Foreword

Roberto Cipriani

The acting body is driven by the mind. The mind manages and coordinates all moves and aims of the body. However, the mind is part of the body itself and is the thinking engine as well as the centre of all decisions.

Even in case of a confused or debilitated state of mind all decisions about how, why and what to do, are taken by the operational mechanism inside the skull. No matter, how irrational or unpredictable it may seem for others. Technology is also a product of the acting body, which recourses to previous experiences, accumulates knowledge in order to apply it for finding new solutions.

Such solutions are usually connected with adjustments after failed attempts, but also with some positive results. Both kinds of solutions merge into the final result, which is the new finding. Such new finding is the basis for further development: from choppers used by primitive man to cut, dig or catch preys to the modern choppers which are helicopters cutting air with sharp and rapid propellers (also called choppers for this reason).

The relation between body and mind is not limited to an interior dimension, but it is able to go beyond, to escape and reach extra-bodily dimensions, which nevertheless remain human elaborations, feelings, emotions, pain and joy. Such perceptions would not be possible without a starting point and reference to the body. For each individual the body is situated in space and time, and it comes to an end with death. Other bodies can keep on having experiences of time and space, even if within limits of endurance which are variable but not infinite. However, the mind, unlike technology, has the possibility to overcome space and time, therefore it is capable of surfing the net in both dimensions much better than any powerful search engine, present or future. Moreover, the mind is powerful enough to make projections into the future and capable of transcending its contingency and imagine the potential future for other bodies (and minds), even when the person imagining all that will not be alive anymore. In other words, the acting body or thinking mind has a boundless potential because it can transcend itself, overcome technology by inventing the future.

The body-and-mind ensemble is therefore able to realize utopias; its bodily icons become a sort of future object-subject which is able to lay the foundations for the future, thus fixing referring meanings that can build future knowledge. The extraordinary potential of the acting body is therefore able to anticipate the future preparing its shape in the present. The strength of acting-thinking can carry out complicated elaborations much better than the most powerful electronic computing machine in use. The fact is that such possibilities cannot be fully implemented. Sometimes we remain astonished before scientific results obtained without particularly advanced technologies. Furthermore, certain bodies seriously damaged by various pathologies can develop an extraordinary content of reflexivity and reasoning suggestions that can produce highly complicated connections and are capable of solving basic problems of living and surviving. In the scientific field, as well as for arts, there are many cases of socially disturbed subjects who prove to be cornerstones or turning points for the development of thought and culture, both artistic as well as material and technological

A rough division of typology concerning attitudes and behaviors would induce to distinguish between those who merely repeat what is existing and already known and pioneers of knowledge who are experimenting to find new solutions and assume an unorthodox behavior if compared to the presumed norms. As a matter of fact, a follower is never just repeating knowledge as well as a pioneer is never only experimenting new possibilities. More often subjects are both pioneers and followers at the same time, because subjects have imitative inputs thus can experiment everyday new adaptive and potentially innovating paths.

This is why it makes sense to say that an acting body is interactive by definition, that is, by its unique characteristic. It is the field in which the interactions take place in space and time, where it generates memories, affections, emotions, canalizes knowledge, suggests solutions for living and fosters unpredictable developments, which may be of the stone-age and of the ancient cultures and technologies or of the present age of short messages from mobile phones that act as prosthesis or extension of human minds.

At last, also the use of red ochre, an earthly variety of hematite, represented for the ancients a sort of chromatic appendix of their body. Not even death could stop such use. In fact, many buried bodies still hold traces of such color after thousands years. This way the body-mind realizes utopias of a prolonged life after death: such a particular and extreme construction of an eternal life is actually a decision of the mind, the decision of maintaining clearly the vital energy of the blood with the red ochre color. So vitality can remain clearly visible after death.

Something similar can be said for the recent widespread of tattoos, which recurs to a tradition started in the Upper Paleolithic Period, continuing in the Neolithic and the Copper Age, between 2,500 and 2,000 BC, especially in the Mediterranean area. However, tattoos disintegrate with the decay of the flesh after death; nevertheless some chromatic traces can be found on the bones, where the color stays longer. The relational value of tattoos has to be underlined, because with a simple form, permanent and usually not expensive assumes the role of interactive tool communicative also on an aesthetic level. It is a sort of diffused "Facebook" ante litteram, with a strong importance for identity belonging, just like a distinctive, almost an individual logo, or an exclusive "trademark" for the subject, who wants to distinguish himself from others, even if he tends to get in contact also through such form clearly perceivable.

Today, also glasses, personal passwords (as many as the different kind of services), pacemakers, dentures, earphones, bypasses, and much more as nanotechnologies represent new frontiers of the acting body. Something is certainly changed compared to the past, but to what extent? Which are the characteristics? And this change towards which goal is heading?

This work presents in both parts many possible answers. Reading it through is deeply intriguing: starting from the titles of contributions which are promising strong reflexive inputs up to the entire work that can be considered a valid new mental stimulator.

Introduction

Bianca Maria Pirani, Ivan Varga

Bodies in Technology

The two volumes of the Selected Papers presented at the Research Committee 54 “The Body in the Social Sciences” Program of the International Sociological Association’s Forum held in Barcelona on September 4-8, 2008—including the papers by some invited scholars who did not attend that meeting—analyze the complex interactions of mind, body and microelectronic technologies. They bring together the most promising and theoretically fruitful research developments by internationally renowned scholars, whose work is at the cutting edge of research. Experts from both fields—research into the mind/body relationship and studies in science and technology—provide an up-to-date overview, from an original integrative perspective.

In particular, the volumes aim at contributing to the understanding of mind under the present conditions. For conceptualizing “mind” we usually mean the aspects of intellect and conscious-ness manifested as combinations of thought, perception, memory, emotion, will and imagination.

According to this definition, mind is the stream of consciousness and includes all of the brain’s conscious processes.

Today, we need to discover that although the world may be shrinking in terms of physical access, its horizon continue to expand across the distributed assemblages in context creating mobile boundaries between sensory experience and technologies. While corporeal existence of human beings is linked to space and time, electronic technologies overcome the limitations cau-sed by the spatial and temporary existence and enable the users to expand the horizon of space and time, and thus influence the relationship between mind, body and technology. One could argue whether technologies could substitute for emotions or will. Some theorists (Levy: 2007) give a positive answer to this problem, but even those who deny this possibility acknowledge that microelectronic technologies could influence emotions and will, and often do. None the less, the complexity of the problem requires a broader approach. Mind, as such, constitutes a link between the body and thought (often called “soul”, even in non-religious texts). Namely, the mind cannot exist without that specific part of the body, called brain. The philosopher Hannah Arendt (1971/78: 30-37), expounds on the relationship between “body and soul, soul and mind”. One can add that with the invention of script (which is also a combination of body and mind) it can “freeze” those thoughts beyond the moment they have been uttered, even if the interpretation of the thoughts depends on the culture of a given society and historical period (suffice it to consider that the holy texts of great religions are subject to interpretations that could contradict one another).

Therefore, the questions arise: Does human memory change as 'mapped' by these mobile, shifting boundaries? How should we best analyze the 'acting bodies' in the context of the enormous complexity of social, scientific and cognitive problems arising from the shifting boundaries between bodies, brain and technologies, between humans and machines and between nature and culture?

The human brain—unique in the organic world—has the infinite capacity to adapt itself to the changing conditions of life. Over the last few years popular books about the brain have become a literary genre. As advances in information technology and communication supply us with information at an ever accelerating rate, the limitations of our brains become all the more obvious. The modern work situation, with its pace and simultaneous demands, often gives us the feeling of having attention difficulties. The torrent of information increases not only the volume of data we are expected to take in, but also the volume we need to shut out. The issue of simultaneous performance is particularly interesting right now, as technological progress seems to encourage or even require it. Thanks to the wireless revolution, we can take technology pretty much anywhere we want to. We chat on the phone while walking, driving or watching television. We can have little displays in our cars showing maps that are continually updated and direct us while we drive. While in meetings we can text people or read e-mails in our BlackBerry. We can sit on the sofa with our laptop while watching television, wirelessly connected to the Internet. New findings in psychology and brain research suggest that the difficulties we find with simultaneous performance and distractions converge onto one central limitation: *the ability to retain information.*

The emergence of the complex, compound contemporary technologies that involve *virtuality, simulation* and *computer modeling* (*including tomography*) has special implications for embodiment and perception. Technologies, inventions of the human brain, obviously have a great impact on the functioning of brain, on the working of mind and on memory. The issues invention of the human brain, and especially the microelectronic technologies, obviously exert a great impact on the functioning of brain, on working of mind and on memory. The issue are complex and often confused, in part because there is overlap and loose usage concerning all the VSC technologies. In popular form, one can enter virtual reality in a virtual reality arcade. Unfortunately, the description and claims made for this arcade experience are usually cast in the now antiquated frame of early modern epistemology.

According to Turkle (2005: 287), computers become "thinking tools" offering new models of what it means to know and to understand:

> computers, with their reactivity and interactivity, stand in a novel and evocative relationship between the living and the inanimate. They make it increasingly tempting to project our feelings onto objects and to treat things as though they were people—an impulse I called the "Eliza effect" after the early AI program that was designed to seem like a solicitous psychotherapist.

Our connection with things, consequently, is becoming an “object relations” perspective “that takes *objects*” as its *subject*. Relational artifacts ask their users to see them not as tools but as “companions”, as “subjects” in their own right. The simple robots are marketed as toys and the more advanced robots remain largely confined to research settings or used for complicated tasks, such as flight simulation or flying unmanned aircraft. In the presence of relational artifacts, people feels attachment and loss: it is at work the metaphor that Turkley calls “Eliza effect”.

The present two volumes—volume one, *The Body as Social Icon*, and volume two, *Mapping Bodies in Networked Space*—intend to give answers to these problems bearing in mind the observation of Leroi-Gourhan (1983:85) that “the very problem is the *link* that connects the technologies with the brain of mankind”.

Volume one is divided in two parts: Part one, “Icon as Utopia”; is the theoretical grounding of the problem. Part two, “The Body as Social Icon” illustrates the social constructionism concer-ning the body by empirical studies of “social icons” and explores the evolution of human perception and subsequent modification of thought and behavior in response to our increasing reliance on provided data in order to experience the world. The volume extensively reviews the ways by which we can measure the brain and the body to understand the person and social behavior. Each chapter defines the relevant construct, traces its historical development, discusses recent findings, entertains controversies, draws connections with other relevant constructs, and points to new research directions.

The structure of volume two is also contains two parts: “The Body and its Prosthetics: Laboratories”; and “Technology, Physiology and Memory”. This volume is a methodological experiment aimed at investigating into the evolution of practices, social formations and experience that underpin the current “knowledge-based society”. The first part explores the social potential of location-aware devices, inspired by the use of tracking technology and wireless media, human relationships, movement and identity, seeking to extend and re-appro-priate the functions of locative technologies by exploring how they can be socially constructive or facilitate new dynamics to occur within everyday life. The second part deals with the embodiment in relation to the cultural evolution of biological memories with a special reference to the networked space.

Based on contemporary theory and research of media and networks, the volume provides an overview of the complex way in which embodiment is enacted across the “recombinant spaces” within which the fast changing physical landscapes and spaces of contemporary social life are being shaped and re-shaped. In short, the essays provide a comprehensive, authoritative exami-nation of the full range of the current “changing bodies”(Shilling, 2008: 1-7) associated with the new computer cultures. The reader will find a representative sample of outstanding research in this emerging and exciting field. By focusing on “acting bodies”, both volumes address these central themes along the temporal axis of information processing. They include basic operations like perception, emotion, embodiment, social comparison, memory, language and culture.

Embodiment is a complex phenomenon that envelops both the locative, perceiving active body I am and body permeated with the cultural significances that are also experienced. Human bodies are an intriguing pivot for theory (Shepherdson,1999) and it is difficult to imagine any geography that would matter without them. They straddle the dichotomy between nature and culture, their space is both influenced by social relations and influencing what forms these social relations may take. Incorporating human bodies into understanding of social relations allows a broader, more defensible, if continually shifting, material base from which theory might develop. Virtual reference points, narratives, fictional and non-fictional, permeate every aspect of our lives by "moving the interface off the screen into the real world" (Dourish, 2001: 101).

Synthetically, the work describes research emerging at the interface of two of the newest areas in social sciences: social neuroscience and bodies regulation by micro-electronic technologies. Recent years have seen an explosion of research into the physiological and neural bases of social behavior. This state-of-the-art science book is unique in approaching the topic from the perspective of developmental social neuroscience and sheds light on how complex social abilities emerge from basic brain circuits, whether there are elements of social behavior that are "hard wired" in the brain, and the impact of microelectronic technologies.

The Invention of Technology

Man is inseparable from his tools. This is why some social scientists call man a tool-making animal. The evolutionary record affirms this. *Homo habilis* used crude stone implements as far back as 2.5 million years ago, more than two million years before *Homo Sapiens* first appeared on the African savannah. Knowledge of this long overlap of human evolution with tool-making produced significant changes in evolutionary thinking. Earlier views, long held in many disciplines, maintained that evolution first effected biology and only later culture. In the current view, it worked on them together. Tool-making and *Homo sapiens* evolved jointly, tools –their making and use—played a part in the development of the large brain that separates present-day humans from their proto-human predecessors.

Man is a species bundled together with technology. The order of tools defines the relationship between the body and things: that is to say, the interfacing mechanisms which enable its orientation in territorial space, its survival and the construction of social life. The deep meaning of technology lies in this pragmatic relationship that allows the body to construct its permanence in the world. Technical relationships are embodied in social relationships and constitute the relational matrix of social intelligence. Werner Sombart (1911: 311-347) considered technology as a great historical modelling force. Technology is a driving force in social change, since its brings about creation and shapes symbolic activities. The development of technical skills, which the body learns by manipulating objects as well as using and perfecting utensils, explains the peculiarity of human cognition compared to animal intelligence as a creative process connecting pre-existing elements in new, and useful, combinations. A "toolbox" fit to invent, after every new interaction, the "able practice" that Marcel Mauss (1936: 394) had already perceived was the "primary tool" of cultural reason. Of all human activities, technique is the only one which does not go back to the starting point. Techniques are learnt and they cumulatively advance with occasional leaps forward. Their aim is to lessen human physical—and lately mental—energy output in under-standing and using the natural world for human purposes.

The development of technical skills, which the body learns by manipulating objects and using utensils, explains the peculiarity of human cognition compared to animal intelligence as a creative process connecting pre-existing elements in new, and useful, combinations. A "toolbox" fit to invent, after every new interaction, the "able practice" that Marcel Mauss (1936: 394) had already perceived was the "primary tool" of cultural reason. The practice of a tool brings about the capacity to repeat a performance with a variation depending upon the changing contexts. This capacity is an issue which implies a sort of correspondence and of stabilization between environmental reactions and conditions. Therefore the technological practice makes the body the *interacting field* connecting the individual with society trough the neurophysiological processes generated and regulated by experience. All types of experience and learning modify the neural maps. Neuroscientists have demonstrated that just three months of activity or passivity can affect the cerebral structure. Indeed, the experiences stimulate the formation of synapsis, activate neural circuits, consolidate them and create new ones. The human brain is an open and dynamic living system shaped by the changes provoked by the constant variation of the environment, able to receive specific stimulation due to its functional connection to other systems, in particular to other brains. Relational neurobiology (Siegel, 2001) reinterprets individual differences with reference to the interaction between hereditary traits, environmental influences and accidental events, and it shows, with increasing evidence, that the brain functions which are at the foundation of human experiences—memory, affection and emotions—are not functionally separated from cognitive ones. The relational need drives human beings to create connections with the external world in order to keep an adequate neurophysiological balance. The physiological, sensorial and cognitive mechanisms which are put into action in relational contexts mediated by present digital technologies are the same which can be found in the traditional relationships between human beings and technology. According to the Swedish neuroscientist Torkel Klingberg (2008: 10-11)

> the ability of the contemporary brain is identical to that of the anatomically modern *Homo sapiens*.

The changing elements are represented by the quantity and complexity of the information constituting the "technological environment". Technology is an *activity* rather than a manufact. The definition of technology by D. L. Sills (1968: 58) implies in particular an *activity*.

Technologies are the body of capacities, of knowledge, and of the practice to create, to use and to do useful things.

According to Sills (1968: 58), technology is a modality of creation derived from the *knowing how* (Ryle, 1949), that is to say from the ability to perform specific procedures based on the identification of specific *stimuli.* As a procedural instrument, the basic function of each different technology is to position the body of human beings in their environment, creating those forms of exchange which identify the social space. The adaptive procedures which granted the body its self-preservation and the transmisson of its genetic heritage correspond to the means of intervention on matter. In human beings the nervous system, and in particular the brain, evolved in order to specialize in problem solving, from the ways to prevent drowning to the research of food or of a partner. Each different technological invention is basically an *active manifestation of a new relational product* whose appearance is determined by the unrepeatable nature of its materials, of its events and of the human beings which constitute it. It basically springs from our imperious need to expand, extend, develop the sensorial abilities of our body until this activation enhances and improves it. The main primary justification for technological inventions is represented by this tendency, since the body establishes new relationships with the *habitat* in the unceasing attempt to gain identity in a more complete way. The direction of technological innovations is not independent of the type of the society in which they happen and of the goals for their use. Max Weber added to Marx's concept of "means of production" the concept of "means of destruction". For example, nuclear technology can be used for both production (say, electricity) and destruction. Technology can improve and destroy the *habitat*.

Therefore, the term "technological invention" defines *the adaptive creative process through which human beings intervene on the surrounding materials according to their own needs*. First of all, it is the chemico-physical use of matter which the hand performs in direct motility during the "complex operations of prehension-rotation-translation which characterize manipulation" (Leroi-Gourhan, 1977, vol.2 : 284). Being the first ones to appear, these operations are the privilege of an archaic and very little specialized human hand in relation

> to the wonderful apparatuses to grab and to run such as the lion's or the horse's paw (Leroi-Gourhan, 1977, vol. 2: 285).

In the course of the evolution of the culture of the *Homo sapiens*, the hand has modified and has improved the operational process through the addition of elements which do not reciprocally nullify and regulate the technical action through the activation of a sequencing process which is both biological and mental. This process aims at determining, in the chassis as well as in computers, the consistency of the technical action as a *relational organization of social intelligence*.

The *transition to the tool* is functionally justified by the field of relationships which the hand embodies and transforms. The order of tools testifies to the casual evolution of the "repertoire of recalls" which connects the social life of the first

Homo who inhabited the savannah until the emergence of the symbolic behavior which constitutes one of the main features of *Homo Sapiens.*

The manufacturing of lithic tools is the most evident expression of the acquisition of a technical intelligence: an aim to attain, the planning, the final performance and then the tool. Although it is true that the use of natural tools such as pebbles, sticks and leaves can be also found in other animal species, from otters to anthropomorphic apes, its systematic use and the resulting technological development is peculiar to the human species. The demands of the first human beings can be traced back to food and defence. Modern anthropology assumes that both men and women collected fruits and food was essentially dependent on what they could find in nature, such as animal carcases, fruit and tubers, so that it is reasonably possible to hypothesize that one of the first problems was the stripping of flesh from animals through the use of sharply edged tools deriving from the chipping of silicon rocks (*chips*) and the break of long bones in order to extract the marrow through their percussion with partially "carved" stones (*choppers*).

The *intentional* use of tools is one of the cognitive faculties of hominids which has been already proved. Hominids get excited and use their emotions to enhance the use of the stone utensils they need in order to obtain the sharply edged splinters and the more robust stone tools which are necessary to cut tendons and animal carcases. Through their emotional intelligence, they have an active role in the techno-social negotiating process which integrates their sensorial faculties to the places which have to be explored and covered. *Homo habilis*, who lived in Africa 2 to 1.5 million years ago, was the first hominid who exploited splintered pebbles.

The *pebble culture* is the oldest existing technology and it is based upon the manufacturing of pebbles. Hominids broke pebbles so as to obtain tools which could dig, cut, cut off and make holes. They soon improved their manufacturing techniques so as to remove splinters on both sides of pebble blocks in order to have sharper edges (bifacial pebble tools). The *pebble culture* presents some primary typologies which summarize its technological evolution.

Today we certainly know that our direct ancestors, defined by paleoanthropologists as "anatomically modern" humans, came into being in Africa 200,000 to 165,000 years ago and genetic evidence has demonstrated that all populations living nowadays are connected to those African ancestors. According to the estimate of the team of geneticists headed by Wolfang Enard from the Max Plank Institute of Evolutionary Anthropology in Leipzig, the moment the human form of the gene pool was fixed in the population (through a process of natural selection following a chance mutation) has to be traced back to the last 200,000 years in human history. The "anatomically modern" *Homo sapiens* began with an irradiation to the rest of Africa around 100,000 years ago and was followed by an expansion from Asia probably through a Southern itinerary towards Oceania and a Northern itinerary towards Europe and America. In the course of these itineraries the linguistic abilities of *Homo sapiens* evolved in those referential expressions which are at the basis of symbolic behavior. In Europe the indicators of a linguistically mediated behavior suddenly appear forty thousand years ago, when *Homo sapiens* begins to replace the Neanderthal forms and manufactures highly-sophisticated lithic tools and throwing weapons. He establishes even long-distances commercial exchange networks. He begins decorating his own body with painting and carves small female, male, and animal figures. He engraves animal bones to create musical instruments and he paints images of extraordinary beauty on the cave walls of Chauvet, Lascaux and Altamira. This is an unprecedented cultural explosion in hominids' history which takes place during their emigration to Europe on a territorial area going from Asia to Cantabria.

There has not been a commonly shared view on the connection between the African origin of modern anatomy and the origin of modern behavior and there is not any agreement on the meaning of "modern behavior". Synthetically, there are two opposite theories:

1. Modern behavior makes its appearance in Africa 50,000 years ago and this event is strictly connected to the behavioral modernity noticed in European Superior Palaeolithic sites;
2. Modern behavior developed in Africa in an older historical period and it is connected to the anatomic modernity through a gradual process which probably originated 200,000 years ago.

Despite the fact that genetic and fossil evidence concerning anatomy has been accepted, scholars cannot still agree on the coexistence of bodily and cognitive behavior.

The recent African archaeological finds pre-date by thousand years the presence of modern behaviors. In Congo, for instance, jagged bone harpoons dating back to 80,000 years, and whose level of sophistication has nothing to envy to similar harpoon discovered in Europe dating back to 25,000 years, have been discovered. In Tanzania beads made of ostrich-egg shells estimated 70,000 years old have emerged. Finally, the proof in favour of the "gradualist" thesis has discovered on the South African coast 200 miles far from Cape Town between 1999 and 2000 at the Blombos cave, the Medium Palaeolithic site which has already revealed to its discoverer—Professor Christopher Hensilwood, from the Centre for Development Studies of the University of Bergen, Norway—the sophisticated bone tools mostly destined to fishing which, on their own, testify to the presence of modern kinds of behavior. From an undisturbed deposit of ashes and sands—which the luminescent technology successively help dating 70,000 b. C.—have emerged two fragments of red ochre each nearly five inches long, finely chiselled with a grid of intersecting lines, next to the remains of a fireside and to tens of pierced molluscs.

What does the new South African discovery suggests us?

According to Hensilwood, the presence of carved material surfaces denotes cognitive skills and operational capacities ascribing them to modern behavior. He assumes a mosaic-like "panafrican" developmental model capable to record ages of innovation and regression in specific contexts. In the whole Africa there is no possibility of a single trajectory towards behavioral modernity, as well as a single area in which it is possible to find an anatomically modern human behavior.

Red ochre, a ferrous mineral, has been frequently found in Palaeolithic sites dated less then 100,000 years and was probably used to protect the skin and to tan animal skins. The boards at issue were first scraped and then ground in order to create flat surfaces, where it was possible to carve the refined grid which leads us to infer the presence of an associative habit. One fact certainly emerges: we are in the presence of a tangible product endowed with an interactive function which has still to be determined, or that it will be impossible to determine because of its strong connection with the spatial and temporal context in which it took place. Carved upon the tangibly present grids in red ochre, this function is a *procedural* one and it is *limited* to its performing context. It is an operational and at once cognitive function: through the dynamic action of one's hand it related the human body to the Blombos findings in the reticular engraving of the red ochre fragments. In this sense, we could be in the presence of an expression of social intelligence. In agreement with the definition given by John Kihlstrom and Nancy Cantor (2000: 359-79), the term "social intelligence" defines "an effective action in social relations": i.e., an "acting body".

The consideration of the human body as an "acting body" will be able to conceptualize technologies as both "technical objects" and "cultural artefacts" and their associative function within the joint activity systems constituting the practices of social interaction from which individuals and groups are continually moulded.

This question emerges from the archaic fragments found in the Blombos cave and remains unsolved, after 70,000 years, in the places of common space shaping the interactive bricks of the current "cosmopolis".

In our times science and technology have created many of the problems besetting us at the turn of the century; yet, paradoxically, we cannot address them without their assistance. Systematic reflection about object-producing devices relates technology not only to the effective production of functionally determined correlations (i.e. technology as teleological operator) but also to the subjective action. This "de-objectivizing" of technology is rooted in philosophy (e.g. Heidegger and Ortega y Gasset) and well established in "social construction of technology" approaches.

On these premises, technology presupposes technique (i.e., any systematic action addressed to the organization and adaptive transformation of environment) as significant human action. Technology denotes thus an operational coherence or, in other words, the organization of social order. Technology enables the social system to cope with environ-menttal complexity and increases its internal complexity. It also increases and diversifies the complex nature of the interdependences between society and individual actors. Simultaneously, the increasing societal complexity demands new forms of technology to be designed and implemented. In one way or another, technology is in the backstage of any relevant discussion on the contemporary nature of society both in the side of problems (risk, control and global surveillance, bio-ethics and bio-engineering, media manipulation, ecology) and in the side of solutions (instant communications, ubiquity, accessibility, safety, knowledge availability).

We can therefore conclude that the body—technology—society relationship is historically changing. This makes even more important to conduct further studies into these relationships.

The Body is the Medium of Knowledge

For millennia architects have been concerned with the skin bounded body and its immediate sensory environment: they have provided shelter, warmth, and safety; cast light on the surfaces surrounding it; created conditions for conversation and music; orchestrated the touch of hard and soft and rough and smooth materials; and breezes and scents. In current social networking the boundaries of the body and the limits of the nervous system have become "less definite, metaphysicians" at the point that

> we will be tempted to reformulate the mind/body problem as the mind/network problem (Mitchell, 1996: 31).

Before we turn to theoretical issues, we must not forget that *the brain is embodied and the body is embedded*. First, the embodiment. All brain activities depend on signals to the brain from the body and from the brain to the body. The brain maps and connections are altered not only by what *you sense* but also by what *you move*. Synchronism between the elementary self-consciousness which regulates somatic processes and the interaction taking place is responsible for the unrepeatable activation that produces the state of active consciousness. Second, the embeddedness. Your body is *embedded* and *situated* in a particular environment that influence it and is influenced by it. This set of interactions defines your "econiche" as the changeable combination of bodily confines and cultural practices. The development of the whole person-organism is carried out by these boundaries, at the same time body and mind, in a continuous *relational field*. The flows at issue make up the core of somato-sensory experience.

Sensation and perception provided the starting points for modern research into our mental processes. In the early nineteenth century the French philosopher Auguste Comte argued that the study of behavior should become a branch of biological sciences and that the laws governing the mind should be derived from objective observation. Comte's new philosophy, which he called *positivism,* was influenced by the British empiricists John Locke, George Berkeley and David Hume, who maintained that all knowledge is obtained through sensory experience, that is what we see, hear, feel, taste and smell. At birth, according to Locke, the human mind is a *tabula rasa,* a blank slate upon which experience leaves its mark. It was this view that led to the emergence of psychology as a separate discipline apart from philosophy, which had long monopolized the study of human mind. Thus, in its early days, psychology came to focus on the experimental study of mental processes by emphasizing sensation as the key of the mind. How does a stimulus lead to subjective experience? By what sequence of physiological events? For the fathers of experimental psychology—Ernst Weber, Gustav Fechner, Hermann Helmholtz and Wilhelm Wundt—those were the central questions. Their findings gave rise to the fields of psychophysics and sensory physiology. Some of the most exciting advances in our understanding of perception have come from merging these two approaches, for example, in recent human experiments that use positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) to scan brain function. Early findings in psychophysics and sensory physiology, however, exposed one weakness in the empiricist argument: A new-born's mind is not blank, nor is our perceptual world formed simply from passive encounters with the physical properties of objects and stimuli. In fact, our perceptions differ qualitatively from the physical properties of stimuli because the nervous system extracts only certain pieces of information from each stimulus, while ignoring others, and then interprets this information in the context of the brain's intrinsic structure and previous experience. Thus we *receive* electromagnetic waves of different frequencies, but we *perceive* them as the colors red, blue, and green. We receive pressure waves from objects vibrating at different frequencies, but we hear sounds, words, and music. We encounter chemical compounds floating in the air or water, but we experience them as smells and tastes. In short, our perceptions are not direct records of the world around us. Rather, they are constructed internally according to constrains imposed by the architecture of the nervous system and its functional abilities.

Our sensory systems are the way by which we perceive the external world, remain alert, form a body image, and regulate our movements. Sensations occur when external stimuli interact with receptors. Sensory information is conveyed to the brain as trains of action potentials travelling along individual sensory neurons and by populations of such neurons acting together. All sensory systems respond to four elementary features of stimuli: *modality, location, intensity and duration* (Kandel, Swartz, Jessel, 2000: 428).

The complex quality of sounds, visual images, shapes, textures, tastes and odors require the activation of large ensembles of receptors acting in parallel, each one signaling a particular stimulus attribute. For us to savor the richness and diversity of perception, the central nervous system must integrate the activity of an entire sensory sensory complex.

Perception is not a pre-given structure, neither according to its gestalt nor according to its sense. It is constantly in the state of developing and changing. A reason for this is that the manner in which sensible objects of perception are given is inadequate. Every phenomenon implies horizons that are empty and undetermined, and that strive toward concrete fulfillment and arrangement. In this way sensory consciousness is constantly held in motion by tensions that provoke regroupings on the objective side and new attitudes on the subjective side. The special correlation of perspectival aspects and horizon found in perception of material things is taken as a preferred model in the phenomenological theory. A thing is directly intuited by us only from one side. But this side remains in a reciprocal, functioning *interrelation* within a network of referential implications with the side of the thing that is turned away from our gaze and is not directly intuitive. According to Husserl, part of the essence of spatial objective experience is the fact that the body is not only presupposed objectively, as it is for a realistic philosophy, but it is also phenomenally co-present (Husserl, 1952: 56, 81, 144; 1966: 298). Merleau-Ponty (1945: 117) adopted this thesis in his critique of gestalt psychology:

> One's own lived body is the constantly co-present third moment in the structure of figure-background.

In Sartre' view (1962: 388), it is the lived body, although it can be identified in the analysis as the underlying center of the mundane nexus of referential implications, which is always "the already crossed", the "silently happened in the execution of perception and action".

Sartre appropriately compares that consciousness which we have of our own lived-body to the consciousness of the sign, which, in a similar way, is passed over for its meaning and neglected in favor of its sense. In a similar way, Sartre distances himself from Husserl. The spatial orientation of perception proves to be utterly relative. Each dominant formation of perception draws toward itself the "zero-point of orientation" (Holenstein, 1999: 57). One's own lived-body neither occupies the orienting dominance in the world of perception constantly nor does it so even originally.

The location and spatial dimension of a stimulus are conveyed *topographically*, through each activated receptor's position in the sensory epithelium, called its *receptive field*.

The cognition of space constitutes an enormous conceptual challenge to the "homeless mind" (Heynen, 1999: 17) supporting the development of the modern thought. Space is indeed a *field in motion* above all if referred to the *dynamic function of bodily space in cognitive acting.* Our infinitely varied motor behaviors are governed by the integrated actions of the brain several motor systems. The primary purpose of the elaborate information processing and storage that takes place in the brain is to enable us to interact with the environment. We are continuously bombarded by molecules released into our environment. Through the sense of smell and taste these molecules provide us important information that we use constantly in our lives. They inform us about the availability of foods and the potential pleasure or danger to be derived from them. The multitude of different flavors that one can experience derives from a combination of gustatory, olfactory and somato-sensory components.

Bodily space is a determining factor in the framing of social relations and is also reciprocally interconnected in the making of space by those very social interactions that occur in space. George's Simmel's inclusion as a significant and early sociological analysis of space and indeed much of Simmel's work contains within it a keen awareness of the interrelationships between forms of sociability and the spatiality that is expressed within and through those "webs of interaction" that, for him, constitute a society.

Henri Lefebvre's analysis on the rhythms, times and places of everyday life, of the routines and alienation inherent in the socially produced spaces of leisure and recreation, domestic life as well as those of work and the urban life has also been influential for developing research on gendered space and on the spatialising of sexual and ethnic identities.

The spatial dimension has been taken for granted too many times and has not yet been recognized as a *crucial area* in social sciences and, in particular, in sociology. Until a few decades ago, the word "space" had a mainly geometric meaning, generally accompanied by epithets such as "Euclidean", "isotropic" or "infinite", with the aim to describe the "empty area" identifying the concept of space. The key to understand this concept lies in the Cartesian thought. Being an "object" juxtaposed with a "subject" and a *res extensa* juxtaposed with a *res cogitants*, the Cartesian concept of "space" was the container of all meanings and all bodies. The research field known as "epistemology" has inherited and adopted, from the revised and corrected philosophy of space of mathematicians, the notion of space as a "mental object" or a "mental place".

According to Lefebvre (2007: 34),

> from the point of view of knowing (*connaissance*), social space works along with its concept as a tool for the analysis of society.

To accept this much is at once to eliminate the simplistic model of a one-to-one or "punctual" correspondence between social actions and social locations, between spatial functions and spatial forms. Precisely because of its crudeness, however, this "structural" schema continues to haunt our consciousness and knowledge (*savoir*).

Science and technology have had a profound effect on the way humans perceive space and time.

One of the most important functions of cyberspace has been to force a re-evaluation of our conceptions of space: since the Enlightenment the reification of physical, geometric space via Descartes, Newton and Leibniz has been an important contribution to our sense of the real world as operating in three dimensions.

Classical conceptions of space have been problematized by a number of cyberspace theorists (Benedikt, 1991; Heim, 1991; Oswald,1997; Wertheim, 1999) drawing on post-structuralist or postmodern theorists, such as Foucault, who have sought to explore space as not merely the geometricisation of symbolic mathematics, but also as territorialisations of power by dominant social and economic groups. Put simply, for many writers and thinkers space is not only that void through which we move but also the *place* in which we live and experience. Benedikt (1991: 4), drawing on Karl Popper, distinguishes

> three types of space—the physical, the subjective and the structural—and sees cyberspace as the third type of world, the structural spaces that provide "patterns" for our experience.

Locative and other technologies, of course, have their own evolutionary time-scale, one that typically moves faster than the time-scale of biological evolution. A decade ago, technologies that could provide information about the location of a motor vehicle, or a computer, or a person, were in their infancy. A wide range of tools are now in use and in prospect, which threaten to strip away another layer of the limited protections that individuals enjoy. An understanding of the landscape of location and tracking technologies, and of the issues that they give rise to, de-pends on establishing a specialist language that enables a meaningful and reasonably unambiguous discussion to take place. Those technologies are now well-established, and lack any form of regulatory framework although there is a growing pressure to establish it. IP-address location remains still quite inaccurate. Cellular triangulation and signal-differential techniques, and self-reporting of GPS measurements, are also error-prone, but their accuracy and precision appear to be improving. RFID and NFC devices identify and locate chips with reasonable reliability, and, because of their short range, with considerable accuracy. The ‘space’ within which an entity’s location is tracked is generally physical or geographical. All of the above examples relate to location within physical space. Other kinds of ’space’ exist and location within such spaces may be defined in other terms. For example, a location may be virtual, as in the case of a person’s successive interactions with a given organisation. A particularly important example is ’network space’. An IP-address records the location in network space of a software process entity (which necessarily is running in a computer entity). Location can be ascertained with varying degrees of accuracy and reliability. The location of installed devices, such as fixed ATMs and EFT/POS terminals, may be quite exact and reliable. Devices such as cellular phones, and portable and hand-held computers, are designed to be mobile, and additional information is needed in order to draw inferences about their location at the time of a particular event. Some kinds of locative definition may be limited to a line or cone (e.g. those relying on directional mechanisms), or an area bounded by three or more lines (e.g. those relying on triangulation). Measures of location may be available with varying degrees of timeliness. By this is meant the lag that occurs between the event, and the availability to a person undertaking surveillance of the transaction data reflecting that event. By tracking is meant the plotting of the trail, or sequence of locations, within a space that is followed by an entity over a period of time. Owing to timeliness limitations, data may only be available for retrospective analysis of a path that was followed at some time in the past. A ’real-time’ trace, on the other hand, enables the organisation undertaking the surveillance to know where the entity is at any particular point in time, with a degree of precision that may be as vague as a country, or as precise as a suburb, a building, or a set of co-ordinates accurate to within a few metres. Moreover, a person in possession of a real-time trace is in many circumstances able to infer the subject’s immediate future path with some degree of confidence.

They are mostly oriented towards entities, and their effective operation depends on the collection of entifiers that distinguish a particular entity and enable transaction data to be reliably asso-ciated with the appropriate entity and perhaps with other transactions. Some technologies are relevant to spaces other than physical (especially net space), and some ones to identities rather than entities. Mobile, location-sensitive devices, semantic mapping and biometrics are all locative and wearable tools that are being deployed in non-authoritarian ways on the street and in the body. Even the critics would agree that locative media art at its best enhances locative literacy and augments the ambiance of the physical places. It carries the ability to intervene on local level whether by creating an on-site experience about the place, transporting us to another site or choosing to abstract us from a given location.

Across a broad range of contexts, the interface between data environments and location has emerged as a central concern, reversing the trend towards digital content being viewed and placeless. In a move away from the virtual reality research, mixed or augmented reality constitutes its phenomenological inverse, where the ultimate goal is to create a system such that the user maintains his his/her presence in that world.

It is extremely simplistic, and contributes to a passive approach, that our choice as consumers at most consists of accepting or adapting to new technologies as they come on line, by. The fact that many people using the Internet—the virtual reality—take it for real, thus there is the possibility to disembody the real world in which we are embedded.

Once again we have the camera as the explicit model for knowledge. What Descartes adds is another analogue: the "mind" or mental substance": the modern subject who is now inside the camera.

Lee Bailey (1989: 66-67) points out

> The *camera obscura* began as an experimental model for the eye and became a ruling metaphor for the mind. By offering a way of picturing the Cartesian inside *Cogito* with a sensory channel admitting pictures from the outside *extension*, the image of skull's darkroom shifted from a suggestive experimental analogy to a concealed methodological paradigm.

The *Cogito*, or the "*homunculus* in the camera", utilizes an artifact (a machine that was taken as a paradigm for the human activity of acquiring knowledge (a cyborg activity), to produce a picture and thus self-understanding of that activity. By taking the subject out of the camera and finding him/her in the world, one has deconstructed the concepts of early modernity and established an embodied, situated knowledge.

Phenomenology takes the *Cogito* out of the camera and finds it, *embodied,* in the world. Merleau- Ponty (1962: 82) makes the point more succinctly:

> I am conscious of my body via the world... I am conscious of the world trough the medium of my body.

As technological systems become more sophisticated, physical systems become devalued and distrusted. The natural and biological have become pathological. This book suggests the body and the senses as the *medium* through which the world is accessible and available and proposes a view of the body as a productive material agent that generates practices in its ongoing materialization. It advocates not simply for a sociology of the body, but maintains that sociology should itself be fundamentally embodied, theorizing not so much about bodies but from *bodies as interacting entities* in space and time.

Embodied action is the result of the interaction of the biological substratum and the totality of relations and emotional experiences that shape our social habits. What really has to be considered in a knowledge based society is the pragmatic constitution of what Husserl calls the “life-word” (*Lebenswelt*) rather than the projections of the brain upon a world supposed already to be organized.

In this sense, the full understanding of the embodied action is one of the most formidable challenges for social sciences in the twenty-first century. We emphasize action, and not only bodily movement that has too long been considered a reaction to stimulation from a fixed environment known in advance by the observer. By the term “action” phenomenologist mean the mental schemas that govern motor intentions, which in the final analysis regulate motor commands, observable in the form of bodily movements. These mental schemes are experienced by the actor as basic abilities, that is as capacity for intervention which become available once one has learned new physical movements, new maneuvers in the practical sphere. Here one encounters Merleau Ponty’s notion of “I can”. What the phenomenologists object to it is the primacy attributed to the environment, that the experimentalists consider as a world wholly made up of things from which messages emanate and to which replies are given. It is necessary to step back from the “laboratory situation”, where experiment assumes an already constituted reality, and take into consideration the role played by the agent himself in building his environment, as Jean Luc Petit (1997: 1-37) has shown.

The human agent does not content itself with being informed about his environment in order to try to modify it afterward; from the beginning he shapes it or better—to use Husserl’s strong formulation in his last unpublished writings—he constitutes it as the world that surrounds by projecting onto the aims of his action and his demands for interaction.

Acting Bodies: a Bridge between Working Memory and Technology

Intelligent infrastructure is a new horizon for computer technology. Computers have proven themselves to be powerful tools for calculation and communication. The next step, experts say, is for computers to become intelligent instruments of control, linking them to data-generating sensors throughout the planet’s infrastructure. In his book *The Technium* Kevin Kelly (2009) forecasts the emergence of a global brain—the idea that the planet’s interconnected computers might someday act in a coordinate fashion and perhaps exhibit intelligence. We are entering in a new phase of computing, in which computers will be interacting with the physical world as never before. With the ability to send attribute data from personal information devices worn on the body to computers embedded in the environment, one-to-one services could be implemented that are tailored to user’s individual needs.

The common thread throughout the research is the remarkable cortical plasticity of the brain, which often adapts to BCIs. With recent advances in technology and knowledge, pioneering researches are now conceivably attempt to produce BCIs that augment human functions rather than simply restore them. The study of how our interactions shape our emotional habits and sculpt the brain has indeed enormous importance for how we do in life. Donald Hebb in his well known study *The Organization of Behaviour* (1949) demonstrates how "experience shapes the brain".

All types of experience and learning modify the brain. You never, step into the same river twice. As the Greek philosopher, Heracleitos said, one cannot step twice in the same river. This means that the constantly changing circumstances and experiences influence the ways our brain is reacting to the impulses from the outside world, and is capable to develop new synapses.

The neurological studies on the plasticity of somatosensory areas (Kaas, Merzenich and Killa-ckey, 1983: 325-56; Kaas, 1991: 137-167) and the Sur's results on visual behavior (Sharma, Angelucci and Sur, 2000: 841-47) show how important sensory stimuli are for determining the way the brain is organized, which in turn underpins the importance of environment.

The primary purpose of the elaborate information processing and storage that takes place in the brain is to enable us to interact with the environment. Research into trained-based brain plasti-city seems to confirm that the brain is able to adapt itself to its environment and the greater demands it entails. The ongoing modification of synapses throughout life means that all beha-viors of an individual are produced by genetic and developmental mechanisms acting on the brain. Therefore, everything brain produces, from the most private thoughts to the most public acts, should be understood as a biological process that is, however, shaped by cultural factors. Environmental factors and learning bring out specific capabilities by altering either the effectiveness or the anatomical connections of existing pathways (Siegel 1999).

Advances in neurosciences, combined with some new forms of approaching the body-mind-society interrelations, have changed our conceptions of the natural and social body, thus giving rise to the possibility of introducing, by "embodied action", a new paradigm. We are beginning to know more about the links between the development and exploration of the body and the use and growth of intelligence and between social experience and creative thought.

We have a better idea of the species-specific capacities of human organism, and know how much humans depend on interaction with fellows to develop them. Since human bodies are the instruments that both discover and make decisions about self, others and the worlds of nature and cultural tradition, the embodied action is concerned with the interface between the body and society, the ways in which the physical organism constrains and inspires patterns of social interaction and invention of culture.

Take the power of emotions to disrupt thinking itself. Neuroscientists use the term "working memory" for the capacity of attention that holds in mind the facts essential for completing a given task or problem. Working memory is a temporary storage system that underpins our capacity for coherent thought. Some 40 years ago, Baddeley and Hitch (1974) proposed a way of thinking about working memory that has proved to be both valuable and influential in its application to practical problems (also see Baddeley, 2007, 2009). The term working memory refers to a brain system that provides temporary storage and manipulation of the information necessary for such complex cognitive tasks as language comprehension, learning, and reasoning. This definition has evolved from the concept of a unitary short-term memory system. Working memory is involved in the selection, initiation and termination of information-processing functions, such as encoding, storing and retrieving data. Working memory has been found to require the simultaneous storage and processing of information. It can be divided into the following three subcomponents: (i) the central executive, which is assumed to be an attention-controlling system, is important in skills such as chess playing and is particularly susceptible to the effects of Alzheimer's disease; and two slave systems, namely (ii) the visuo-spatial sketch pad, which manipulates visual images and (iii) the phonological loop, which stores and rehearses speech-based information and is necessary for the acquisition of vocabulary of both native and other languages. Memory for plan and actions relies primarily on working memory, in particular the operation of the central executive component.

By memory we usually mean our capability to remember certain events of our past or to retrain and retrieve data and knowledge. Classical theories of memory tended to portray it as a thing-in-itself, something *deposited* in the brain and mind—an impression, a trace, a replica of the original experience, like a photograph. Fortunately, we now know enough about memory to relate laboratory studies to the world beyond. In other words, our scientific knowledge of memory and how it works can help us to explain those aspects of memory that most people find of greatest interest. The neurobiological study of memory has yielded three generalizations: memory has stages, long-term memory in multiple regions throughout the nervous system, and explicit and implicit memories involve different neuronal circuits. Different types of memory processes involve different regions and combinations of regions in the brain. Explicit memory underlies the learning of facts and experiences. Declarative or explicit memory contains single recollections or informations that may be reported and described; it may also be called a "knowing that". Declarative memory relies on a medial temporal lobe system, whereas habit learning relies on the striatum (Cohen & Eichenbaum, 1993). Implicit memory processes include forms of percep-tual and motor memory—knowledge that is stimulus-bound is expressed in the performance of tasks without conscious effort, and is not easily expressed verbally. Implicit memory flows automatically in the doing of things, while explicit memory must be retrieved deliberately. It is now appreciated that memory is not a unitary mental faculty but the operation of many separate systems. This raises the possibility that different cellular mechanisms may be involved. One broad classification scheme distinguishes declarative (explicit) memory from non-declarative (implicit) memory (Squire 1987). Declarative memory includes the facts, episodes, faces and routes of everyday life and is accessible to conscious recollection. Declarative memory is affected in amnesia, and it depends on the integrity of the damaged structures and connections. Non-declarative memory includes skillful behavior, conditioned responding and priming. Pri-ming refers to facilitation in identifying perceptual objects, including words, that is produced by their recent presentation Non-declarative memory affords the capacity to acquire knowledge without conscious efforts. In the case of skill learning, knowledge of the skill is embedded in procedures, and the skill is expressed in performance by engaging the procedures. In the case of conditioning, dispositions are gradually acquired to respond to stimuli. In the case of priming, perception and processing of stimuli are facilitated (Tulving *et al.* 1988).

Studies on the biology of memory show that the so-called consolidation process (the transformation of unstable, short-term memories into a long-lasting code) is *not permanen*t as it was hypothesized. If we consider the meaning of memory in an evolutionary view we should look at the organisms for their potential to change as the result of events that occur during the lifetime of the individual. The experiences of an organism can modify the nervous system, and the organism later behaves differently because of these experiences. This abi1ity to change gives organisms the capacity for learning and memory .

The capacity for memory is a special case of the ability of neurons to exhibit plasticity. Plasticity is a general term describing the fact that neurons can grow or shrink, or otherwise change their input and output characteristics, as a function of their local histories.

Reflections about the physiological basis of memory led most earlier biologists to consider some type of growth or change in the existing structure of neurons. Thus, the idea that existing nerve cells can grow seemed a reasonable way of accounting for the persistence of memory. This basic idea was made more specific by Hebb (1949), and it has been restated several times since, making explicit the idea that the synapse (the tiny gap between neurons) is the critical site of plastic change. Experimental evidence has become avai1able only in the past few decades. Not surprisingly, some of the most direct evidence comes from animals having relatively simple neuron systems. For example, the *Aplysia,* a sea slug examined extensively by Erik Kandel (1976), has about 18,000 neurons distributed among nine cell groups called ganglia. This animal exhibits several simple forms of learning and memory, including habituation (the weakening of a response through repeated stimulation), sensitization (the facilitation of a response by a strong or novel stimulus) and classical conditioning (wherein a previously neutral stimulus comes to elicit a response as a result of repeated temporal association between the neutral stimulus and a second stimulus that ordinarily elicits the response). The short-lasting varieties of habituation and sensitization have been shown to depend on changes at synapses in the nerve circuits. Speci-fically, there is either a decrease (in the case of habituation) or an increase (in the case of sensitization) in the amount of chemical transmitter released at these synapses. The important conclusion is that the neurons of vertebrates show considerable capacity for morphological growth and change in response to experience: these principles were proved to fit for humans as well. One kind of neuronal plasticity involved in memory is long-term potentiation (LTP). LTP is a long-lasting increase in the strength of a synaptic response following stimulation of an input pathway. It occurs prominently in the hippocampus, a structure that is important for memory. LTP also involves morphological change in the structure of neurons (Lynch and Baudry, 1984).

A large body of experiments points to the conclusion that memory is stored by changes in synaptic efficacy, and that these changes are brought about by common cellular events that may be found in many or all of the neurons that change. What makes memories specific depends largely on which neuronal connections are altered, and on the architecture of the specific networks in which alterations occur. Questions about how individual neurons change in response to experience are fundamentally important. In recent years, a number of neurophysiological techniques, mostly brain imaging, such as functional magnetic resonance (fMR) and positron emission tomography (PET), brought new knowledge on the relationships between memory and the brain.

The main result is that there is no specific memory "center" where the whole memory is stored.

The most likely site of memory storage is the set of particular cortical processing systems that are ordinari1y engaged during the perception, processing, and analysis of the material being learned. Memory can be considered to be distributed in the sense that no single memory center exists and in the sense that many parts of the nervous system participate in the construction of a single event. Despite this holistic view of memory, specific brain structures and connections that participate in memory functions have been identified through the study of the human amnesic syndrome and animal models of the syndrome. Amnesia is a severe impairment in the ability to acquire new knowledge or to recall recently acquired knowledge, which occurs when there is bilateral damage to the medial temporal lobe or the midline of the diencephalon. The point is that there are brain structures, which are not themselves repositories of permanent memory , that are important for memory functions. The use of magnetic resonance imaging has made it possible to detect abnormalities in the hippocampal formation of some amnesic patients. Further studies indicate that the full medial temporal memory system consists of the hippocampus and the adjacent, anatomica1ly related structures. While the stability of long term memories has been assumed for a long time, an increasing body of knowledge suggests that long-term memory is *not as stable and impermeable* as it was hypothesized in the classic models of memory. In particular, it appears that recalling a memory renders it fluid and unstable—able to be changed before being re-fixed into the circuitry of the brain—and that change could include altering its meaning or even deleting it completely.

Until recently it was thought that the memory stays in the backwaters of the mind, aging but essentially remaining the same. Yet, recent data refuted this idea. To study the process of consolidation, researchers interfere with the steps involved in fixing a memory in order to test their influence on long-term recall. Joseph LeDoux and Karim Nader (2000) trained rats to associate a darkened box with an electric shock to their paws. The rats learn the box is to be avoided and freeze the next time they are put into it (fear conditioning). If, a few days after this conditioning, the animals were given a drug to prevent protein synthesis before being reminded of the box, there was no difference in their ability to remember it as a bad place. The memory seemed fixed and safely stored in line with the classical view of memory consolidation. But, if the rat had a brief reminder of the box just before the drug was administered, the rat lost its fear conditioning. The memory had somehow been erased. LeDoux and Nader labeled this phenomenon as *reconsolidation*.

Traditional consolidation theory suggests that memories are fixed locally by protein changes within a few hours of the event and then filed to long-term storage in the cortex after a period of days or weeks. After conditioning rats in the same way, they left them for 45 days, by which time the memory should have been fixed and immune to interference. As before, the rats given no reminder of the box before being injected showed their conditioned response to the box. But the rats that were given a reminder of the box before being given the drug did develop amnesia. The consolidated memory—which conventional theory said was permanent and stable—had been removed by the action of recalling it. It appears that memory moves from the hippocampus to the cortex during consolidation, but is returned to the hippocampus for reconsolidation by the act of recall. This dynamism would be unnecessary if the brain just wanted a photograph album, but it fits perfectly if memories exist to make sense of the present, and distorting some memories while generalizing about, or even deleting, others serves to improve the mind's recognition and understanding of the world in order to in order to successfully act within it. If a memory becomes plastic every time it is recalled then it can be re-filed in a usefully updated way. The mind can make choices about whether to merge old and new or to reinforce their differences. In brief, then, reconsolidation theory suggests that when memories are recalled they become vulnerable to change. The amount of information that can be stored in the long-term memory is virtually boundless. *The capacity of working memory is instead limited to the location of space-time.*

The mapping process is aimed at determining this location relatively to spatial contingency. The mapping process was first identified in the late 1940s by University of California-Berkeley professor Edward Tolman, and, it began with laboratory rats. In his experiments, Tolman challenged each rat with a maze that offered food at the end. He noticed that each time the rats passed through the myriad small paths and blind alleys, they made fewer mistakes. Eventually, they were all able to move swiftly to the goal with no false starts. This told Tolman that the rats had internalized the makeup of the maze in their brains, which Tolman called ”the central office”. Similarly, human infants come to realize through experience that crying will bring food and/or attention. A child learns not to touch a hot stove. A person who has been blinded can still find his way around his house.

In 1971 John O'Keefe and John Dostrovsky made the remarkable discovery that hippocampus contains a cognitive map of the spatial environment in which an animal moves. The location of an animal in a particular space is encoded in the firing pattern of individual pyramidal cells, the very cells that undergo LTP when their afferent pathways are stimulated electrically. The animal is thought to form a “place-field” *map* of the space that it occupies. When the animal enters a new environment, new “place fields” are formed within minutes and are stable for weeks to months.

The mapping process refers to the attributes and relative locations of people and objects in the environment, and is an essential component in the adaptive process of spatial decision-making, such as finding a safe and quick route to and from work, locating potential sites for a new house or business, and deciding where to travel on a vacation trip. Thus, cognitive mapping is a form of memory, but it is also more than that. Retaining the sequence of streets in the directions to your house is memory; seeing these streets in your ”mind’s eye” as you speak is cognitive mapping. One working definition of cognitive mapping comes from Downs & Stea (2005: 34) in their textbook *Cognitive Mapping and Spatial Behavior:*

> a process composed of a series of psychological transformations by which an individual acquires, codes, stores, recalls and decodes information about the relative locations and attributes of phenomena in their everyday spatial environment.

The mapping process should be hypothesized as the spatial location of working memory: it encodes information about location, orientation, distance, and direction. In everyday life it has numerous functions. It enables us to remember places and to remember how to find our way around. We can recognize places as familiar and recall routes from one location to another. We can devise novel routes or shortcuts for reaching a goal. Mapping is also used for locating objects and for remembering how to find them. It organizes the interaction between bodies and the immediate environment through the ability of social actors to search locations, to find shortcuts and novel paths, to estimate distances between remembered places, and to draw sketch maps of the explored environment as functional factors in the evolutionary development of the brain.

The map, in all possible ways, constitutes a unique contribution toward error detection and its use not only in the forms of geographical maps but in the form of the *chemical and electro-magnetic flows* connecting the body to its environment. Maps preceded both language and counting. Mapping practices are contingent intersections of technologies and the cultures and processes of social life. Historians and anthropologists have now examined a wide set of cultural contexts in which mapping has been practiced and have documented a historical range extending into prehistory and across the vast majority of human cultures. From the stick charts of the Marshall Islands to the Aboriginal map-paintings of Australia to the modern Western topographic devices, the map is central to human activities. According to Matthew Edney (1993, 1996, 1997), maps are *social constructions* as well as each mode of mapping is intimately tied to social, cultural and technological relations, which are contingent on particular times and places. For example, after the Renaissance the three primary modes were chorography, charting and topography, reflecting mapping activity at various scales. By the early eighteenth century, however, these modes had merged into a single mode of mathematical cosmography (i.e., the geometrical and astronomical processes of mapping). Synthetically, maps are paradigmatic examples of spatial knowledge that is produced in the knowledge space we inhabit. Not only do we create spaces by linking people, practices and places, thus enabling knowledge to be produced, we also assemble the diverse elements of knowledge by spatial means.

Fifty years ago, Marshall Mc Luhan (1964: 157) made a claim which simultaneously was a challenge:

> Maps are a prime vehicle for repositioning, reframing, rethinking science because theories are maps, maps are science instantiated, without maps science would not have been possible.

In order to meet McLuhan's challenge and rethink the self-evident rationality of science and the map/science relationship, we need to ask what is so fundamental in the map.

The primary purpose of the elaborate information storage that takes place in the brain is to enable us to interact with the environment. To perceive how the world impinges on our bodies, the brain is organized to map the tactile sensory system of the skin. The receptive fields of cortical neurons become progressively more complex with each stage of information processing, thus extracting more cohesive features of a stimulus at each stage. The primary purpose of the elaborate information storage that takes place in the brain is indeed to enable us to interact with the environment. To perceive how the world impinges on our bodies, the brain is organized to map the tactile sensory system of the skin. The receptive fields of cortical neurons become progressively more complex with each stage of information processing, thus extracting more cohesive features of a stimulus at each stage. Mapping is an expression of an "invisible college" which constitutes almost a new discipline cutting across the old disciplines of geography and sociology, with a considerable dash of other social sciences, and even a tantalizing flavor of hi-story, as we move *from space into space-time.*

The map concept is perhaps the real key to the renewal of the social sciences. This is an aspect of the theory of scientific epistemology which has not been sufficiently explored.

In the composition of relations or capacities between different bodies, you do not know before what a body or a mind can do in a given encounter, a given arrangement, a given combination. Borrowing terms from the Middle Ages or from geography, we can define a body by *longitude* and *latitude.* A body can be anything; it can be an animal, a body of sounds, a mind or an idea; it can be a linguistic corpus, a social body, a collectivity. We call *longitude* of a body the set of relations of speed and slowness, of motion and rest, between particles that compose it from this point of view, that is between "unformed elements": what Spinoza calls "the simplest bodies". We call *latitude* the set of affects that occupy a body at each moment, that is the intensive states of a galvanizing force generated by the acting body in interaction with the context (territorial, social, geographic). In this way we construct the *map of a body*. The longitudes and latitudes together constitute the *locative memory* which is always variable and is constantly being altered, composed and recomposed, by individuals and collectivities. This memory constitutes the plane of immanence or consistency, which is always variable and is constantly composed and recomposed by individuals and collectivities.

The contribution the body makes to the brain is not limited to supporting vital operations, but includes regulating the space and time which organizes the contents of a normal mind. There is no bodily existence without or outside the space-time-frame. The mapping process provides the *localized acting of the space-time frame* relatively to the working of system specific patterns of wanting, feeling, doing and interacting. Embodied action consists of this mechanism that we define *acting body*, to mean the *active field* generated by the synchronization of biological memories with the execution of the contingent action.

Both of this book consider the acting body as an *arc of action* that concerns with embodied practices in contemporary culture.

By incisive theoretical contributions and empirical works, the authors of volume one *The Body as Social Icon* seek to shed light on the notion of "socially constructed body". By focusing on "social icons of the body", they suggest a revisioning or repositioning of the disembodied sense of "vision" that has dominated sociology, and much of Western social thought. The disembodied sense of vision in sociology may be seen in the relationship between the researcher (observer) and the researched (observed), which traditionally have been viewed in term of distance. We are our body, in the sense in which phenomenology understands our motile, perceptual and emotive being in the world. But we are also bodies in social and cultural sense, and we experience that too. The focus of volume one is on the individualized contingency of the embodiment analyzed by the authors in different cases studies. In developing different foci instead of broad categories of subjectivity the focus has moved firmly towards the complexity of individual body.

Reaching the body: stability or change? is the capital question that connects volume one with volume two, *Mapping Bodies in Networked Space*.

The second volume is concerned with the ways humans are "tied to" the technological frame. Consequently, its key task is to capture the ways that new technologies enter everyday life and how the process of such integration is at once practical and symbolic. The focus of attention becomes how orderly social conduct emerges from the detail of each setting in which it is undertaken, and orderliness is achieved in the face of the endless contingencies to which it is subject. Rather than humans and non-humans, we are beginning to think about flows, movements, arrangements, relations. It is trough such dynamics that the human (and non-human) emerges from the densely interwoven system of social networks "within which the knee bone is connected to the I-bahn" (Mitchell, 1996: 173).

The first part of this volume, "The Body and its Prosthetics: Laboratories", is a socio-technical assemblage aimed at exploring the increased surveillance of bodies through the development of new technologies. This is a complex analysis of how both gun and human are transformed. The second part, "Technology, Physiology and Memory", looks at the body as the result of the interactions among the biological substratum and the whole of relations and experiences with the new technological environment.

Synthetically, both volumes draw together these themes and methodologies as a means for developing a methodological frame able to determine the basic functions that bodies play in the extensive mapping of the human memory.

The modern cultural tendencyto separate body from mind, and to elevate the mental over thecorporeal, has trivialized the extent to which the body is theobvious point of departure for any process of knowing, especiallyparticipant observation. This cultural tendency, as well asa weakness for mistaking words for things and for viewing materialobjects as neutral and mute, contribute to the neglect of thematerial world. This disconnection can become a disconnection between the body and the sense of self, emotions, thought, sensations and memory.

And yet, it is through our bodies that we understand and act within this world. Our ability to experience is directly related to our embodiment in a given context. These experiences involve the mapping process. The mapping process is related to the biological basis of consciousness and the mental processes by which we perceive, act, learn and remember.

The actions of the brain underlie not only relatively simple motor behaviors such as walking or eating, but all complex cognitive actions that we believe are quintessentialy human, such as thinking, speaking and creating works of art or philosophical and scientific ideas.

Humans are vastly superior to other animals in their ability to exploit their physical environment. The remarkable range of human behavior—indeed the complexity of the environment humans have been able to create for themselves—depends on a sophisticated array of sensory receptors connected to a highly flexible neural machine, brain, that is able to discriminate an enormous variety of events in the environment.

Humans are remarkable for the complexity and pace of their evolutionary history. No other mammal has spread over such a large geographic and ecological range, and evolved so many similar species and radically new forms of behavior, within just two million years. The origins of this variability are fundamentally genetic—in the human genome—and natural selection produces new species entirely out of the genetic variation within existing species. But the accumulation of early hominid technology and culture gave our biological variability an accelerating push. The brain with which we are born today are almost identical to those with which modern *Homo sapiens* were born forty thousand years ago. At the "information portal", the same brain's capacity is loosing its ability to retain information. In 2004, a number of well known neuroscientists including Nobel laureate Eric Kandel, wrote a review about the ethical dilemma computer technologies raise. The article begins:

> Humanity's ability to alter its own brain function might well shape history as powerfully as the development of metallurgy in the Iron Age.

The review was entitled "Neurocognitive Enhancement: What can we do and What should we do? " (2004: 421-425).

By introducing the concept of *acting body,* this book intends to contribute to answer to the question concerning the future development of *Homo sapiens.*

We consider the acting body as a *bridge* between technology and working memory. Viewing the body in memory and action makes for a radical change in our approach to the social sciences.

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