and deduction in design think of these types of reasoning as tools to aid in the validation of the solutions proposed by abduction, without making them a central point of an epistemology of design. This view is, in a certain way, contrary to what an epistemology of science would be, which, concerned with describing and explaining the world as it is, use only induction and deduction - by collection recurring empirical facts to create true general laws (induction) and applying these same laws to predict the behaviour of the world (deduction).

#### **Critique of the epistemological split between science and design:**

Considering Peirce's theory of abduction, which is the basis for the view of an epistemology of design, the separation between the ways of knowing of the designer and the scientist is incoherent. As the author showed - in the second period of his theory - abduction, deduction and induction are three steps in a whole: while the first one is the only one capable of proposing new ideas, the other two are the only ones capable of verifying them. The designer could not claim exclusivity in the use of abduction, just as it would be impossible for the scientist to ignore it. This separation would only be possible by a restricted use of the first period of Peirce's theory, in which the types of inference are relatively independent and both abduction and induction are considered expanding inferences, that is, inferences that can propose new ideas. In this case, science would be authorized to continue to ignore abduction, given that it would be able to discover new hypotheses by induction. This, of course, contradicts Peirce's own later understanding, which we defend in this essay. To believe that induction alone can create hypotheses means that it is possible to look to the world in a neutral manner, apprehending the reality and the truth directly through empirical cases, that, grouped and without any sort of interpretation or creative mediation would yield general rules that demonstrate the world's behaviours. This positivist view is the target of multiple critiques. For Popper (2013), observations are never exempt, but are always interpreted in light of theories. Similarly, Glynn (1985) tells us that, in contraposition to the view that theories are directly derived from facts, a quick look in the history of science would demonstrate that theories determine facts as much as

the other way around. For Robson (2002), the belief that the direct experience is the basis of scientific knowledge is questionable, given that it is impossible to distinguish the language of observation from the language of the theory. For the author, the theoretical concepts are not a "1:1 scale representation" of the observed reality, and the facts cannot be separated for values. Therefore, if in an induction process there is addition of interpretations that are extrinsic to the facts by inferring a general rule, there is a creation of something new that is not in the observed case, and such process can no longer be considered induction, but rather it may be considered abduction. Induction will only occur after the hypothesis is created, when, by testing it, there is a gathering of induction interpretations of the facts to fit them into the formulated hypothesis. Even if there is something new at each new interpretation of the case, no new hypothesis is being formulated, but just verified. Thus, abduction is also a type of inference of the scientist when she proposes new hypotheses, even when she believes that she is using - by ingenuity or ideology - induction. Therefore, the epistemological differences between design and science cannot reside on the fact that the former uses abduction, and the latter doesn't.

It also does not seem valid the argument that claims that even if both epistemologies use the three types of inference, that abduction would be more relevant or important to design. Nothing in Peirce's theory seems to indicate how it would be possible to measure whether abduction is more or less relevant, or how an area of knowledge could use it in a better manner than another. Again, for Peirce, the three types are an integral part of a whole without which the creation and verification of new knowledge cannot occur. Nothing points to the supremacy of abduction regarding the other two types of inference; on the contrary, abduction is just a preparatory step, from which deduction and induction are the final steps. This leads us to believe that induction and deduction are both equally relevant for design as is abduction. When one takes any project methodology, one hardly encounters only stages of new ideas propositions - such propositions are most often accompanied by test and validation of the proposed ideas. If what creates new propositions is really abduction, the viability of its test is possible only through deduction (predicting the result one wants to achieve) and induction (collecting the cases to prove whether the result achieved is that which was predicted). It seems, therefore, that there are more epistemological convergences than divergencies between science and design. For both, the three types of inference are essential for the proposition of a new artefact (be it scientific theories or design products), in the same way that for both deduction and induction are essential in order to validate the veracity of the proposition, demonstrating that the theory is correct or that the proposed design product achieves its proposal of value.

If in fact there is an epistemological difference, it is not in the types of inference, but rather on the goal of the knowledge created. Scientists create knowledge to understand the world as it is, which in turn helps designers to act on this world to reconfigure it. Designers create knowledge to transform the world into what it should be, which in turn provides science with new facts to be understood. If there are differences regarding the types of inference, they do not seem to be more on the realm of narrative and ideology more than on epistemology, manifesting themselves through that which each discipline chooses to value as its unique characteristic. If scientists operate using the three types of inference, why do they emphasize only deduction and induction? If design also can only operate using the three types, why value just abduction?. This essay will make such considerations at the conclusion, as it will further debate about the implications of such similarities and differences, real or alleged. Next, it will present an allegoric critique that allows for the understanding of how this confusion of the three types of inference is ingrained in our daily lives, exemplifying it with an excerpt of science fiction audiovisual work.

**Critical and allegorical analysis of the work of fiction "3%":** The work of fiction "3%" is a Brazilian audiovisual series from 2016. The background in which the action takes place is a dystopian future in which the young of a poor country compete to gain access to

“Maralto”, a rich community. During the selection process, the candidates are put through a series of ordains. One of such tests is presented as a logical challenge, and it seems appropriate for the discussion of the three types of inference. During the challenge, the candidates are separated into groups and then put in an environment that simulates a house where there are four people - alike mannequins - that sit at a table eating dinner. One of them appears to be sick, and the logical challenge consists in analyzing the clues that are present on the scene in order to figure out what is happening to the sick person. The character who supervises the challenge, in a professorial tone, states that the goal is to ascertain the induction reasoning of the candidates, and she explains that the task occurs from the particular (the clues) to the general (what happened to the sick person). Additionally, she emphasizes that deduction is the opposite of this (as it goes from the general to the particular). However, no mention of abduction is made. As can be seen from this description, the epistemology adopted by the narrative is akin to that of traditional science. Discovery is something inductive, that occurs by observing of particular regularities that in turn become a general rule. In this view, the term discovery is completely appropriate, given the belief that there exist a general and unique truth hidden behind facts. To uncover each piece using induction would be the way to reveal the truth.

However, if this is the view, openly defended throughout the narrative, what ensues as the plot moves forward contributed to deconstruct this argument. By analyzing the elements from the scene, the candidates arrived at three possible conclusions: the person choked or was poisoned or was allergic to the silverware. None of these conclusions can be considered true because they are derived by the interpretation of the clues that were presented. They are, therefore, hypotheses, temporarily created, and not truth discovered. Therefore, the candidates are using abduction, not induction. The only way to discover the valid conclusion is to test them - in this case, by submitting them to the sieve of the challenge coordinator. Instead of being an exercise of induction, as proposed, this scene actually illustrates the process of scientific discovery of the second phase of Peirce's theory, that prescribes the sequence of abduction, deduction and induction reasoning. All the hypothesis created by the candidates are temporary suppositions that try to explain the facts, but there are no guarantees that they are valid or true - thus making them propositions from abduction. After choosing on the hypothesis, the candidates declare it to the coordinator as a form of truth that arises from the clues as a way to explain what happened, that is, the candidates present a general rule that allows for deduction. The coordinator acts as the validating test of the proposition, that is considered true and is thus validated by her. This validation occurs in all the groups that proposed the same rule - a series of induction tests that support the validity of the proposition. This validation will be the truth until there is an opposing fact to disprove it and demonstrate the ephemeral and temporary character of knowledge.

## CONCLUSION

Considering Peirce's theory, and based on the arguments presented, there follows a conclusion that it is not possible for the designer to claim exclusivity over abduction. This type of logical inference - the only one that allows the addition of new ideas that were not previously present on the premises - is the reasoning that creates hypotheses in any form of knowing, for designers as well as for scientists. If there are epistemological differences, they would not be at the core of how each discipline creates new ideas. Rather, one difference pointed out in this essay resides on the intention with which each discipline creates these new ideas. Scientists create hypotheses using abduction to explain the actual observed facts (current or past facts) and their relations, while designers also use abduction to transform the facts into an imagined future reality. The epistemology of scientists aims at understanding the world as it is, while designers aim at creating the world as it should be. There is a moral difference within this proposition, assuming that scientists would try to conduct the research with the freest of regard, while

designers would be guided by values. This should be further discussed under the theoretical framework of design and values of philosophy of design - outside the scope of this essay. But why do scientists value in their narratives and praxis just deduction and induction? This question is also outside the scope of this essay. However, given the discussion presented, a possible clue to be investigated is the permission given to the narrative that science is free of values, neutral, concerned exclusively with the truth that arises from the observed facts, and independent of ideological influences. To admit that science knowledge is also created by abduction is to admit that there in fact exists influences from the scientist, her surroundings, cultures, beliefs, values, view of the world and to admit that knowing is not discovering the existing truths in the world, but, in fact, creating them. By keeping this refusal of abduction, scientists may, negatively, hide their convictions and beliefs under a layer of neutrality. They may also lack in their capacity of creating knowledge, by maintaining a limited view of the process of knowledge creation and their role in it. They incur in the lack of realizing their creative potential as actors in knowledge creation by not actively incorporating creative process into their praxis - thus relegating solely to designers the role of creating. This narrative usually contradicts multiple areas deemed to be scientific in which new artefacts are created (to give one example, the creation of new medication). To deny abduction is to deny these fields as science.

Another question raised was: why designers value abduction over deduction and induction? The motivation behind these behaviours is outside the scope of this essay, and is subject of further considerations, but some ideas have emerged: One of these suppositions is that by claiming abduction as something only designers can use creates an exclusivity over creative actions. The greater acknowledgement by designers of abduction and the continued refusal by scientists to adopt it fully put the formers in a privileged position to take control and guide the creative processes. As Dorst (2011) tells us, the designer's praxis is that of searching for innovative solutions to open and complex problems, in a way that is putting design thinking as the paradigm for problem solving in multiple areas of knowledge. Following this path has given designers a greater legitimacy to use abduction to be at the top of an ever-increasing domain in participating and coordinating groups in search of problem solutions and innovation in many diverse sectors. But this split among the types of inference may hinder the design praxis due to at least two reasons. The first, as Peirce himself points out, refers to the fact that the three types are not dissociated, but rather they are part of the same whole. To focus just on abduction, forsaken deduction and induction, lead to incomplete knowledge, because of lack of validation against the facts. However, this narrative is also not completely true, given that the design process often includes evaluation and verification of the propositions. As a continuance of this problem, there arises the second: the difficult of design to be accepted as a science (like the natural and traditional sciences) because it doesn't intend to explain the world as it is, but rather to transform it. This approach doesn't prevent design to create knowledge in a systematic, rigorous, replicable and scientific. For this, a personal experience of one of the authors was the alert given by a professor on the first day of class in a design postgraduate course: “you are not here to execute design projects, to create any new artefact, this is done in the market, you are here to do science”.

In this scenario, one thing that becomes clearer is that the benefits for each area to place itself as the most legitimate to operate each of the types of inference are restricted to the domain of narrative only, or, since this essay touches on the philosophy of design, on the field of aesthetics. The argument does not inform the differences in the way each field creates knowledge, given that, in order to be complete, both need to use abduction, deduction and induction in their epistemology. Both can and should act creatively on the world, and both should and must be considered scientific. Their epistemological differences are elsewhere, mostly on their motivations: to create science to understand what already exists or to create something that ought to exist.

Thus, designers and scientists would benefit by coming together to reflect on their research. A “scientist designer” could present a broader view and use a gamut of tools tailored to explore creative processes as the basis of creating scientific hypotheses through abduction. Conversely, a “designer scientist”, acting on the sciences of the natural, would better understand the temporary and ephemeral nature of her hypotheses yet to be validated, using deduction and induction to evaluate them, validate or refute them in order to create equally valid and accepted scientific knowledge as natural or traditional science does.

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