# Philosophical Foundation for the Design of Interactive Systems

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**Abstract.** This paper presents a philosophical overview for the field of design in general, and interaction design in particular. Based on selected but important and influential philosophical theories I argue for a hermeneutic position grounded in phenomenology. The popular view of Cartesianism is criticized due to its limitations, and the four causes of Aristotle are introduced to overcome those limitations regarding the academic demands of design. Phenomenology is presented as an alternative position to establish the ontological foundation for interaction design and to overcome the restricted self-view of modern science. Thrown-ness into this world ('being in the world') is the basic assumption on which any (interaction) design starts from a first person view to change our environment in a conscious and responsible manner. The idea of a third person view (also called 'God's eye view') is critiqued as a myth.

**Keywords**: Aristotelian causes, Cartesian anxiety, first person view, interaction design, hermeneutic, phenomenology, technology, thrown-ness

## 1 Preface and Disclaimer

At the begin of such kind of position paper I have to apologize that I took the liberty to summarize and combine main arguments in the context of more than 2000 years of history in philosophy, meta-physics and science. This kind of endeavor is based in many hundreds, if not thousands of pages of other scholars in the past. I am convinced that the presented but very condensed arguments based on a specific selection are worth to be considered as convincing and the conclusions are valuable for a foundation of interaction design. This paper has two main objectives: (1) enhancing the concept of causation to adapt the needs of design in general (i.e. the *four* causes of Aristotle), and (2) grounding modern developments for interaction design in *phenomenology* in particular.

## 2 Introduction

For a very long period, Aristotle's *Physics* [1] was the foundation to study natural sciences. Aristotle began with an analysis of *change*, which introduces us to the central concepts of *matter* and *form*. Next he moved on to an account of explanation in the sciences and a defense of *teleological* explanation. After this he turns to detailed and important notions of *continuity*, *infinity*, *place*, *time*, and *void*. He ends with a profound argument to show that the changes we experience in the world demand as their cause a single unchanging cause of all change, namely *God* as a divine concept ('the cause without a cause').

The dominant paradigm in modern science is *logical positivism* (or also known as modern empiricism), and the implications of this philosophy for research methodology have been already intensively discussed (see [2] [3]). Logical positivism seeks to determine the *truth* of claims or statements. It is already noticed that a broader set of assumptions underlies the use of positivist methods. These meta-assumptions can be understood in the more global philosophical position as *Cartesianism* or *rationalism*. One of the most fundamental ideas in Cartesianism is the separation between *mind* and *body* [4]; it is also assumed that *reality* must be deduced and then described in mathematical terms [5]. The understanding of Cartesianism determines the way in which science is supposed to be executed today [6] but also has to face its limitations [7]. Going back to Aristotle and passing by the long philosophical history I can describe and hope to explain the main deficiencies of our modern view on science and the possible options to overcome these recognized limitations by incorporating design as a holistic approach

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towards nature. Although humans achieved in modern and highly industrialized countries the situation that we are surrounded by design artifacts, and nature as such hardly exist anymore [8], it still makes sense to assume that nature as such exists. If it comes to design as an academic field, we have to 'explain' how design works and what kind of reasoning is adequate [9]. But as long as we try to answer those questions in the constrained framework of Cartesianism and rationalism, we will not be successful. Therefore I believe we have to enlarge our concept of causation by going back to what we already had long time ago but forgot.

## 3 The Cartesian Anxiety

Kant [10] required that we should frame the epistemological problem in an entirely different way. The crucial question is *not* how we can bring ourselves to understand the world, but how the world comes to be understood by us. This is a very interesting perspective, because Kant operated on the assumption that we as humans are capable of this; but how can we be assured of this? Kant described two concepts: (1) analytic *a priori* judgments include all merely logical truths and straightforward matters of definition; they are necessarily true; (2) synthetic *a priori* judgments are the crucial case, since only they could provide new information that is necessarily true. Analytical judgments can only be provided in a formal system and could be seen as a kind of tautologies (i.e. we cannot get more out of our axiom system than we put in from begin on; although we normally do not fully understand upfront what we put in; this holds also for most by humans designed artifacts in a broad sense). On the other hand, synthetic judgments create something out of nothing, and this is still difficult to understand [11].

The lack of an *undisputed foundation* of our being (i.e. science lost its 'cause without cause', and tried to recover by coming up with the 'big bang' as starting point for our universe [12]) is called by Bernstein the *Cartesian Anxiety* [13]. Even though this anxiety began long before Descartes' "cogito ergo sum", he argues that the 'grand Either/Or' is most clearly set forth: "Either there is some support for our being, a fixed foundation for our knowledge, or we cannot escape the forces of darkness that envelop us with madness, with intellectual and moral chaos" ([13] p. 18). His book substantiates how we must eliminate this Cartesian Anxiety without falling back into religious believes in divine concepts (like Aristotle). To face up to this dichotomy is to expose it and argue against its plausibility or appeal as a focus of our lives [14]. This movement beyond must follow the path of post-empiricist philosophy of science, of philosophical hermeneutics, of praxis, and end with the injunction that we must seize the "dialogical character of our human existence" ([13] p. xv). To expose and overcome the anxiety is a practical task of conversation and communication or of the need to "cultivate dialogical communities" ([13] p. xv). This is a task to which Bernstein has made a major contribution. We should acknowledge and accept our *thrown-ness* into this world and try to understand, accept and live with [15].

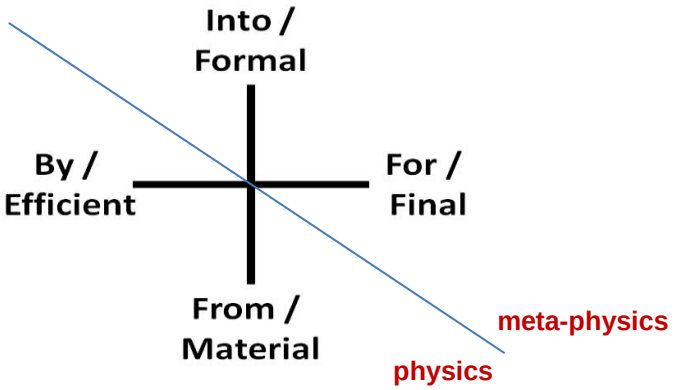


**Figure 1.** The four Aristotelian causes: Efficient, Material, Final, and Formal Cause (adapted from [16]) and the fundamental split in physics and meta-physics introduced by Francis Bacon [17].

## 4 The Four Aristotelian Types of Causation

The Aristotle's four causes are closer to being *be-causes* since they are usually thought of as the reasons or explanations for things [18]. The presented example of the four causes is what is needed for the building of a house. A house is built *by* the craftsmen, *from* the raw materials, *into* the form shown on blueprints, *for* the homeowner to live in (see **Figure 1**). This example is concerned with the *making* of something. Final and formal causes have been abandoned since the beginning of the scientific revolution. Sir Francis Bacon claimed [17] that the only scientific reasons for things were the material and efficient causes. For materialism it was coined as *matter in motion*. Aristotle thought that matter can exist in *space* and motion in *time*. But what shall we do with form or finality? I will discuss each Aristotelian 'be'-cause separately and as close as possible to its original meaning. At the end of each I provide also my interpretation, which can feed into the philosophical foundation for interaction design.

### 4.1 The Efficient Cause

An *efficient cause* is the fundamental mechanism that causes changes and motion (i.e. to start or stop, accelerate or slow down, create or destroy, etc.) of objects ('that *by* which something is made'). An efficient cause is the agent that initiates a change or brings a thing into being. Mostly this is simply the force that brings something about [19].

The efficient cause is the force, mechanism or agent immediately responsible for bringing this form and that matter together in the creation of a thing. Thus, the efficient cause of a house would include the carpenters, plumbers, and other workers who used specific materials to build the house in accordance with the blueprint for its construction. Clearly the house would not be what it is without the workers' contribution [20].

**My interpretation**: The most appealing interpretation in this whole quartet of causes is the mainly accepted 'cause-effect' interpretation in its broad sense. A *cause* can be anything which influences the being of another thing; the last one is called *effect*. A *principiant* or *principle* is that from which a *being* originates or proceeds in any way. According to Coppens [21] it may proceed from it: A) *Logically*, as the conclusion does from the premises in reasoning. B) *Physically*, by deriving physical being from the principiant. It may happen as follows: (a) the principiant may produce it, e.g., a plant producing fruit. (b) The principiant may be one of its constituent elements, as a wheel is of a clock. A principiant is always prior to that which proceeds from it, in one of two ways: (a) in *time*, by existing sooner. (b) By *nature* only, when one being produces or constitutes another without existing before it.

### 4.2 The Material Cause

The *material cause* of an object is equivalent to the *nature* of the raw material out of which the thing or object is composed ('that *from* which something is made'). With other words, the material cause is the basic quality out of which the things are made. Aristotle applied the word *nature* to both (1) its potential in the raw material, and (2) its ultimate finished form. In a sense this form already existed in the material [19].

The material cause of a house, for example, would include the bricks, wood, metal, glass, and other materials used in its construction. All of these aspects belong in an explanation of the house because it could not exist unless they were present in its composition [20].

**My interpretation**: Aristotle could not think of matter without a particular form attached. Due to the developments in chemistry we can now understand matter without this constrain. The periodic table [22] describes and classifies all elements of which matter is made, and even more, we can now create new kind of matter by combining elements. The material cause is therefore the matter out of which a being/thing is made. The quality of the chosen matter determines the being/thing next to all other causes. This interpretation of matter excludes any immaterial quality (e.g. knowledge, information, minds, etc.) of being a material cause.

### 4.3 The Final Cause

Final cause, or *telos*, is understood as the inherent final purpose (i.e. end, aim, or goal) of the phenomena under investigation ('that *for* which something is made'). This Aristotelian cause is also one of the most controversial types of cause in modern science, because *telos'* causal effects work from the future back into the present. One could argue that Aristotle's conception of *nature* is teleological in the sense that he believed, that nature as a whole, has *telos*, apart from those that humans have. This is possible, because Aristotle thought "that a *telos* can be present without any form of deliberation, consciousness or intelligence" [19].

A lot of scholars thought and still think that one of Darwin's main accomplishments was to provide biology with a *non*-teleological explanation of adaptation. However, quite a lot of Darwin's closest biologists, and even Darwin himself, would probably not agree on that. Darwin saw selection explanations of adaptations as *teleological* explanations. The confusion in the last centuries about Darwin's attitude to teleology is argued by Lennox "to be a result of Darwin's teleological explanations not conforming to either of the dominant philosophical justifications of teleology at that time" [23]. This is one view to argue that Darwin brought back the concept of teleological causes on the scientific agenda!

**My interpretation**: The *final cause* is the purpose or the end *inherent* in a particular action; e. g., when a person exerts himself to acquire fame, the acquisition of fame is a true cause of his exertion. The goal itself aimed at in the future, i.e., fame, is the final cause *effectively* considered in the present; the acquisition of this fame is the final cause *formally* considered [21]. We could go even further, when "retroactive effects of a subject's present mental effort on a previous random event" can be observed and seen as a form of 'non-causal' lawfulness [24].

### 4.4 The Formal Cause

*Formal cause* [eidos] is a term describing the form or pattern that makes *matter* into a particular type of thing, which we recognize as *being* of that particular type ('that *into* which something is made'). This particular cause is Aristotle's continuation of Platon's world of ideas because Aristotle had to distinguish this form from the form given in the material cause [19]. The formal cause is the pattern or essence in conformity with which these materials are assembled. Thus, the formal cause of our exemplary house would be the sort of thing that is represented on a blueprint of its design. This is also part of the explanation of the house, since its materials would be only a pile of rubble if they were not put together in this particular way [20].

**My interpretation**: After we separated matter and form, we can now say that the form *is* the formal cause, which specifies the matter to become a particular being/thing. A form exists in two ways: (1) *Substantial* if the form makes the very nature of the being and cannot be removed without changing the nature of this being; (2) *Accidental*, if the form can be removed or changed without affecting the nature of the being [21]. If we design a table, there are substantial form aspects and accidental form aspects; if we take the substantial aspects (often called 'function') away, the table will not be a table anymore. If we take the accidental aspects away (often called 'style') the table still functions as a table but changed appearance.

### 4.5 Discussion and Conclusion

As I have argued, the four different concepts of 'causation' have their adequate place in the foundation for design of interactive products and systems. Although the original interpretations from Aristotle are not directly applicable any more, the clear distinction of those concepts is still valid and useful. Buchanan introduced as an external view the four elements of a product: (1) manner, (2) materials, (3) function, and (4) form [25]. He motivates these four elements because "the new perspective on products deepens our concern for, and understanding of, the nature of form" by arguing that 'form' should not be understood from an external view but from an internal view: "form as a synthesis of what is useful, usable, and desirable." Now, form becomes dynamic and contextualized [26]. Hence, interaction design is dynamic form giving in a particular context of use! Designing the dynamic form is not only in three spatial dimensions but also has to include the fourth dimension 'time'. "Time is clearly one of the most important features of the new understanding of products" [25]. Some of the remaining questions are, how can we capture and describe those dynamic forms, how can we 'sketch' our ideas if

they are dynamic and fluid, and finally how can we design for these complex, volatile and transitory new dynamic forms?

The problem with the term 'causation' is the change in meaning over the past: from having an effect (i.e. causal or a-causal changes) to causal relationship only (i.e. effects are determined). Therefore I will introduce the more general concept of 'creation' which entails not only causation but also effectuation. Although the term 'effectuation' was introduced by Saravanthy [27] in an entrepreneurial context, I will use this term also in the broader context of design. Effect is something that is produced by a cause or agent and can be seen as the result. Effectuation is a human way of thinking that enables designers in the processes of opportunity identification and new creations. Effectuation includes a set of decision-making principles designers are observed to employ in situations of uncertainty. Effectuation can be seen as the 'a-causal' counterpart to causation. Both are necessary to achieve meaningful creations in a material sense. In particular the concept of 'synchronicity' is discussed by Peat [28] as the inconstant connection through equivalence or contingence to create meaning, and therefore to bridge the gap between mind and matter.

*"Synchronicities have ... served as the starting point on a journey that has led us to the limits of human imagination. Once we realize that our consciousness is without limit, then it becomes possible for us to engage in a creative transformation of our own lives and of the society we live in." [28, p. 241]*

## 5 About Creation and Ontology

To introduce and discuss creation based on causation and effectuation makes only sense if there is something to be caused or effected! Since ancient history any kind of philosophy tried to address this ontological question and several answers are provided. Ontology is the branch of metaphysics that studies the nature of existence or being as such. But how do we know what exists already and further, what can become existent? E.g., Heidegger and Fink have used the platonic 'allegory of the cave' to explicate certain aspects of Husserl's phenomenological philosophy [29]. Before I go into the phenomenological aspects, I will discuss the challenging concept of 'reality' first.

The 'allegory of the cave' was described by Plato [30], the most important pupil of Socrates. Plato described a gathering of prisoners who have lived chained to the wall of a cave all of their lives, facing a blank wall and nothing else. The prisoners can only watch shadows projected on this wall by things passing in front of a fire behind them, and begin to designate names to these shadows. The shadows are as close as the prisoners get to viewing reality. Plato then explains how a philosopher is like a prisoner but who is freed from the cave and comes to understand that the shadows on the wall do not make up reality at all. Now he can perceive the true form of reality rather than the mere shadows seen by the chained prisoners. This allegory can be related to Plato's theory of forms, according to which the 'forms' (or 'ideas', 'archetypes'), and not the material world of change known to us through sensation, possess the highest and most fundamental kind of reality. Only knowledge of the forms constitutes real knowledge. Those philosophers who have ascended to this highest level of insight about reality, however, must not remain there but must return to the cave and dwell with the prisoners, sharing in their labors and honors [31].

Although this cave allegory reveals deep insights into reality based on gained knowledge, the underlying assumptions are still somehow misleading. The whole allegory is based on our 'normal' worldview as *the* reality only to be seen by an enlightened 'philosopher', and the artificial 'cave world' is constrained in such a dramatic manner that everyone can understand how the unchained prisoner can now really understand our reality as such. Although this seems to be a one-step 'enlightenment' process relying totally on the distinction between the unreal (i.e. cave world) and the real (i.e. outside the cave), we still don't know much about our real worldview. Our problem still is, given our normal worldview what comes beyond this?

I prefer the metaphor of a 'curtain' to emphasize the difference *before* and *behind* this curtain (see Figure 2). The curtain separates the stage before and behind this curtain. We as the audience cannot look through and have to wait until someone 'opens' the curtain for us, disclosing the stage behind the curtain. Opening of the curtain has a very similar effect as getting unchained in the cave allegory. But do we get closer to the real world by looking behind this curtain, or do we just see another curtain? I am afraid that this later is the case. The curtain is our ontology, the imprint of our reality; the curtain's

fabric contains all our compiled explicit and implicit knowledge about all relevant (and also irrelevant) concepts, the way how we agreed upon to capture and understand our environment and ourselves. Despite all other ideas, our first person view onto our curtain is all we have. Kant was very clear about this [10]: (1) there exists a world behind our curtain totally independent of our mind, and (2) this world is completely unknowable by us; this world behind the curtain consists of the 'things-in-themselves', but are untouchable to us. The 'thing-in-itself' does not exist in space and time and do not enter into causal relations. Kant expressed his clear conviction that there is something behind the curtain (and not just another curtain).

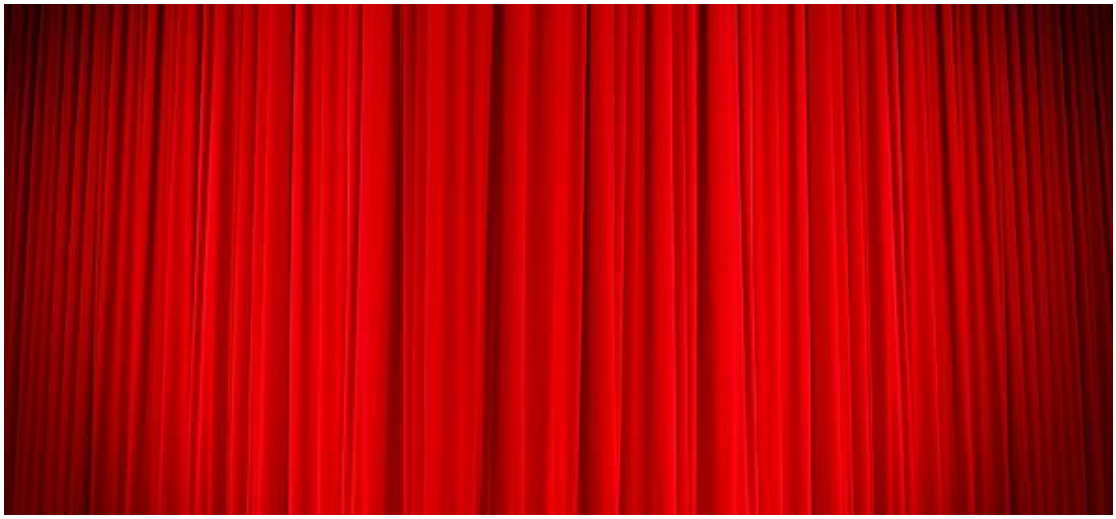

**Figure 2:** The 'curtain' metaphor for our ontology
[free download from http://psddaily.blogspot.nl/2013/08/free-download-psd-curtain-background.html]

Long time ago, Laozi was arguing similarly [32]: (a) The Tao that can be spoken of is not the eternal Tao; (b) the name that can be named is not the eternal name; (c) the nameless is the beginning of heaven and earth; (d) the name is the mother of the ten thousand things; (e) send your desires away and you will see the mystery; (f) be filled with desire and you will see only the manifestation. According to Laozi we get and construct our 'curtain' (i.e. the manifestations of the 'mystery' behind) because of our desires (see f). There is indeed one very fundamental 'desire', if not a necessity: Our need to communicate with other human beings! This fundamental human need requires a *language* (in a broad sense, from local dialects up to universal mathematics [33]). Vygotsky argues that learning is a necessary and universal aspect of the process of developing culturally organized, specifically human, psychological functions" [34, p. 35]. However, any kind of language is a representational system referring to something else (e.g. *deixis* [35]) but also creates and embed new concepts without referring to something beyond and outside the semantic scope of this language [36]. "Abstract concepts are largely metaphorical" [37]. "From the perspective of socially created reality, the role of unrecognized metaphors and their power over the user's mind is much greater than in the case of metaphors that are intentionally used…" [38]. Latour argues that 'scientific facts' are fabricated by groups of scientists as socially constructed concepts [39]. Even further, Lakoff and Johnson propose that all our *language is metaphorical* [37]! Metaphors are omnipresent in our lives and this is true not only for colloquial languages, but also for scientific languages [38].

But, there is one fundamentally important although dangerous consequence in using any representational system: The third person perspective! This view is also called 'God's eye view' to express clearly that this view comes from outside our world. "God's eye view is a name for a point of view where the speaker or writer assumes they have knowledge only God would have" [40]. In our modern times this is probably the most attractive, even seductive but totally misleading concept: Whatever we as human beings thrown into this world will do, we will not be able to look through 'God's eyes'. This third person perspective is nothing more and nothing less than another *first person view*, pretending being something else. In case we look at any representation (e.g. right now when you are reading this text) we have the impression of something like a 'third person view'; we look *through* the text to the concepts and meanings behind those words [41]. Although we wrongly assume this as a third person

perspective, this is not a God's eye view, but just our first person view on the text. As long as we are aware about that, we have left *only* our first person view, we are now enforced to take responsibility for our actual situation, our *thrown-ness* into this world [42]. We cannot and shouldn't longer dream of an escape into God's world behind the curtain. People like Michel Foucault (and many others too, of course) fully understood this thrown-ness by not only writing books about their insights but also going out on the street and campaigning against anything they considered unethical [43].

This first person perspective is of utmost importance not only for philosophers and physicists but also for designers and their designs. Several decades ago, this particular aspect − the inherently intertwinedness of 'observer and observed', 'designer and artifact', 'human and technology' − was already discussed by Everett for the 'observer' in quantum mechanics [44] (see in particular the 'Copenhagen Interpretation' of quantum mechanics [45]), and by Bateson and Mead about the foundations of Norbert Wiener's cybernetics [46]: Design from outside or from inside the 'box'; Bateson and Mead stated that every engineer and designer should design from *inside the box*! Now we are bounced back to our actual situated-ness with all accompanying responsibilities and no escape from this. What does this grounded-ness mean to us?

Recent work in philosophy, linguistics, and cognitive psychology has argued that cognitive processes are 'embodied', i.e., grounded in our bodily experience with the environment [47]. In this view, the sensory and motor activities of the body are important determinants of human cognition, which in turn shapes the structure and use of language [37]. We are thrown into this world and directly connected to our environment, through all our senses and metaphorical interpretation schemata. Through this strong coupling we cannot escape from this (even death might just be another, although radical transformation of our relationships to our environment).

As I have already discussed with Salem [48] that artifacts are also carriers of culture, we have to specify and declare our relationship to artifacts in particular, and technology in general. In the past, Jaspers and Heidegger expressed their concerns that technology alienates us from ourselves and from our environment. This concern is debated and vivid till today. But based on the work of Ihde, Latour and Borgmann, Verbeek presents a modern view how artifacts are reflecting our culture but at the same time shaping our existence and experience [49]. We have to understand that artifacts are the results of certain creation and production processes which are by themselves culturally determined. These kinds of production processes can also be discussed under the umbrella of 'technology'. "We must understand that there are four major types of these 'technologies' each a matrix of practical reason: (1) technologies of production, which permit us to produce, transform, or manipulate things; (2) technologies of sign systems, which permit us to use signs, meanings, symbols, or signification; (3) technologies of power, which determine the conduct of individuals and submit them to certain ends or domination, an objectivizing of the subject; (4) technologies of the self, which permit individuals to effect by their own means or with the help of others a certain number of operations on their own bodies and souls, thoughts, conduct, and way of being, so as to transform themselves in order to obtain a certain state of happiness, purity, wisdom, perfection, or immortality" [50, p. 18].

The most promising view on technology in general and artifacts in particular is that these artifacts are 'prosthesis' of our shortcomings as human beings. In the case of human perceptibility Don Ihde introduced the concept of "translation mediations" [51]. After our birth we as human beings are the most unspecific specie on earth in terms of skills and knowledge, we have to be educated for many years before becoming a productive and responsible member of society; on the other side this enables us to be open minded, inventive (i.e. because we have to), and at the end highly adaptive towards the environment we are born in. Humans are extremely inventive to overcome our shortcomings; the best phrasing is that we design permanently new types of *prosthesis'* to enrich our life [52]. Design in general, and technology in particular is in its essence 'prosthetic design' [53]. All these kinds of 'prosthesis' enlarge the scope of meaningful relationships to our environment [54]. "Humans do not see and act on the physical qualities of things, but on what they mean to them" [55]. Accepting this view, we can conclude that technology is part of our 'curtain's fabric', our way to relate to our world because it is a constituent component of this world. But why was it so difficult to understand this very important insight?

## 6 Discussion

As long as we identify (a) intuition with subjectivity and (b) rationality with objectivity, we will not resolve the mind-body split [56]. Francis Bacon's *New Organon* [17] was revolutionary in its attempt to give formal philosophical shape to a new and rapidly emerging empirical science to challenge the church by finding the truth experimentally instead of interpreting the Christian bible only. At that time Bacon challenged the entire state of the art of the philosophy and learning, and he deeply influenced all subsequent discussions of scientific method till today. Bacon wrote [57] that natural science "doth make inquiry, and take consideration of the same natures: but how? Only as to the material and efficient causes of them, and not as to the forms." According to Bacon, apart from the *laws of nature* themselves, the causes relevant to natural science are **only** *efficient causes* and *material causes*, or to use the famous formulation, all nature visible to human science is *matter* and *motion*-nothing more, nothing less (see **Figure 1**). Using the above concepts of Aristotle to describe the four causes in nature, Bacon divided our world driven by causes into *physics* and *metaphysics* [17]: efficient and material causes for *physics*, and final and formal causes for *metaphysics*. This deep cut in our knowledge space was later confirmed and fixed for centuries by Descartes [58]: *res extensa* (realm for science; physics) and *res cogitans* (realm for the church; meta-physics). Till today science suffers from this fundamental split by facing the 'mind-body' problem [59]. Only if we can accept the full set of Aristotelian four causes, we can address our 'mind-body problem' successfully in an integral manner to overcome this schism.

The question about the nature of real nature (*true* reality) and artificial 'nature' (*artificial* reality) is not as easy to answer as it appears at first glance. How do we perceive real or virtual reality? How can we differentiate between real and virtual worlds? In order to understand what real and virtual worlds are and what their definite distinctions are at best, it is necessary to first outline the fundamental aspects of perception and knowledge, as well as assume the various epistemological positions. Since the meaning of the world is primarily established by actions [60], the individual knowledge of the world is stored in an action-related manner [61]. Instead of a passive portrayal, the world is determined actively [62]. Understanding is only possible in the re-construction of the world. Re-constructions that can be inter-subjectively experienced with the senses in an *objectivized* or inter-subjectively imparted form enable new dimensions of communication through design.

Rossi's analysis [63] is an important milestone in the historiography of the origins of modern science. Rossi shows how the ideas of the man considered the father of modern science were firmly rooted in traditional magical and alchemical knowledge. Bacon was a product of Renaissance philosophies and simultaneously opposed and rejected them. The provided analysis recounts the complexity of the Bacon's intellectual development from magic to science and highlights both connections and elements of discontinuity with the past. Rossi emphasizes Bacon's notion of a cooperative and public science, that is, a science shaped by the contributions of many individuals and aiming to dominate nature and promote human progress [64]. Although this was the admirable starting point, it turned centuries later into the opposite. Modern science changed into a dogmatic enterprise, and seems to have severe difficulties to liberate itself from this [7]. Heidegger [65] calls our here and now *Dasein*, the field in which both *being* and *time* become manifest. Heidegger analyzes *Dasein* in its everydayness in a deepening sequence of terms: being-in-the-world, world-hood, and care as the being of *Dasein*. Unfortunately through modern science we are caught in two main beliefs: (a) science is all about capturing nature in computational terms (i.e. no genuine space for unpredictability [5]), and (b) science looks 'down' to nature from a third person perspective (i.e. God's eye view [66]); this last belief hinders us to deeply understand and accept our un-avoidable *thrown-ness* into exactly this very nature, our world and universe around us: our *being-in-the-world* [42].

Flores and Winograd [15] illustrate the 'thrown-ness': "When chairing a meeting, you are in a situation that (I) you cannot avoid acting (doing nothing is also an action); (II) you cannot step back and reflect on your actions; (III) the effects of actions cannot be predicted; (IV) you do not have a stable representation of the situation; (V) every representation you have of the 'situation' is an interpretation; (VI) you cannot handle facts neutrally; you are creating the situation you are in".

After psychology as a strict behavioral based science has been separated from philosophy [67], the research of more than half a century developed into recognizing mental states as necessary concepts to be taken into account. Modern cognitive sciences accept that human self-consciousness depends on the meta-representation of mental and bodily states as one's own mental and bodily states. "First-person-perspective taking is not sufficient, but necessary for human self-consciousness" [68]. To assign a first-

person-perspective is to center one's own multimodal experiential space upon one's own body, thus operating in an egocentric reference frame. The brain regions involved in assigning first-person-perspective comprise medial prefrontal, medial parietal and lateral temporoparietal cortex. These empirical findings complement recent neuro-biologically oriented theories of self-consciousness which focus on the relation between the subject and his/her environment by supplying a neural basis for its key components [68].

One of the major achievements of Gadamer [69] is the destruction of the dominance of objectivism. The basic but fundamental idea of the hermeneutic circle (i.e. thrown-ness into our world) and, in particular, the idea that the *interpreter* is inevitably a part of the circle, is not compatible to the objectivist position. We must participate in or share in that which we attempt to understand in the sense that we can accomplish understanding only through invoking "the fore structures and prejudgments that are constitutive of our being" (p. 137). This kind of existential view, and Gadamer's extended critique of the Cartesian tradition, has left little for objectivism to ground on (see Cartesian anxiety above).

According to Greeno [70] Gibson developed an *interactionist* view of perception and action. This view focuses on information that is available in the environment of the context of use. Gibson rejected the common implicit assumption of separating *external-physical* and *internal-mental processes*. The alternative interactionistic position focusing on processes of *agent-situation interactions* is taken in ecological psychology and grounds in phenomenology. This interactionist view is also gaining popularity in recent research on complex, socially organized activity, conversational communication, and philosophical situation theory [71]. The concepts of *affordance* and *ability* are core concepts in the interactionist approach. "In situation theory, abilities in activity depend on attunements to constraints, and affordances for an agent can be understood as conditions in the environment for constraints to which the agent is attuned. This broad view of affordances includes affordances that are recognized as well as affordances that are perceived directly." [70]

Sahin et al. [72] defines an affordance as an acquired relation between a certain *effect* and an (entity, behavior) tuple, such that when the user applies the *behavior* on the *entity*, the *effect* is generated: (effect, (entity, behavior)). Gibson vehemently objected to the view that perception has to create and relay on a *generic world model* (i.e. often referred to as *representation* or *mental model*) over which the user infers whether an affordance exists or not [73]. Gibson argued that affordances are *effortless* and therefore *directly* perceivable (i.e. without using a world representation and without making inferences). Recently cognitive science explores effortless attention and action [74]. So far we investigated and understood attention and action to require effort, and we normally expected that effort has to increase to meet rising demand. However, attention and action sometimes seem to happen effortlessly despite high demand. Effortless attention and action have been described across a wide range of everyday activities [74]. So, how can we utilize on those recent insights to enhance design?

According to Fischer [75] one of the basic design principles that Donald Norman [76] gives is: The designer should get the *mappings* right! The mappings according to Norman indicate the relationships of (1) the interaction controls and their movements and (2) the results of these actions in the real world. *Natural mapping* should be used to get the mappings *right*. But what is a natural mapping? [77] It is a mapping that leads to immediate and therefore effortless understanding through the user because the representation of the functionality in those controls is made based on physical analogies and cultural standards matching the mental model of the user. Although this looks like a promising approach it includes at least two open questions. *Question-1:* Which aspects of the interface can be described using natural mapping and which effects, generating a natural mapping, can be used? *Question-2:* What exactly are physical analogies and cultural standards? For almost fifty years a lot of research was done on this latter question. This research area is called the *stimulus-response compatibility* (S-R compatibility). Possible aspects that can be of aid to the designer are according to Norman [76]:

- *biological effects* (the biological functions of the user have effect, e.g., in dual task performance the stimulus offered in the same hemisphere of the user as the hemisphere that directs the response offers faster response time and lower error rate);
- *cultural standards* (the control-response mapping follows a culturally determined convention, e.g., in the west 'clockwise is more');
- *perception effects* that allow for natural grouping and patterning of controls and feedback (similar controls are grouped in a way to reveal their relation, e.g., placing certain displays close together as a group to show their functional equality, proximity compatibility);

- *spatial analogy* (the control space is an immediate mapping of the response space, e.g., lighting lights using the same pattern for the controls as for the lights). [75]

The use of *natural mapping* and results of S-R compatibility studies is constrained by a number of aspects. E.g., concerning the different principles for changing difficult tasks into simple ones needs further elaboration. It can be noted that except the fact that Norman's principles are formulated in a narrative rather than a formal way the current state of the research also does not allow making the seven principles of Norman useable as a set of operational design guidelines. Therefore, two necessary developments are proposed [75]: (a) the development of a methodological framework in which all principles are incorporated; and (b) the formalization, unification and complementation of all relevant knowledge. When in the future these two aspects are fulfilled Norman's principles could form the backbone of a design methodology. With the current state of research *natural mapping* alone could be a powerful tool in developing user products and applications [78]. It might be possible to build a full methodology based on this first start. This is partly so because other principles are based on similar factors which play an important role in natural mapping. However some investigations into fundamental research areas have to be performed and the concept of natural mapping should be formalized before this could be applied as a foundation for affordances.

## 7 Conclusions

How can we now utilize on these insights based on phenomenology and alternative hermeneutic view in contrast to Cartesian science? Can we learn something useful for design? Yes, we can! Over the last decades Overbeeke and Hummels have advocated a set of design premises [79]. By taking their clear stance, Overbeeke and Hummels expect to combine the rational with the experiential, to reconcile *thinking* (rationality) with *feeling* (intuition). This might not be the only approach (see also [80] [81]), but they and I too believe it is *one* successful way to advance d*esign* towards a truly transformative level, a level that can lead to useful and sustainable innovations that can enable and guarantee our lives worth living. I tried to resolve the old problem of direct access to nature versus access only through a conceptual layer by providing two main arguments: (1.) humans are social creatures and have to communicate with each other; this communication can only be done through a conceptual layer; (2.) this conceptual layer is our only way to capture our environment, and this can only be done through a first person perspective. The most important consequence is that a third person view does not exist, the God's eye view is impossible for humans! [82] Even more, design is an exceptionally suited discipline to take the lead guiding science into the future where science sets people really free by overcoming established dogmas [7], as any good science did in the past [83]. In a nutshell, we *cannot* jump out of the loop of our 'thrown-ness' into this world! Therefore we have to subscribe to *conscious design*: being aware and acting responsible [84].

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