THEORIES OF TECHNOLOGY AS EXTENSION OF HUMAN FACULTIES

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The idea that technology is an extension of the human organism is encountered regularly in the history of thought about technology. The idea, in its most basic form, is that technical objects extend the human organism by replicating or amplifying bodily and mental abilities. This idea is usually presented as a key to a better understanding of technology. In this essay, I will discuss three theories of technology as extension, as developed in book-length studies by Marshall McLuhan, Ernst Kapp, and David Rothenberg. My aim is to investigate whether there is a valid and useful sense of 'extension' according to which technology can indeed be analyzed as an extension of human faculties or organs. The outcome of this investigation will be affirmative, and I will end up presenting a unified account of technology as extension of human faculties, that builds on previous accounts.

As I will argue later on, the value of a perspective of technology as extension of human faculties is twofold. First, such a perspective can serve to provide a better understanding of the evolution of technology, and its diverse forms and applications. Second, this perspective can be useful in evaluative analyses of the role of technology in society. The argument that a perspective of technology as an extension has this potential value is made in section 5. The bulk of this essay, however, is devoted to a development of the account of technology as extension of human faculties itself. In the next section, the extension theories of McLuhan, Kapp, and Rothenberg are reviewed. In section 2, these three theories are evaluated and a unified theory of technology as extension is argued for. Section 3 further develops and expands this theory, and section 4 discusses various ways in which technical artifacts, perceived as extensions, may relate to the human organism.[1]

1. Theories of Technology as Extension of Human Faculties

In his famous *Understanding Media*, subtitled *The Extensions of Man*, Marshall McLuhan depicts technologies as extensions of humanity:

> During the mechanical ages we had extended our bodies in space. Today, after more than a century of electric technology, we have extended our central nervous system itself in a global embrace, abolishing both space and time as far as our planet is concerned. Rapidly, we approach the final phase of the extensions of man - the technological simulation of consciousness, when the creative process will be collectively and corporately extended to the whole of human society, much as we have already extended our senses and our nerves by the various media (McLuhan, 1966, p. 19).

In his book, McLuhan time and again analyzes different technologies as extensions of humanity. However, McLuhan does so in a very informal style, and does not advance a definition of the notion of extension or a clear taxonomy of different types of extensions. Yet, it is clear upon careful reading that McLuhan means by an extension (or, as he also calls it, a 'translation', 'repetition' or 'intensification') an amplification or acceleration of existing human faculties or behaviors. As he puts it, 'It is a persistent theme of this book that all technologies are extensions of our physical and nervous system to increase power and speed. Again, unless there were such increases of power and speed, new extensions of ourselves would not occur or would be discarded' (p. 91).[2] All technologies are hence analyzed as amplifications or accelerations of functions originally performed by the unaided human organism, that take over or supplement these functions.[3]

McLuhan appears to distinguish two broad classes of extensions of the organism: *extensions of the body* and *extensions of cognitive functions*, which include functions of the senses, central nervous system, and 'consciousness'. By extensions of the body, McLuhan means extensions of parts of the human body that are used for acting on or protecting oneself from the environment, or regulating bodily functions. Specifically, they include the limbs, teeth, and bodily heat-control systems (including the skin). The senses, the central nervous system, and higher cognitive functions are not defined as parts of the body. The basic types of extensions of the body, McLuhan claims, were introduced during the mechanical age. Examples of them include weapons such as bows, spears and knives, which are analyzed as extensions of hands, nails, and teeth. Likewise, clothing is seen as an extension of the skin, to extend its function of bodily heat control and protection. The wheel is seen as an extension of 'feet in rotation'. Other mechanical tools and utensils, such as jars, matches, and money, are also analyzed as technologies that extend 'storage and mobility functions'. Mechanisms, generally, are analyzed as specialized, segmented

amplifications of 'bodily postures and motions'. 'What makes a mechanism is the separation and extension of separate parts of our body as hand, arm, foot, in pen, hammer, wheel. And the mechanization of a task is done by segmentation of each part of an action in a series of uniform, repeatable, and movable parts' (p. 218).

Media are analyzed by McLuhan as extensions of the senses, particularly those of sight and sound. Thus, the radio and telephone function as long-distance ears, and visual media, including writing and print, are extensions of the visual function. Electric media are analyzed, moreover, as extension of the information processing functions of the central nervous system. That is, electric media take over functions of information management, storage and retrieval normally performed by the central nervous system. Consequently, a human being in the electric age is quite literally , in McLuhan's analysis, 'an organism that now wears its brain outside its skull and its nerves outside its hide' (p. 64). 'Consciousness', by which McLuhan seems to refer to creative cognition and higher thought, and which he appears to see as distinct from the central nervous system, is the final form of extension McLuhan envisions. The extension of consciousness is not so much performed by conventional, analog electric media as it is by digital computers. McLuhan envisioned an era in which human intelligence and creativity would be automated and translated into information functions performed by machines.

Almost a century before McLuhan published *Understanding Media*, philosopher Ernst Kapp published his *Grundlinien einer Philosophie der Technik* (1877), the first work to present itself as a study in the philosophy of technology. In this work, Kapp presents an extended argument that all technical artifacts are projections of human organs, in that 'humans unconsciously transfer form, function and the normal proportions of their body to the works of their hands' (Kapp 1877, p. v-vi, my translation). Chapter after chapter, different classes of artifacts are compared with human organs, as Kapp attempts to make plausible his claim that the artifacts under discussion are imitations of human organs. Although Kapp tends to use the term 'projection' (*Projektion*) and not (a German equivalent of) the term 'extension', he does repeatedly refer to artifacts as continuations (*Fortsetzungen*) of biological organs. He also repeatedly states that properties of biological organs are transferred (*verlegt*) to artifacts, and that many tools and machines enhance (*steigern*) the natural powers of the hands and arms. However, he tends to see artifacts less as supplements than as replacements (*Ersätze*) of human organs.

Perhaps the most important difference between the views of McLuhan and Kapp is that Kapp, unlike McLuhan, argues that the form of technological artifacts imitates the form of human organs. McLuhan only claims that functional properties of human organs are translated, in amplified form, to artifacts. He makes no claim that morphological

properties are transferred as well. Kapp, however, claims: 'Since the organ whose utility and power is to be increased is the standard, the appropriate form of a tool can only be derived from that organ' (p. 45, my translation). According to Kapp, therefore, form follows function, and for two things to be functionally similar, they must also be morphologically similar. Consequently, artifacts must be morphological analogues of human organs. The bent finger becomes a hook, the hollow of the hand becomes a bowl, the human arm and hand become a rake, oar, or shovel, the human nerves become telegraph cables, lenses in optical instruments imitate the lens in the human eye, railway systems imitate the structure of the vascular system, and the whole human body functions as a model for the construction of machines.[4]

A second important difference between the views of McLuhan and Kapp is that Kapp holds that the properties that artifacts have in common with human organs are the result of a process of projection. This is to say that human beings use their own faculties as a standard (*Massstab*) whenever they create new artifacts. Kapp holds that this process projection of form and function of organs to artifacts is not normally a conscious process. Instead it is a process executed by the human unconscious, and functional and morphological parallels between organs and artifacts often become apparent only after the fact. However, even if projection is not a conscious process, it is still an intelligent process performed by human beings, that explains the functional and morphological similarities between organs and artifacts. McLuhan, in contrast, does not, or at least not explicitly, hypothesize any process of projection, but merely points out the existence of parallels between artifacts and human faculties because of which the former can be seen as extensions of the latter.

More than a century after Kapp's *Grundlinien*, and almost thirty years after *Understanding Media*, David Rothenberg's *Hand's End* portrays technology as an extension of humanity. Rothenberg argues: 'Techniques can extend all those human aspects for which we possess a mechanical understanding, that is, we know how it works' (1993, p. 16). These are human faculties that can be conceived of as 'a faculty, appendable by a device' (p. 16), such as our eyes, or our hands. What is not extended are faculties that cannot be conceived of as appendable or mechanizable, which are our faculties of judgment, morality and 'the sense of place.'

Those human faculties that can be extended by technology, Rothenberg claims, can be categorized into two broad classes: faculties of action, and faculties of thought. Technologies are hence either extensions of action or extensions of thought (or both). Extensions of action roughly correspond to what McLuhan calls extensions of the body. They include, first of all, hand-driven tools and other devices which are 'direct extensions

of the motions of our body' (p. 31), particularly of manual actions. A second class is formed by technologies for transportation, that are directly controlled by us, that is, vehicles and piloted machines. These are extensions of 'our bodily presence if not specifically actions of our arms, legs, hands and feet' (p. 31). A third class is constituted by 'separate machines', which are relatively fixed structures in the environment such as roads, buildings, irrigation ditches, waterwheels, and lighting fixtures, that extend 'our restless need for movement' and 'our struggle to survive' (p. 33).

Extensions of thought correspond to McLuhan's extensions of the senses, the central nervous system and consciousness. Rothenberg distinguishes three kinds. First, there are artifacts that improve the senses by directly extending perception, such as telescopes, microscopes, telephones, radios, communication satellites, wires, and television. Second, there are 'tools of abstraction', which are instruments that extend cognitive dexterity by extending abstract thought and language functions. These technologies include devices such as computers and calculators, but also 'immaterial' technologies such as natural languages, numerical systems, and formal languages such as those of mathematics, symbolic logic, and computer programming. Finally, there are material extensions of memory, which are material means by which experience can be encoded, stored and retrieved. Rothenberg's prototypical examples of material memory are not devices that encode information in abstract or symbolical form, but that try to capture human experiences. These devices include storage media such as photographs, video tapes and sound recordings, and corresponding equipment for recording and retrieval.[5]

Rothenberg's theory of technology as extension of humanity has a number of similarities to McLuhan's theory. Most importantly, Rothenberg, like McLuhan, construes technological artifacts as entities that extend functional properties of human faculties, but not necessarily morphological properties. Like McLuhan, Rothenberg refrains from claiming that these extensions are the result of a conscious or unconscious process of projection. Rothenberg's typology of extensions also looks a bit like McLuhan's. There is a major difference between the theories of Rothenberg and McLuhan, however. Whereas McLuhan sees artifacts primarily as extensions of human faculties, Rothenberg sees them only secondarily so. The primary thing that artifacts are an extension of, according to Rothenberg, is human intention. Our intentions, or desires, are normally contained within our own organism. However, as we create technologies, these technologies become carriers of our intentions, and hence extensions of them. Only secondarily can we also recognize technologies as extensions of human faculties. Presumably, although Rothenberg does not say this explicitly, technologies are often extensions of human faculties because these faculties are the original bearers of our intentions. It is only to be

expected, then, that as we extend our intentions, the artificial means by which they are extended tend to share functional features with our human faculties.

McLuhan, Kapp and Rothenberg all develop their account of technology as extension of human faculties in order to raise larger questions about human nature, and the social, cultural, and psychological role and implications of technology. Kapp, for one, argued on the basis of his theory that technology only serves the individual and the community when it projects from human faculties. Technology that is instead only developed so as to fit into a technological system designed to serve a higher purpose ultimately limits human freedom, security and culture.

McLuhan was also concerned with the social, cultural and psychological implications of technological choices. He claimed that any extension of human faculties implied a 'numbing' of these faculties, or even a 'self-amputation,' with great psychological and social consequences. He also believed that by relying too much on our extensions, we were becoming 'servomechanisms' to them. He warned, too, against the commercial exploitation of extensions of our faculties. 'Who owns your extended eyes?' he asked, and exclaimed: 'Once we have surrendered our senses and nervous systems to the private manipulation of those who would try to benefit from taking a lease on our eyes and ears and nerves, we don't really have any rights left' (p. 73). McLuhan moreover emphasized the great difference between the 'old' extensions of the mechanical age, which tended to be specialized and differentiated, and the 'new' extensions of the electric age, which tend to totalize and to translate all social, economic and cultural processes into the form of information.

For Rothenberg, the purpose of conceiving of technology as extension of humanity is to be able to reevaluate the question of how technology disconnects us from nature, and how it can help reconnect us. He asks what we are extending ourselves for, ultimately, and whether we would be better served with different kinds of extensions. Some artifacts, such as hand-held tools, are more 'transparent' than others, he claims, in that they help us realize our intentions in a natural and effortless way, whereas others, such as roads and buildings, create their own world of order and may in this way take away our autonomy. Rothenberg emphasized that artifacts, particularly those that are not transparent to our intentions, are not neutral means that extend our ability to realize our intentions, but that also serve to modify our intentions and to generate new ones. As new means are added to our existing means, our experience of ourselves and of our world changes, we develop new priorities, and we discern new shortcomings in our existing inventory of artifacts that we resolve by introducing yet other artifacts.

For these authors and for others,[6] a conception of technology as extension of human faculties enabled them to ask novel questions about technology and its consequences, and to treat familiar issues in a novel and unified way. These explorations only have their worth, however, if the claim that technology is an extension of human faculties can withstand scrutiny. Specifically, it has to be shown that there is a sufficiently restrictive sense of 'extension' according to which technical objects can be literally claimed to be extensions of human faculties, with no counter-examples existing. In the next section, I will evaluate the extension theories of McLuhan, Kapp and Rothenberg according to these criteria. I will end up proposing my own theory of technology as extension of human faculties, a theory that will incorporate ideas from McLuhan and Rothenberg, as well as from other authors yet to be discussed.

2. Extensions of the Organism as Extensions of Its Inventory of Original Means

All three of the above theories of technology as extension of human faculties are suggestive, and gain support from many examples. Still, I will claim, they suffer from important flaws that makes them untenable in their current form. Kapp's claim that artifacts are morphological projections of human organs, first of all, does not stand up to closer scrutiny. Admittedly, Kapp presents an impressive range of artifact-organ pairings between which morphological similarities exist, and there are many historical examples of artifacts that were clearly inspired (even consciously) by human organs. However, there are many counterexamples to Kapp's claim. Fishing nets, books, lighters, telephones, and airplanes, for example, do not seem to have clear morphological similarities to human organs. Of course, anything is similar to anything else in some respect, and so one may try to compare a fishing net to webbed fingers, and airplane wings to outstretched arms, but I take it to be evident that for these and many other artifacts, human organs hardly served as an inspiration.

McLuhan does not presume that all artifacts are morphologically similar to human organs, but does hold that they are all functionally similar in some respect.[7] Every artifact enhances a functional property displayed by some human organ, such as the ability to move, dig, cut, store, or perceive. An artifact is an extension of a human organ, in McLuhan's sense, just in case it has functional abilities also possessed by this organ and adds to, amplifies, or takes over, some of its functioning. It can also be demonstrated, however, that not all technological artifacts are functional analogues of human faculties. There are many things that artifacts can do that have little similarity to anything humans can do. Electric lighting, for example, is able to give light, but there is no human faculty

that even gives a modest amount of light. Explosives, electromagnets, ionizers, and roads are other examples of technological artifacts that have no interesting functional resemblances to human organs or behaviors. It may still be argued that these artifacts nevertheless correspond functionally to human organs in more abstract ways. For example, ionizers may be claimed to share with human hands the ability to 'transform matter.' As one resorts to such abstract and far-fetched properties, however, the idea that artifacts are functional copies of human organs becomes increasingly hollow.

Rothenberg's theory, finally, is ambiguous. Sometimes Rothenberg seems to claim, like McLuhan, that any artifact functionally corresponds to some human organ. This has been shown to be mistaken. More often, however, Rothenberg appears to claim that what is extended by technology are not human faculties, but human intentions. However, if this is what Rothenberg means, then it appears that his theory is really not a theory of technology as extension of human faculties, but a theory of technology as extension of the human will.

It hence appears that neither Kapp, nor McLuhan, nor Rothenberg presents a theory of technology as extension of human faculties that is both coherent and defensible. Should it be concluded, then, that the idea of technology as extension of human faculties has no integrity? No. There is a notion of extension, I will now argue, that is coherent, and to which there are no counterexamples. This notion of extension has its closest affinities with the notion of extension proposed by David Rothenberg. Rothenberg was seen to claim that all technologies are extensions of the will, or, equivalently, of human desires or intentions. As Rothenberg puts it, 'when we make something, we thrust our intentions upon the world.' (p. 16). Our intentions, normally only contained within our own organism, become embodied in our artifacts, and are hence extended by them. I have some difficulty making sense of the idea that intentions are things that can be 'extended' by technology or that can be 'thrusted upon the world.' Nevertheless, I believe that Rothenberg's analysis of technology as extension of human intention contains an important insight.

Rothenberg's idea that technology extends human intentions may be reformulated to say that technology extends the *means* by which human intentions are realized. Thus, it is not human intentions themselves that are extended. Human beings, I claim, are beings who continually try to realize their intentions, whether selfish or altruistic. As a result, they try to change the world so that it conforms to those intentions. To do this, they initially only have their bodily and mental faculties available. These are the original means by which they can realize their intentions. Technological artifacts extend, or add to, these means. This idea may be summed up in the following thesis.

Extension Thesis: All artifacts extend the set of naturally given means (i.e., human bodily and mental faculties) by which human intentions are realized.[8]

The extension thesis emphasizes, as McLuhan and Rothenberg both do, that artifacts build on the human body by adding functional features to its functional features. However, it differs in that it makes no claim that these added functional features must resemble, or build on, the functional features of individual organs. In this way, it also accounts for artifacts that have functional abilities not possessed by human faculties, such as the ability to give light, ionize, or magnetize.

Let me expand on this thesis. I am claiming that the human organism harbors a set of mental and bodily faculties that are intentionally employed for the realization of intentions. These faculties include the limbs, controllable muscles, sense organs, those mental faculties that are under conscious control, and any human faculty that can be controlled by the central nervous system. These faculties constitute one's inalienable set of means that can be employed to realize intentions formed by the will.[9] Thus, when one eats an apple, one uses one's arms, hands, and jaws as means, or instruments, by which the apple is eaten, and when one walks, one uses one's legs as instruments for transportation. In this way, human faculties constitute the original 'tool set' that humans use to successfully move around in their world. The body, as Lewis Mumford (1967) put it, is a 'primary, all-purpose tool', 'man's total equipment for life.' (p. 7).[10]

One's original inventory of means, defined by one's mental and bodily faculties, may be extended by other, external means. External means are alienable means, that are not part of the standard inventory defined by our bodily and mental faculties.[11] External means serve to extend the range of actions, or tasks, that someone is capable of, either by enhancing existing capacities, or by adding genuinely novel capacities. They may then help one realize intentions that could not be realized with just one's own faculties. For example, when one is placed under an unclimbable apple tree, with an apple hanging some ten feet above one, one finds that one cannot, by means of just one's own faculties, realize one's intention of having the apple. An instrument such as a long stick, a ladder or a chainsaw extends one's 'action horizon', and one suddenly finds oneself able to realize one's intention.

3. Elaborations of the Theory

3.1 Social and Cultural Extensions

Reading Kapp, Rothenberg and McLuhan, one would almost forget the many social, cultural and symbolical functions performed by artifacts. All the technological extensions discussed by Kapp, Rothenberg and McLuhan concern practical uses of technology, for the extension of physical action, perception, and cognition. This neglect of the social and cultural roles of artifacts may seem to speak against extension theories. However, I will argue that the extension theory proposed in the previous section can easily accommodate the social and cultural dimensions of technology.

The extensions discussed by Kapp, Rothenberg and McLuhan usually relate to *physical functions* of artifacts: functions that are performed in virtue of their physical capabilities. For example, a knife has the physical function of cutting, which it can only have in virtue of its physical sharpness. Likewise, a binocular enhances perception, in virtue of its optical properties. John Searle (1995) has argued, however, that artifacts may also have powers and corresponding functions that do not derive from their physical properties but instead derive from collectively imposed *status functions* on them. Dollar bills, for example, are able to function as a medium of exchange not because they have an inherent physical power to perform this function, but because people have collectively assigned the function of being a medium of exchange to them. Without this assigned function, dollar bills could not function as money. Likewise, a wedding ring can be used to show that one is married only because there is a collective agreement that it has the status of symbolizing that someone is married.

Functions of artifacts are hence not just physical functions, but also include status functions, that can be performed because of collective agreements about the status of an artifact that prescribe how the artifact should be interpreted and used. Status functions make it possible for artifacts to perform various social and cultural functions next to their sundry physical functions. These social and cultural functions include symbolical, moral and religious functions, that are used to satisfy spiritual needs, such as worship, identity formation, and self-expression (e.g., a musical instrument can be used for self-expression, and a religious shrine can be used for worship). They also include social functions such as the marking of social status (e.g., a Rolex watch is not just used to tell the time, but also to signify social status).

Notice, however, that these uses of artifacts are still purposive, even if the purpose is not a practical one. When artifacts are used in their capacity of bearers of status functions, they are hence still means to ends. Thus, a statue that people kneel to and use to get into

contact with the divine still serves, in a quite straightforward sense, as a means to an end. It adds to the means available to one for religious worship. Similarly, a musical instrument is a means, next to one's own bodily means, by which one can express oneself. Clothing, likewise, is more than a means to protect the body and to regulate temperature. It can also serve as a means to express one's personality and social status.

Most extension theorists, including McLuhan and Kapp, show insufficient awareness of the social and cultural dimensions of artifacts. Thus, when McLuhan analyzes artifacts as mere means to more power, he appears to stress practical functions of artifacts and to overlook their cultural roles. Rothenberg displays more sensitivity to the social and cultural role of technology, but still classifies technological artifacts in a functional scheme that only recognizes their role as instruments for knowledge and physical action. Yet, it has to be observed that artifacts have both (practical) physical functions and (social-cultural) status functions, both of which serve to extend abilities of the human organism.[12]

3.2 Organisms and Natural Objects as Extensions

So far, my emphasis has been on technical artifacts as instances of external means by which one's faculties can be extended. It is a distinguishing feature of technical artifacts that they have been designed to serve human ends. They differ in this from natural objects, such as rocks, sand, sticks, and water, as well as from humans, animals and plants. However, any object or organism that is capable of being a means to an end can come to extend the human organism. For example, a stick or stone, picked up in the woods, can amplify one's abilities to defend oneself or to modify raw materials. Organisms other than oneself, that is, plants, animals and other human beings, are also frequently used to extend one's abilities. The distinguishing feature of technical artifacts, as opposed to natural objects, is perhaps, that they have been intentionally designed to function as extensions.

The use of animals and human beings as extensions merits special consideration. Before the large-scale use of water mills in the eleventh century, live animals and human beings were the only reliable means available to perform labor. If someone wanted certain work to be done that he could not do or did not want to do himself, his only choices were therefore to enroll the labor force of animals or other human beings. This required him to find a way by which animals or humans could be made to act in accordance to his

intentions. Through training, animals were and are made into instruments that perform heavy physical labor for human beings. Animal training is essentially a method of carrots and sticks in which an animal learns to respond to cues with appropriate behavior. It is the way by which a human being imposes his will on an animal so as to make it useful as an extension of his own inventory of means.

Human beings also use other human beings to perform labor for them. One difference with the use of animals is that human beings may not only be used for 'dumb' tasks that mainly require physical labor, but also for intelligent tasks. They are hence able to serve as extensions of someone's mental faculties as well as of his bodily faculties. Suppose, for example, that a landlord wants to know how many pounds of rice he needs to plant his paddy fields. If he cannot calculate this himself, he may hire an expert to do the calculation for him, someone who then functions as an extension of the landlord's own mental abilities. Subsequently, hired rice planters, functioning as extensions of the landlord's own physical abilities, may do the planting for him.

Perhaps the vastest extension of himself that a human being can attain is an extension consisting of a network of human beings, animals and artifacts that only work for *him*. For such a network to be manageable for one person, these different actors must be locked into a hierarchical system designed to enable him to issue commands that are obeyed by it. Lewis Mumford (1967) has noted the existence such systems in history and has called them *megamachines*. In a megamachine, one individual, an absolute monarch, controls a vast system of human beings and other 'parts' that could be put to work to build pyramids, roads and temples, fight wars, or perform other specialized tasks that require a high degree of organization, in an almost corpselike obedience.[13]

3.3 Individual and Collective Extensions

So far, I have been making the simplifying assumption that artifacts function to further the intentions of single individuals, being their users. However, many artifacts are used to further collective interests. McLuhan recognized this, and identified, next to extensions of the 'individual organism,' extensions of the 'social organism' as well, that is, extensions of social groups or societies. For example, dwellings, in their function as shelter for families or groups, are analyzed by McLuhan as 'collective skins' that function as heat-control systems, and cities as extensions of bodily organs for the use of large groups (1966, p. 117ff). Hence, artifacts that are collectively used for a shared purpose do not extend individuals, but collectives.[14]

A single artifact also frequently serves different functions for different individuals, simultaneously extending individuals in different ways. For example, seat belts protect drivers from physical harm, but simultaneously help protect insurers from financial loss. A pair of jeans extends the skin of the wearer, but also furthers the intentions of the manufacturer to sell more of them by means of its prominently displayed logo. Artifacts may hence tie different individuals together in the way that they serve as technological extensions by which these individuals realize their intentions.

4. Technological Extensions and Their Relation to the Body

4.1 Amplificatory and Complementary Extensions

Not all artifacts, we have seen, functionally correspond to some human faculty. Some artifacts, like lighters and magnets, have genuinely novel functional properties not found in any human faculties. Nevertheless, there is still a sizable collection of technical artifacts that do serve a function that is similar to that of a human faculty. A distinction may hence be made between artifacts that do not functionally extend some human faculty but introduce new functional features alongside existing ones, which I will call *complementary extensions*, and artifacts that functionally amplify some human faculty, which I will call *amplificatory extensions*. Amplificatory extensions are artifacts that have functions also possessed by some human organ and add to, amplify, or take over some of the functioning of that organ.

McLuhan believed that all technical artifacts are amplificatory extensions, but I have argued that this is not the case. McLuhan is certainly right, however, that many artifacts can be understood as means by which activities of the human organism can be performed better or faster, and that these artifacts have been designed for this reason. Such artifacts range from clothing, which amplifies the function of the skin to protect and regulate bodily heat, to telephones, which amplifies hearing abilities of the human ear. The evolution of many artifacts, therefore, can be explained by reference to their amplifying or accelerating function in taking over or extending tasks normally performed by means of human faculties only.

4.2 Embodied and Separate Extensions

Amplificatory extensions, artifacts that amplify the functioning of human organs, may maintain three different types of relations with these organs: replacement,

supplementation, and enhancement. 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 that purpose. 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.

Still other artifacts *enhance* the functional powers of the organ that they extend, 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, not by engaging in perceptual tasks independently from the eye (as for example infra-red detectors do) but by teaming up with the eye, thus forming a functional unit consisting of telescope plus eye, that is more powerful than the eye alone. When a telescope is used, inception of visual perception no longer takes place when light rays hit the eye, but when light rays hit the front lens of the telescope. Similarly, a megaphone extends the voice by forming a new functional unit, voice plus megaphone, that yields a more powerful voice. A megaphone is therefore quite different from a speech synthesizer, which is able to produce speech independently from the human voice.

Not every symbiotic combination of artifact and organ is a functional enhancement of the organ, however. A saw, for example, performs its function in combination with the arm and hand that hold it, but cannot be conceived as an amplification of the arm and hand, because arm and hand are completely incapable of sawing. Similarly, one's hands and a piano constitute a functional unit that produces music, but it is not the case that the piano enhances already existing capacities of the hands to produce music. Saws and pianos are hence not amplificatory artifacts, whereas telescopes and megaphones are.

Artifacts that engage in symbiotic relationships with human organs, whether they amplify a human function, such as telescopes and megaphones, or form a new functional unit, such as saws and pianos, can be identified as artifacts that engage in *embodiment relations*. The notion of an embodiment relation has been introduced into the philosophy of technology by Don Ihde (1979, 1990), and can be traced back to the work of Merleau-Ponty and Heidegger.[15] Embodiment relations are relations human beings have to artifacts of technologies in which the artifact mediates one's experience of, and interaction with, one's environment. They have as a characteristic that they are not become themselves an object that is encountered in the world, but mediate human encounters with their world. They 'withdraw' and serve as (partially) transparent means through which the world is encountered, thus engendering a partial symbiosis of oneself and it.

A blind man's cane, for example, is an artifact by which a blind man learns to perceive and navigate through his environment. When learning to use the cane, he learns to perceive and locate elements in his environment through the stick. The cane itself 'withdraws' and becomes a medium like other senses, that is not itself experienced, but through which the world is experienced and engaged. As the blind man's cane illustrates, embodied artifacts have a special relationship to the human organism, in that they are tacitly present yet immediately available, just like one's own bodily and mental faculties. They are means through which perceptual and motor abilities are expressed, rather than themselves objects of perception or action. As such, they are experienced as direct extensions of ourselves, as integral parts of our bodies. In this way they differ fundamentally from artifacts that are not embodied, like the door one opens, the nail one hammers, and the roof above one's head.[16]

Symbiosis, and hence embodiment, does not only take place with artifacts that extend action or perception. It also takes place with artifacts that extend cognition, or *cognitive artifacts*, as psychologist Donald Norman (1993) has called them. Cognitive artifacts are artifacts that are able to represent, store, retrieve and manipulate information. They include items like computers, calculators, abacuses, as well as pencil and paper, and books. Cognitive artifacts extend cognitive abilities, such as abstract thought, memory, problem solving, and language use. When a cognitive artifact, such as a calculator or computer, engages in an embodiment relation with a user, it becomes a medium through which representations (in the form of symbols or icons) are perceived and manipulated. The user of a calculator, for example, performs cognitive tasks in symbiosis with this device. The calculation is not performed solely by the user (who relies on the calculator), nor by the calculator (as it has to be operated by a skilled user who knows what operations to perform in what order). It is, instead, performed by a new symbiotic unit, a system composed of two mutually dependent functional units, human and machine.

5. Conclusion

An analysis of human faculties as means for realizing intentions, and of technical artifact as extensions of the bodily inventory of means provides, I will now argue, a useful perspective from which to explain and evaluate a number of facts about human culture and technology. What this perspective may help explain, to begin with, is the evolutionary trajectory of technology in its diverse forms. Technical artifacts are developed and used to extend the ‘natural instruments' of their body, and when designing artifacts, people will 'build on' these faculties. This implies that artifacts are normally only developed when they

are perceived to be a useful addition to, or substitution of, capacities already possessed by the body (along with extensions that are already available). New technologies can therefore be understood by analyzing how they help realize human intentions by extending and building on the existing inventory of human means, including human faculties (at their current state of development) and other extensions already present.

The perspective of technology as extension of human faculties also serves, I have claimed, to put the social, cultural, and psychological role of technology in a new perspective. I have already noted some of the issues that concerned McLuhan, Kapp and Rothenberg. I will now summarize and expand on some of their main concerns. First, the perspective of technology of extension of humanity raises Rothenberg question of what we are extending ourselves for. Upon closer analysis, it may be found out that many artifacts extend us in ways that are incompatible with our most fundamental ideals. So a question raised by the extension perspective is: Do the artifacts that we have created and that we use extend us in a way that is compatible with what we desire most?

A related set of issues, raised by McLuhan, concerns matters of liberty, justice, and social equity. How are the intentions of different members of society represented by the technologies in a society, or to what extent do they fail to be represented? As functions that used to be performed by one's mental and bodily faculties are taken over by machines, what does this imply for one's personal autonomy? To what extent are we becoming 'servo-mechanisms', in McLuhan's terms, that have to subject to the operating conditions imposed by our technologies?

A third set of issues concerns the implications for our own mental and bodily faculties that their 'extension' has. As many functions that used to be performed by humans are taken over by machines, what functions do our bodily and mental capacities still serve, apart from operating machinery? Is there any truth to McLuhan's claim that new extensions of human faculties have great psychological (and physiological) consequences, and that they put the relation of our faculties to each other in disarray? Ivan Illich (1973) and Albert Borgmann (1984), amongst others, have argued that contemporary technology reduces human beings to passivity, and does not engage the body. Is this indeed true, and if so, how can technology be designed in a way that does engage the body?

A fourth and final set of issues concerns the consequences for self-understanding of technologies that substitute for human functions. As we 're-create ourselves in technology', how does technology re-create us? As pointed out, Rothenberg holds that technology can only extend human faculties that can be understood in mechanical terms, and not our most fundamental faculties of judgment and morality. So technology only shows us 'mirrors' of quite limited aspects of ourselves. One nowadays often has a choice to have a task be performed by a machine or by a human being. Could this lead to an

understanding of human beings in 'technomorphic' terms (and of machines in anthropomorphic terms)?

I hope to have shown, in conclusion, that a conception of technology as extension of human faculties of the sort outlined in this essay is both theoretically and empirically valid, and that it provides a starting point from which many old and new issues concerning technology and its implications can be approached in a unified way.

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ENDNOTES

[1] By 'artifact' or 'techn(olog)ical artifact' I mean to refer to refer to human-made tools, machines, utensils, or built structures.

[2] Later on, McLuhan claims that increases in speed occur in the interest of increasing power, so that, ultimately, all technologies are created in order to enhance power.

[3] Strictly speaking, McLuhan distinguishes two types of extensions: extensions of the 'individual organism' and extensions of the 'social organism.' See sec. 3.3 of this essay.

[4] At the time of Kapp's writing, mechanical technologies were still prevalent, and Kapp explicitly states that his focus is on mechanical technology. Hence, his analysis correlates with the mechanical technologies of McLuhan, but treats these much more extensively. McLuhan's analysis, in contrast, places emphasis on electric media, that were (apart from the telegraph) still to come after Kapp. Kapp's only reference to electric technology is, indeed, in a chapter devoted to the electric telegraph. There, Kapp notes, much like McLuhan does for electric media technologies in general, the profound and 'complete' parallel between the telegraph system and the nervous system. He even claims that the correspondence in built between a nerve and a telegraph cable is greater than the correspondence between any other organ and its projected technology. As he claims, here the predicates 'gleichsam' (so to speak) and 'gewissermassen' (to some extent) may be dropped: the telegraph cables are quite literally the nerves of humanity, just like nerves are cable installations of the animal body. Kapp also refers to telegraph cables, as McLuhan does to electric media in general, as 'extended nerves'. Another similarity between Kapp (1877) and McLuhan (1966) is that both see projections or extensions as not limited to tools and machine networks. Language and the state, for example, are also analyzed as extensions or *externa* of human nature.

[5] Although *Hand's End* contains several references to *Understanding Media*, none of these mentions its theme of technology-as-extension. *Hand's End* also contains no references to Kapp (1877), nor to the extension theories of Gehlen (1980/1957) and Bergson (1911/1907). McLuhan (1966) does not refer to Kapp or Gehlen, but does refer, like Gehlen (1980/1957), to Bergson (1911/1907).

[6] Other authors that have analyzed technology as an extension of human faculties include, amongst others, Henri Bergson (1911/1907) and Arnold Gehlen (1980/1957).

[7] Sometimes, Rothenberg also seems to defend this idea.

[8] Because human intentions are the controlling factor in my analysis of technology as extension of the human organism, my analysis distinguishes itself from a biological, or evolutionary, theory of technology as an extension of the human organism, according to which artifacts are to be explained as biological adaptations. Dawkins (1982), who presents such a theory, analyzes the evolution of both organisms and artifacts as determined by selection processes defined over genes. In Dawkins' theory, genes exercise their 'will' to survive and replicate by means of their host body as well as by means of artifacts and the bodies of other organisms that serve as 'extensions' of the organism, or phenotype.

[9] I use the somewhat archaic term 'will' to refer to the mental faculty for deliberate action. The will forms desires or intentions, and tries to implement them by deciding on appropriate courses of action. Thus, it is because of one's will that one chooses to eat a sandwich, to focus one's gaze on some object, to quit one's job, or to execute other voluntary actions. Note that the will does not extend to involuntary actions, such as reflexes, bodily processes such as digestion, and the many cognitive processes, such as processes of recognition and association that are normally executed automatically. There may be no strict boundary, however, between voluntary and involuntary actions.

[10] Note that the functional capacities of the 'tools' that are included in one's original 'tool set' are not just determined by their physical properties, but also by the skills possessed by the corresponding person.

[11] Prostheses replace, rather than add to, instruments in one's original 'tool set'. Prostheses may be (semi-)permanently attached to one's body, in which case they become inalienable instruments. My focus in this essay, however, is not on prostheses but on instruments that remain external to the body.

[12] It may also be noted, *contra* McLuhan, that not all artifacts designed to perform practical functions are designed to enlarge our natural abilities. Many artifacts are, instead, designed to disburden us, and relieve us of tasks that we are perfectly well able to perform ourselves (cf. Borgmann, 1984). These artifacts can relieve us without necessarily performing better or faster than our own organs.

[13] In his analysis of technical artifacts, Bruno Latour (1992; 1995, Akrich & Latour, 1992) abolishes the very distinction between human beings and technical artifacts, since maintaining this distinction is held to obscure the fact that technological artifacts and human beings often perform similar functions. Human beings, Latour claims, often seek to 'delegate' tasks to other entities, which Latour calls 'actants': things that act, or that have an function. Actants may be human or non-human; this does not matter in his theory. For example, the patron of a hotel who wants to keep its front door shut can either close the door behind guests herself, try to discipline guests to perform this tasks, appoint a porter, or install a door closer. In the last three cases, the patron uses an extension of herself to realize her intentions. It does not matter, for her purposes, whether this extension is human or nonhuman, as long as it does the job.

[14] Organizations, conceived of as purposive entities, also use artifacts to further their interests. Organizations are not collectives, because they are more than the sum of their members. Because organizations have no bodies, however, it may make no sense to label such artifacts as extensions of these organizations; they are merely additions to the set of means by which the organization operates.

[15] Heidegger (1962, p. 99) may have been the first to recognize embodiment relations. Merleau-Ponty (1962, pp. 142-147 and 151-153) contains a more extended treatment of them.

[16] It appears that the distinctions drawn here, those between mere 'stuff' in one's environment, embodied extensions of one's faculties and extensions that are not embodied, were also recognized by Heidegger (1962/1927). Heidegger called objects that were only recognized as mere objects 'present-at-hand' (*vorhanden*). Objects that are understood as means to one's ends he called 'ready-to-hand' (*zuhanden*). Objects that are ready to hand so closely that they 'withdraw' (*zurückziehen*) he called 'proximally ready-to-hand' (*zunächst zuhanden*) (1962, p. 99).

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