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EXTENDING MINDS AND SIMULATING WORLDS: FUNCTIONAL AND PHENOMENAL ROLES OF THE COMPUTER

1. Introduction

How can the relation between computers and their human users be understood from a philosophical point of view? In this essay, I will answer this question from two angles. I will first explore the *functional relationship* between computers and humans. Computers have many functions for human beings, for example as word processor, calculator, information provider, and gaming device. What I will attempt in this essay is to abstract from these diverse functions and attempt to arrive at an analysis of the functional relationship between humans and computers that is both more general and more profound. Next, I will explore the *phenomenal relationship* between humans and computers, which is the way in which computers transform our experience of and interaction with our environment or world. Both analyses, I will argue, similarly point to a dual relationship that humans have with computers: a cognitive relationship, in which the computer functions as a cognitive device that extends or supplements human cognition, and an ambient relationship, in which the computer functions as a simulation device that simulates objects and environments.

The distinction between functional and phenomenal relationships can be observed in previous work in the philosophy of technology. Thinkers like Ernst Kapp, Marshall McLuhan and Arnold Gehlen, have tried to understand the *functional* relationship of technological artifacts to human beings. They did more than analyzing the functions or functional capacities that various artifacts have. Instead, they attempted to analyze how the functions of technological artifacts related to abilities already possessed by human beings, and the way in which artifacts build on, augment or extend these abilities. That is, they were specifically interested in functional *relationships* between artifacts and human beings rather than mere functions of artifacts. The *phenomenal* relationship between a human beings and a technological artifact concerns the way in which this artifact transforms his or her experience of and engagement with his or her world. Early phenomenological perspectives on human-technology relationships have been advanced by Merleau-Ponty and Heidegger. The most important contemporary phenomenological studies of human-technology relationships are those of Don Ihde (1979, 1990).

In the next three sections, I intend to investigate how computer technologies maintain a functional relationship with their human users, and how this relationship is different from that of other technologies.[1] In the section thereafter, I intent to analyze

[1] These section are based on Brey (2005) in which the functional relationship between humans and computers is discussed more extensively.

phenomenal relationship between computer systems and human beings. The results of my study of functional relationships will be important building blocks for this phenomenal analysis. These two analyses are intended to clarify the fundamental roles that computers have in our personal lives, as functional items and as items that change the way in which the world is experienced and engaged.

2. Cognitive Artifacts

In an earlier paper, titled "Theories of Technology as Extension of Human Faculties," (Brey, 2000a) I have argued that technological artifacts often serve to extend or augment existing human capacities or faculties. For example, instruments like microscopes and telescopes extend our vision, so that we can perceive objects or patterns that we could otherwise not perceive. Vehicles like bicycles and automobiles extend our locomotive abilities, so that we can move faster or with less effort. Tools like hammers and drills extend the ability of our hands to modify materials. Walls, heaters and air conditioners extend the thermoregulatory capacities of the human organism. Millions of other artifacts likewise extend perceptual, motor and regulatory functions of the human organism. Does computer technology likewise extend one or more of our faculties? According to Marshall McLuhan, it does. As I pointed out in my paper, McLuhan claimed in his *Understanding Media* that with the advent of electric media, it is no longer just perception and motor functions of humans that are extended by technology. He argued that electric media extend the information processing functions of the central nervous system, taking over functions of information management, storage and retrieval normally performed by the central nervous system. He specifically argued that digital computers extend creative cognition and higher thought. McLuhan hence saw the digital computer as extending cognition, as opposed to perception or motor functions.

I here intend to develop McLuhan's idea that the computer extends human cognition by building on human cognitive capacities. My focus will be on the question *how* computers extend human cognition, which I intend to answer by analyzing the functional relation between human cognition and computer activity. I will be arguing that the computer is a special kind of cognitive artifact that is capable of extending a broad range of cognitive abilities of human beings. The notion of a cognitive artifact has been introduced by psychologist Donald Norman (1993). According to Norman, there is a special class of artifacts that are distinguished by their ability to represent, store, retrieve and manipulate information. Norman calls such artifacts cognitive artifacts. He defines them as artificial devices designed to maintain, display, or operate upon information in order to serve a representational function. The keywords here are "information" and "representation." They distinguish cognitive artifacts from other artifacts.

Norman's definition provides a clear criterion from distinguishing cognitive artifacts, such as thermometers, newspapers, clocks and Internet search engines, from noncognitive artifacts, such as hammers and automobiles. A thermometer has as its function is to inform us about temperatures. A newspaper has been made to stores and displays information on current events. A clock has been designed to accurately represent and display the time. An Internet search engine has been designed helps us to find information on the Internet. All these functions are representational functions. A hammer, in contrast, does not normally serve a representational function, as it does not normally maintain, display or operate upon information. There are perhaps some peripheral ways in which it may still serve representational functions. For example, it may contain a symbol or language that informs who the manufacturer is. And it may be put on a coffee table at home to remind oneself about a carpentry job that needs finishing. In that case it serves a representational function by making an indexical reference to the carpentry job. But it is not designed for such a purpose and therefore these cognitive functions are peripheral to its primary functions which are to hit nails and flatten or shape materials. Hence, it is not a cognitive artifact. Similarly, an architectural sketch that has been made to accurately represent a building is a cognitive artifact, whereas an artistic drawing of a nonexistent building is not a cognitive artifact, because it has not been designed to display information, but rather to please aesthetically.

Cognitive artifacts are properly called 'cognitive' because they, in quite straightforward ways, extend human cognition. They help us think, plan, solve, calculate, measure, know, categorize, identify, or remember. Various classes of cognitive artifacts may be distinguished, based on the primary cognitive capacity or capacities that they extend or aid. I will now list various basic cognitive abilities that have been recognized by cognitive psychologists, and illustrate how cognitive artifacts may extend or aid such abilities.

1. Memory.

Human memory is the psychological faculty by which we store information and retrieve it for later use. Cognitive artifacts that extend memory functions may be called *memory devices*. They are artifacts that help us encode, store and retrieve information. Sometimes, memory devices merely help us to locate information in our own memory. For example, some banks issue cards that help you to reconstruct the PIN-code of your ATM card based on an easier to remember verbal code. More often, memory devices serve as memory systems themselves: they store information in organized ways. If memory is a means for encoding, storing and retrieving information, then any device which has this as one of its primary functions is a memory device. So a notepad is a memory device, as its function is to store notes for ourselves or others, and pens and pencils are memory devices used for inscribing data into external memory.

Psychologist Merlin Donald (1991) has argued that one of the most important changes in the transition from Neolithic to modern culture is the emergence of a system of external memory storage, of which the storage of symbolic (linguistic) information is the most important. He claims that nowadays this external memory system contains more information than biological memories do, and that most human beings rely on it extensively. Media used for external memory storage include books, newspapers, microfilms, digital storage media, and others. For inscribing or reading them we have pens, pencils, microfiche readers, monitors and the like. Most important are paper and electronic (especially digital) storage devices. External memory devices serve in straightforward ways as extensions of human biological memory.

2. Interpretation

Interpretation is also a fundamental human cognitive ability. Interpretation is the ability to assign meanings to input data, through the assignment of one or more concepts or categories. For example, when one tries to recognize objects in one's environment, one may perceive certain shapes and colors. To recognize what these shapes and colors stand for, one needs to apply concepts to them that make a 'fit'. For example, a curved yellow shape can only be recognized as a banana when the concept of a banana is applied to it. The interpretation of perceptual data is the way in which perceptual stimuli are made useful as objects of conceptual thought, which does not range over sensory images, but over concepts.

Interpretation can be qualitative or quantitative. *Quantitative* interpretation is the assignment of a numerical value to a perceived quality. Another word for this is *measurement*. Measurement is a cognitive activity that we typically, though not invariably, perform with the aid of artifacts, *measuring devices*, like thermometers, spectrometers, clocks, yardsticks, sextants, etc. The history of science and technology, if not economics, politics and management, is to a large extend a history of measurement, along with the measuring devices that have been developed for it. Measuring devices extend our abilities to estimate the size, number or intensity of phenomena in the world, and are hence extensions of our ability to interpret the world.

Qualitative interpretation is the assignment to data of a qualitative concept or category. There are many cognitive artifacts that aid in the qualitative interpretation by giving criteria, templates or examples for the application of a concept. For example, color charts aid in the correct identification of colors. A book on animal tracks, with drawings op typical animal tracks, helps one in the identification of tracks observed in the woods. Medical texts list criteria for the correct identification of diseases. Few artifacts exist, however, that do not just support qualitative interpretation but that do the interpretive work themselves. The digital computer is an artifact capable of autonomous interpretation. Most qualitative interpretation performed by computers takes symbolic inputs, such as sentences, numbers or names, and assigns categories to them. For example, a computer program may take names of animals and classify them as "reptile," "mammal," "bird," "amphibian," etc. Or it may take a sentence, and parse it by assigning grammatical roles to words and phrases. Computers are also capable, when suitably programmed, to recognize objects and scenes in pictures, although their capabilities to do this are more limited.

3. Search

When we interact with the world, we often actively look for things that we are trying to locate but have not observed yet. We constantly look around for people, pens, purses, stores, food, stamps, road signs, words, barcodes, and numerous other things that we need to see, locate or use. The ability to search and subsequently recognize things is one of our fundamental cognitive abilities. Searches sometimes take place with exact specifications of what you are looking for, but more often they are heuristic, and take place according to hypotheses: you assume that there is something in your vicinity that meets a set of loosely formulated criteria, and search for something that meets these criteria. Searches do not just take place in the external world; we also frequently search our own memories for information.

Search is a cognitive process, because it involves activities like mental scanning and pattern matching. It is another process that can be assisted by cognitive artifacts. Cognitive artifacts can aid search by structuring the search space in such a way that it can be more easily scanned, and by 'flagging' types of items that one may scan for (e.g., by marking them with colors or symbols). Examples of cognitive artifacts that aid search are labels and filing systems. A special ability of computer systems is that they can perform searches themselves. They can do so because of their ability to do pattern matching and their ability to systematically scan through a search space.

4. *Conceptual thought*
The most important cognitive ability that distinguishes human cognition from animal cognition is the ability to engage in conceptual thought, and particularly the ability to engage in abstract thought, using abstract concepts. Conceptual thought is the ability to arrive at new conceptual structures (ideas or beliefs) through the modification (analysis or synthesis) of existing ones. Conceptual thought often involves *problem solving*: it often involves cognitive goals like finding the solution to a mathematical equation, determining the best way to furnish a room, finding an adequate translation into English for a sentence in Spanish, or thinking up the most diplomatic answer to a potentially embarrassing question. Problem solving can be aided by cognitive artifacts that help to arrive at an accurate representation of the problem space or of the kinds of steps to take to find a solution, such as models and diagrams, and procedural manuals. Computer systems are, again, special in that they are capable of autonomous problem solving. When suitably programmed, computers are capable of solving equations, thinking up room designs, translating sentences from Spanish to English, or answering questions. Computer intelligence of course still has its limitations. Results are not impressive, for example, in the areas of language use and reasoning in informal domains. Nevertheless, computers are nowadays frequently used for all kinds of tasks that ordinarily require conceptual thought, whether they are performing calculations, correcting grammar, engaging in dialogue, planning distribution routes, or designing copying machines.

3. Computer Systems as Cognitive Artifacts

Among the many cognitive artifacts that exist, computer systems are certainly unique. As has been observed in the previous section, computers are special in that they often go beyond the role of facilitating or aiding human cognition: computers are capable of performing cognitive tasks *autonomously*. Computers are special because they are capable of *actively manipulating representations*. Most other cognitive artifacts cannot manipulate representations, because they are not capable of systematically discriminating different kinds or representations and responding to them in meaningful ways. More specifically, still, computers are *physical symbol systems* (Newell and Simon, 1976), systems that manipulate (meaningful) physical symbols in virtue of their formal (syntactical) properties according to a finite set of operations, thus producing as output (meaningful) symbolical structures. This capability is the reason that computer systems are the most versatile and powerful cognitive artifact, that can either support or perform almost any cognitive task.

The functional relation that computers, as cognitive artifacts, have to their human users is hence that they extend cognition. Specifically, they extend the memory, interpretation, search, pattern matching and higher-order cognitive abilities of human beings. There is not, however, a single way in which computer systems functionally extend human cognition. I observed that computer are capable of autonomous cognitive processes. But they may also serve as a mere facilitator of human cognitive processes, as happens for example in word processing. I will now go on to further analyze how exactly computer systems add to, augment or replace the cognitive capacities of human beings.

As my point of departure, I will take a set of distinctions made in the formerly mentioned essay "Theories of Technology as Extension of Human Faculties." In this essay, I argued that artifacts that amplify the functioning of human organs may maintain three different types of relations with these organs. An artifact may *replace* the functioning of an organ by performing the function of that organ in a way that makes the organ redundant. For example, when driving a car, one's legs are not used as a means for transportation. An artifact may also *supplement* an organ that it extends, by performing a function that the organ in question is also performing. For example, clothing adds to the protective and temperature control functions already performed by the skin. Third, an artifact may *enhance* the functional powers of the organ that it extends, not by independently performing a function that resembles the organ's function, but by cooperating with the organ in a way that enhances its activities, in this way engaging in a *symbiotic relationship* with the organ. For example, a telescope extends visual perception by teaming up with the eye to form a new functional unit consisting of telescope-plus-eye that is capable of doing things that neither the telescope nor the eye is capable of doing by itself.

The relevant faculty or 'organ' that is extended by computer systems is our faculty of cognition, located, according to neuroscience, in our brain, specifically in the neocortex. Is a computer system an artifact that mostly replaces, supplements or enhances human cognition? All three roles are visible in computer systems. In its early days, the computer was often called the 'electronic brain,' and a common fear was that computers would replace human brains as the primary locus of cognitive activity. The computer as a replacement of human cognition is an autonomous information processing system that operates like a human cognitive agent, producing its own plans, solutions, and other knowledge structures without human intervention. In this role, the computer fits the early ideals of artificial intelligence research to 'build a person,' and the ideal of expert systems research to replace human experts.

The idea of the computer as a replacement of the human cognitive system has never been fully realized, and it is nowadays recognized that AI's dream to 'build a person' still depends on significant breakthroughs in AI research that have not been realized in past decades. The idea of the computer of a supplement to human cognition, in contrast, was an idea already powerful in the early days of computer and one that still holds currency. The computer in its supplementary role does autonomous information processing, but remains limited to those tasks that are tedious, time-consuming, or error-prone when performed by humans. These are tasks like doing large calculations ('number crunching'), database searches, and organizing and reformatting data. The implicit distribution of labor between humans and computers is then that humans perform the more intuitive and creative cognitive tasks and are responsible for the overall structure and goals of large cognitive tasks, whereas computer systems autonomously perform more tedious or time-consuming cognitive tasks that are defined as 'subroutines' within such larger cognitive tasks.

Since the rise of the personal computer, however, a third powerful interpretation of the role of the computer has emerged: that of a versatile tool that we handle directly and that enhances our own power to get work done. In this role, the computer is not an autonomous cognitive unit, but a cognitive aide, that enhances our own cognitive powers. It does not perform cognitive tasks by itself, but helps us to perform them. Our relation with the computer in this role is more *symbiotic*: the performance of a cognitive task depends on the information-processing abilities of both human and computer, and the exchange of information between them. When we use a word processor, spreadsheets, web browsers, and other software tools, the cognitive tasks we perform, such as producing well-formatted documents, performing calculations, or navigating the Web, are performed in cooperation with the computer. When we check the spelling of a document with the aid of a spelling checker, for example, this cognitive task depends on both the ability of the spelling checker to identify possible misspellings, and our own ability to operate the spelling checker and to decide whether its proposed corrections are valid.

Even in their role as tool, however, computers still engage in autonomous information processing. The previously mentioned spelling checker may not autonomously correct the spelling of a document, but it does make autonomous proposals. On the other hand, the computer in its role as a supplement to human cognition still requires a knowledgeable human operator, so its operations are not entirely autonomous. So the distinction between supplementary and enhancement roles of the computer is by no means absolute. In both cases, cognition is made into a distributed process that depends on the information-processing abilities of both humans and computers. The mutual dependency is greatest, however, when the computer functions as an enhancement of human cognition. In these cases, the computer operates *in tandem* with the human mind, and the integration of cognitive functions becomes so great that human and computer are best regarded as a single cognitive unit, a *hybrid cognitive system* that is part human, part artificial, in which two semi-autonomous information-processing systems cooperate in performing cognitive tasks.

4. Computing and World-Simulation

In its early days, roughly from the late forties to the late seventies, the computer was exclusively a cognitive tool, since the only tasks that it was designed to do were cognitive tasks, like calculation and information management. This has changed with the advent of computers with good graphical and multimedia abilities in the late seventies, eighties and nineties. These computers, most of them personal computers, acquired new functions that were not primarily cognitive. When a computer system is used to make a creative drawing, to play an adventure game, or to listen to music, it is not used as a cognitive artifact, because the performed functions are not information functions: artistic drawings, adventure games and music are not meant to inform, but rather to please or entertain. These activities may involve cognitive activity (almost any activity does), but their principal goals are not cognitive. The computer systems and software that supports such activities therefore do not qualify as cognitive artifacts.

Most of these new noncognitive functions of computer systems critically depend on newly acquired abilities of such systems to graphically represent, simulate or model interactive objects, structures and environments. I will term such abilities *simulation abilities*. With the rise of high-quality graphical capabilities in computers, the computer is no longer just a *cognitive device*, it is now also a *simulation device* (cf. Turkle, 1995). To wit, the two functions, cognition and simulation, are not mutually exclusive. In fact, many of the early efforts at graphical simulation were aimed at making the computer a better cognitive artifact. The Xerox Star was, in the late seventies, the first computer to make use of a graphical user interface, using a desktop metaphor that has since been copied by Apple (Macintosh) and by Microsoft (Windows). Desktop interfaces offer graphical user environment with documents, folders, trash cans, rulers, pencils and in and out boxes, that can be operated and manipulated in ways not unlike their physical counterparts. Their primary function, however, is to better support information-processing activities, particularly those performed in offices.

The advantage of graphical user interfaces over the older symbol-based interfaces (such as DOS and UNIX) is that they rely on our sensorimotor abilities to orient ourselves in space and to recognize and manipulate objects. Symbolical user interfaces make no good use of our sensorimotor abilities, and instead rely on our capacities for abstract thought. However, because people's sensorimotor abilities are usually better developed than their capacity for abstract thought, it pays to treat data and programs as manipulable, visible objects, when possible. As a result, the tendency in software development has been to devise programs in which data strings, (sub)programs and procedures are translated into visual icons and actions like clicking, 'dragging,' and scrolling.

Around the same time that graphical user interfaces came into vogue, the first noncognitive graphical computer applications started to become popular: graphical computer games and creative software like paint and music programs. These applications are noncognitive because they do not have as their primary function to assist in the performance of information-processing tasks. Instead, they are intended to extend our means for entertainment and creative expression. They do so by simulating physical environments, objects and events. Tools are simulated with which we can interact with the world, like paint brushes, golf clubs, wrenches and guns, and the objects encountered in the graphical environment can be programmed to respond visually and aurally like their physical equivalents. Many environments can even be navigated, representing a position for us, and giving us the option to move to a different position. And in some environments, we can even interact verbally or nonverbally with computer-generated characters.

The computer in its role as (graphical) simulation device functions perhaps less as an extension of ourselves than as an extension of our world. The virtual interactive environments generated by computers offer us new structures to experience, navigate and interact with. They are hence an augmentation of the world as it existed before. Although these structures are not physically real, they are nevertheless meaningful or useful to us, sometimes as much as their physical equivalents. They can clearly be useful for performing cognitive tasks, as I argued in my discussion of graphical user interfaces. They are also useful for learning, particularly for learning sensorimotor skills, through their ability to faithfully simulate physical structures that we interact with. And they are useful for entertainment and creative activity. They hence serve a functional role as broad and diverse as the functional roles of many of the structures encountered in the physical world.

5. A phenomenology of human-computer relationships

In the previous three sections, I analyzed the functional relationships that exist between computer systems and their human users. An analysis of functional relationships reveals fundamental functional roles of computers and their functional relation to the abilities of their users. In this section, I will analyze phenomenal relationships. The phenomenal relationship between a human being and a technological artifact is given by the way in which this artifact transforms his or her experience of and engagement with his or her world. Such an analysis can reveal significant shifts in the way people experience and engage with their world. Understanding such shifts is necessary for an understanding of the significant social, cultural and psychological changes that accompany the digital revolution.

Philosopher Don Ihde (1979, 1990) has argued that, from a phenomenal point of view, there are three basic types of relations between technological artifacts may relate to human beings. First, they may mediate between humans and the world. This happens in *mediation relations*. In mediation relations, an artifact is a means by or through which the world is experienced, engaged, or studied. In this way, the artifact becomes part of one's intentional stance towards the world, and co-determines the way in which the world is experienced or engaged. Ihde recognizes two basic mediation relations. In *embodiment relations*, an artifact mediates between self and world through a direct mediation of perception of or behavior towards our world (cf. Brey, 2000b). Embodiment relations occur in the use of artifacts like glasses, telescopes, bicycles and hammers. When used, such instruments become transparent means through which the world is perceived or acted on. They are 'incorporated' into our perceptual apparatus and motor programs, and may even come to feel like they are part of us. In hermeneutic relations, an artifact mediates between self and world through one or more representations of the world. Hermeneutic relations occur in the use of artifacts like maps, control panels and thermometers. These are artifacts that mediate our experience of or engagement with the world through symbolic or pictorial representations of the world.

The second type of relation identified by Ihde, next to the mediation relation, is the alterity relation. In alterity relations, artifacts are experienced and engaged as objects encountered in the world. In alterity relations, we direct our attention to an artifact, and observe it or interact with it. Alterity relations may involve attitudes and feelings towards the artifact, for example of admiration, resentment or love. Any artifact may take part in alterity relations, although some, like automobiles, sculptures and jewelry, receive more attention than the average artifact. The third type of relation is the *background relation*, in which artifacts function as background objects in the world that people do not directly engage with, but that constitute part of the context in which people operate. Examples are central heating systems and electric lights that function as background objects that affect the way we experience and interact with the world without functioning either as a medium or as an object of perception or engagement.

All four of these relations, embodiment, hermeneutical, alterity and background, can be established between human beings and computer systems. Most salient, perhaps, are hermeneutical relations. When computers are used as cognitive artifacts, a hermeneutical relation is established with them. In such a relation, the computer represents information about the world, and the user reads, observes, navigates, or reformats this information, and may also add information about the world herself, or instruct the computer to produce or transform information. A consequence of the frequent use that is made of computers as a hermeneutic device is that increasingly, our knowledge of the world is mediated by computers. Importantly, this mediation is not a passive process of rendering pictures or texts. Computer systems also engage in interpretation, calculation, reasoning, planning, and decision making, and thus play a very active role in the formation of our knowledge of the world and our plans for acting on it.

Also salient in our use of computers are alterity relations. The computer is frequently experienced and engaged with as an 'other,' an artifact that is interesting both to observe and to interact with. The alterity relations that people establish with computers are more complex and emotional than those established with most other artifacts. As Sherry Turkle (1984, 1995) and Reeves & Nass (1996) have observed, computers are often anthropomorphized: they are considered and treated as persons. Anthropomorphization occurs with other artifacts, for example with automobiles. But computers have much greater similarities with human agents: they autonomously perform actions, they like other human beings respond to symbols, to human language even, and they appear capable of intelligent behavior. Whereas much of this behavior is attributed to 'the computer,' there is an increasing tendency to model agents *on* the computer. That is, agents capable of performing specific tasks are identified on the computer, like office assistants, search agents, Tamagotchis and chess opponents, and may even be equipped with expressive faces and speaking voices. In this way, our world is increasingly populated with artificial agents to which we establish alterity relations, whether cooperative, competitive or neutral. As Turkle (1984) has argued, a consequence of our experiences with the computer as an 'other' that is located somewhere in between a dumb machine and an intelligent organism is that people are renegotiating their conceptions of intelligence, mind, self, and life, along with their attitudes. Is a Tamagotchi (a simulated pet) really alive, and if not, why can its death feel so real? Is the display of intelligent behavior a sufficient condition for having a 'mind'? These are the kinds of issues that have to be (re)negotiated in a world filled with artificial agents.

Whenever we use a computer, we also establish embodiment relations with it. To be precise, we establish embodiment relations with the input and output devices, like keyboard, mouse, joystick and monitor. But through these physical devices, we are also capable of establishing embodiment relations with virtual objects on the screen, like pointers and paint brushes (e.g., in a paint program) and guns, telescopes and automobiles (e.g., in three-dimensional simulations and games). Such embodiment relations often exist simultaneously with other relations, like hermeneutical and alterity relations. For example, when someone plays chess against a computer opponent, both embodiment, hermeneutical and alterity relations are established. The special character of embodiment relations with computers is that the 'world' that is experienced and engaged through their input and output devices and their virtual correlates is not a physical but a virtual world.

This implies that sensorimotor skills are learned that relate not to physical objects and environments, but to virtual ones, with all their peculiarities.

Let us finally turn to as phenomenon that is difficult to reconcile with Ihde's typology of mediation, alterity and background relations. I argued in the previous section that virtual environments generated by computers may be regarded as extensions of our world that offer us new structures and environments to engage. Such simulations are like physical worlds, in that they can be interacted with and navigated, and the objects they contain can relate to us in all the ways indentified by Ihde: embodiment (e.g., a virtual wrench), hermeneutical (e.g., a virtual map), alterity (e.g., a computer-generated dog) and background (e.g. a virtual light source). One way in which virtual environments may be understood in the context of Ihde's scheme is as aspects of computer systems to which alterity relations are established. In this view, a virtual environment is a computer-generated artifact that we experience and interact with, as in an alterity relation. Only, the structure is so rich that within the context of this alterity relation, we can establish more specific alterity relations with substructures of the environment, as well as embodiment, hermeneutical and background relations with yet other substructures.

Alternatively, virtual environments may be analyzed as straightforward extensions of the physical world that should not be understood as complex artifacts but as *worlds*. Worlds are not artifacts to which we have relations, but contexts within which such relations are established with specific objects. Both interpretations of virtual environments, I wish to suggest, have their own worth. The first interpretation downplays the idea of virtual environments as genuine worlds and tells us that the long hours we spend playing designing virtual landscapes, playing Tomb Raider or surfing the Internet are not hours spent in the real world but with a machine. The second interpretation accepts virtual environments as genuine worlds, and hence the idea that our experience and interactions in virtual environments can be as meaningful and 'real' as those in the physical world. Both interpretations are valid because virtual environment are ambiguous in precisely this way: they are both mere artifacts and genuine worlds, depending on how much one invests and 'believes' in them.

6. Conclusion

The functional analysis of computer systems presented here has identified computer systems as both cognitive devices and simulation devices. In its role of a cognitive device, the computer extends human cognitive faculties by both supplementing and enhancing them. It is particularly in this latter role that collaboration between human mind and computer system becomes so close that one may speak of a hybrid cognitive system that is part human, part artificial. In its role of a simulation device, the computer does not so much extend human faculties as extend the world. Computer-generated, virtual environments offer extensions of the physical world that are useful for entertainment, creative activity, learning and social interaction.

The phenomenal analysis of computer systems has revealed that computer systems, in their role of cognitive device, engage with their users in hermeneutical and alterity relations. It was claimed that a consequence of the many hermeneutical roles played by computer systems is that our knowledge of the world is increasingly mediated by computers, not just passively, but actively, in that computers are actively engaged in the production of knowledge structures. A consequence of the alterity roles played by computers is a blurring of the traditional distinction between (intelligent) human beings and (dumb) machines, so that many of our concepts and attitudes regarding this distinction need to be reevaluated. Finally, it was claimed that virtual environments can be interpreted either as computer-generated artifacts that are a mere object of alterity relations, or as genuine worlds, that can be navigated and interacted with in myriad ways. It was argued that both interpretations have their validity, as their ambiguity between artifact and world is an essential property of virtual environments.

REFERENCES

Brey, P. (2000a). 'Technology as Extension of Human Faculties.' *Metaphysics, Epistemology, and Technology. Research in Philosophy and Technology, vol 19*. Ed. C. Mitcham. London: Elsevier/JAI Press.

Brey, P. (2000b). 'Technology and Embodiment in Ihde and Merleau-Ponty.' *Metaphysics, Epistemology, and Technology. Research in Philosophy and Technology, vol 19*. ed. C. Mitcham. London: Elsevier/JAI Press.

Brey, P. (2005). 'The Epistemology and Ontology of Human-Computer Interaction,' *Minds and Machines 15*(3-4), 383-398.

Donald, M. (1991). *Origins of the Modern Mind*. Cambridge and London: Harvard University Press.

Heidegger, M. (1962/1927). *Being and Time*. J. Macquarrie and E. Robinson (trans.). New York: Harper and Row. Originally published in German as *Sein und Zeit*.

Ihde, D. (1979). *Technics and Praxis: A Philosophy of Technology*. Boston: D. Reidel.

Ihde, D. (1990). *Technology and the Lifeworld: From Garden to Earth*. Bloomington: Indiana University Press.

McLuhan, M. (1966/1964). *Understanding Media: The Extensions of Man*. New York: McGraw- Hill. Paperback edition, 1966.

Merleau-Ponty, M. (1962/1945). *Phenomenology of Perception*. C. Smith (trans.). New York and London: Routledge. Originally published in French as *Phénoménologie de la Perception*.

Newell, A. and Simon, H. (1976). 'Computer Science as Empirical Inquiry: Symbols and Search,' *Communications of the Association of Computing Machinery*, 19: 113-126.

Norman, D. (1993). *Things that Make us Smart: Defending Human Attributes in the Age of the Machine*. Reading, MA: Addison-Wesley.

Reeves, B. and Nass, C. (1996). *The Media Equation: How People Treat Computers, Television, and new Media Like Real People and Places*. CSLI Publications.

Turkle, S. (1984). *The Second Self. Computers and the Human Spirit*. London: Granada.

Turkle, S. (1995). *Life on the Screen; Identity in the Age of the Internet*. New York: Simon & Schuster.