8 CONCEPTUALIZING AND DESIGNING THE PROCESS OF APPROPRIATION: THE STORY OF A DISAPPEARANCE

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We consider here two modes of relation to an instrument: "in-hand" and "put-down". For the user, these two modes are phenomenologically mutually exclusive; we discuss the conditions for passing from one mode to the other. More precisely, the constitution and the effectiveness of the "in-hand" mode for a new tool depends on a process of appropriation that needs to be characterized and conceptualized. For the design of interaction, taking into account this appropriation process translates into writing a scenario for a disappearance, that of the tool itself, in favour of the space of action that the tool makes possible.

Keywords: Appropriation, Interaction design, Technological phenomenology, Field of presence, Haptic devices.

1. INTRODUCTION

In the context of interaction design, where the aim is for the user to interact not so much with the instrument but rather with the (real or virtual) environment *via* the instrument, it is crucial to understand the process of appropriation. Between the initial moment when the instrument/tool is viewed as an object that is distinct from the user, and the moment when the tool has been appropriated thus opening up perspectives for novel relations with the environment, there is a mechanism which leads, on the phenomenological level, to the disappearance of the tool as such from the user's field of presence. It is this process of appropriation which conditions the possibility that the tool may bring forth a world of lived experience (perception, memory, reasoning, creating and so on).

In order to study this process of appropriation, about which little is known, we are carrying out research in the domain of *perceptual supplementation* and technically-mediated cognition.[1] In particular, our work has led us to develop the Tactos platform, which provides the user with access to a minimalist environment and the haptic reading of virtual digital figures. The interest of this device is that in order to obtain a perceptual experience, the user is obliged to act. This makes it possible to observe the evolution of the subject's activity, together with that of their perceptual performance; we can thus study the dynamics of the appropriation of the tool as the mediator of the relation between the subject and the haptic environment being explored.

This research, on the dynamics of the constitution of perceptual experience associated with grasping an instrument and using it to mediate interaction with the environment, has led us to make a distinction between *appropriation* and *learning*. Appropriation is the process whereby the tool is incorporated and forgotten; it allows the externalisation of the point of action in the explored environment which is at the heart of immersion. Learning, on the other hand, is the mechanism whereby the capacity to act is constituted; in this case, it is by exercising this capacity that the figures can actually be perceived.

In order to refine our study of these two aspects of the genesis of a prosthetic perceptual experience, we draw on work in experimental psychology on the passage from proximal experience to distal experience in the field of sensory substitution. By showing that gains in appropriation are correlated with gains in perception, this work indicates that there is a certain reciprocity, or even indissociability,

between the constitution of the world that is perceived by the subject thanks to the tool on the one hand, and the development of sensory-motor capacities to use the tool on the other. In addition, to the extent that *forgetting* the tool as it disappears from the field of experience seems to be concomitant with the user's access to a stabilized world of experience, it may be interesting and relevant for the study of the appropriation of technical devices to investigate the actual subjective experience of the user: this phenomenon of forgetting could serve as a measure of the process of appropriation. In this respect, we invoke philosophical work, such as that of M. Merleau-Ponty, which bears on the appropriation of technical devices from a phenomenological point of view, and which is consistent with certain observations of contemporary cognitive psychology.

2. CONTEXT OF THE RESEARCH

The Tactos platform is a perceptual supplementation (enabling) technology which defines an environment for the haptic reading of shapes. The principle is simple (see Figure 1). The subject moves a stylus on a graphic tablet, which controls the movement of a cursor in the digital space (just as a mouse moves a cursor on the screen). This cursor represents the surface of a "sensory captor" (which can have various shapes and configurations of sub-fields). When the receptor field of this sensory surface crosses a black pixel in the digital space, it triggers the activation of a tactile stimulation by an electronic Braille cell. In this deliberately minimalist setup, the perception of an object as a whole requires an active exploration of the object; the generation of appropriate patterns of exploration or reading is what we call a "strategy".

We employ the term "haptic" here in a special sense which calls for some explanation. Classically, the term "haptic" is equivalent to "tactilo-kinesthetic", involving the stimulation of tactile receptors associated with movements of the body which also stimulate the proprioceptive system; such perception is thus intrinsically composite. More recently, the term "haptic" has been associated with felt resistance, in particular as simulated by force-feedback devices without tangential tactile stimulation; movement and proprioception are again involved.

In the present design of Tactos (Figure 2), the situation is different again from these classical senses. The variation in tactile stimulation of the finger is not direct (the object is virtual so the skin of the finger is not objectively in contact with it); and it is produced by movement not of the finger itself, but of a stylus held in the other hand. Thus, there is indeed variation in tactile stimulation associated with movement of the body; but the link here is prosthetic. The perceptual experience is both constituted and constrained by the Tactos device which mediates the relation between action and sensory feedback. In fact, the constitution of this experience is based on implicit kinesthetic knowledge. There is no way that a mere temporal succession of tactile stimuli could give rise to the perception of an object. The role of these stimuli is essentially to guide the actions; it is proprioceptive knowledge of these actions which gives rise to a *gestural experience* of the shape.

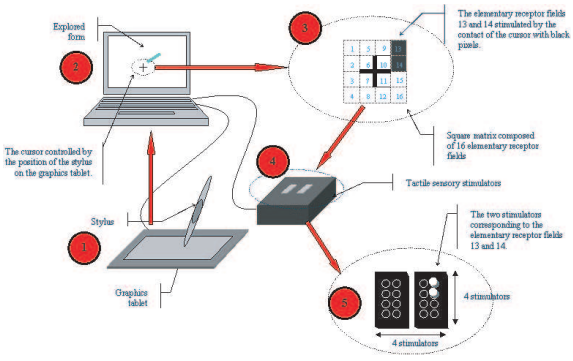

Figure 1. Functional schema of the Tactos platform.

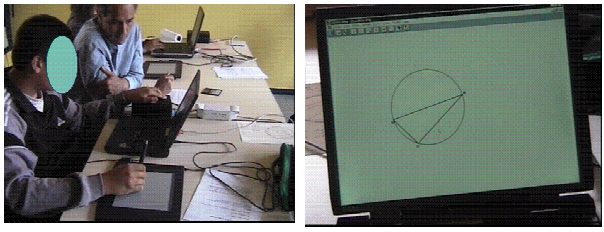

Figure 2. The Tactos platform being used by a blind high-school pupil in a geometry class.

What then do Tactos users actually experience? If there is already perception in the absence of tactile stimuli (kinesthetic perception of the gestures made with the stylus), how does the availability of sensory feedback modify the perception? First of all, we may note that the appropriation of Tactos, which enables its disappearance from conscious experience, is not immediate. Thus, novice users often report that their attentional focus "switches" between the gesture and the tactile stimuli. This phenomenon of "selective switching" between one or other of the components of the interaction is an indication that the tool has not yet acquired a full "*in-hand*" status. The subject does not yet fully envisage his/her gesture as corresponding to the movement of a point of view in the virtual space, and to interactions with tactile objects that are located therein.

However, although these phenomenological elements indicate that the appropriation of the tool is not yet sufficient to give rise to a stabilized experience of a field of objects corresponding to "in-hand" status, the tool is not experienced either in the complementary "*put-down*" mode as a simple object in the environment that is contemplated from outside. At this stage, for novice users, the tool has an *intermediate* status: it is no longer an object in the external environment because it is already being used for an initial incursion into the virtual environment; but it is not yet fully appropriated as a transparent part of the lived body. The phenomenon of mutually exclusive focussing either on the tactile stimulations, or on the gestures, corresponds to a sort of *analytical* experience of the tool.

These observations indicate that the initiation and stabilization of an *immersive* experience, where consciousness is fully focussed on the perceived object (and no longer occupied by the body or the tool), is anything but immediate. Indeed, it may be possible to distinguish different *levels* of "presence" of the object, ranging from the simple impression of its "presence" to the possibility of actively exploring and reasoning about its properties.

3. CHARACTERIZING THE PROCESS OF APPROPRIATION

We will focus our discussion on two critical aspects involved in the constitution of the appropriation process:
the plasticity of the lived body, and the constitution of distal perception.

- Plasticity of the lived body

The very possibility of *appropriating* an instrument, if we take it seriously, implies that the body — as it features in the perceptual and practical experience of an individual subject – is endowed with a certain plasticity. My body is the vehicle of my intervention in the world, my means of action; it is also the vehicle by which I am exposed to the actions of other agents. The appropriation of an instrument or a device involves experiencing a modification of my body. The fact that I can really appropriate the instrument that I use thus implies that the body that I experience as being my very own is something other than a representation of the physical organism. If the "lived body" were indeed only a simple image of the physical body, the instruments that I use would be condemned to remain simple external objects, they could never be truly appropriated: the blind man's cane would forever be perceived as something in the palm of the hand, it could never be the instrument *with which* they explore and perceive their environment.

This conception of the nature of the lived body, as irreducible to a representation of the physical body, is suggested by numerous situations of dissociation between the lived body and the physical body: the well-known phenomena of phantom limb[21] and alien limb,[23] or rubber-hand studies.[22] It is also supported by a series of neurological observations concerning the plasticity of somatotopical maps[20] and by recent behavioural studies concerning the reorganization of ambient perceptual space induced by the use of a tool. If the meaning and value of a tool lies first and foremost in the modification of the user's power of action (that is what makes it a tool), it would nevertheless be a mistake to confine the study of the appropriation of tools to a mere question of practical performance. Merleau-Ponty[2] already pointed out that for a perceiving agent immersed in activies of commerce with the environment, the practical and the perceptual are indissociable in the sense that the individual always perceives a world organized by reference to the possible actions at his disposal. This reciprocity between an individual's possibilities for action, and the world he perceives, is also at the heart of the ecological theory of perception developed by Gibson.[3] It follows that appropriating a tool means not only enlarging the scope of practical possibilities, but equally *perceiving the ambient world by reference to these possibilities.*

This view has received substantial empirical confirmation. Various studies have shown that the use of a tool to reach targets situated in the ambient space can lead to a reconfiguration of perceptual space, bearing on what is considered as "near" or "far". Thus, targets which cannot be reached without the use of a tool are considered as "nearer" when the tool is available.[4] Similar observations have been made in electrophysiological studies in the macaque,[5] and in behavioural studies on line bisection tasks with subjects suffering from unilateral neglect[6] as well as healthy subjects.[7] These observations have led certain psychologists to propose the idea that these phenomena of expansion of the peri-personal space could result from an integration of the tool in question into the *body schema* of the individual. Head and Holmes[8] already suggested the possibility of such an integration, citing the examples of the carpenter's hammer, the blind person's cane, or even the feather in a woman's hat! This idea has also been supported by studies on phenomena of intermodal extinction[9] and intermodal interference[10] and other observations suggest that it is not so much the visual perception of a continuity and spatial extension of the physical body itself that counts, but rather the zone of the ambient space where the individual *can exert an action* .

The genesis of prosthetic perceptual experience, understood as a process of appropriation of the instrument and the associated action schema, is illuminated by these studies which indicate that what the individual (or brain) envisages as *their body* is a power of intervention in the environment. What the bimodal neurones studied by[5] and others represent is *not* a physical body with fixed dimensions and boundaries, but rather a "body" which is only *one's own* to the extent that it is invested with a form of confidence which raises this body to the status of a capacity which one has at one's disposal. One's *own* lived body (in the sense that the individual experiences it as *their* body, in terms both of practical intervention and as the seat of perception) is thus the result of actual use. It is something like the sedimentation of a capacity to act; the individual becomes progressively conscious of this capacity in the course of exercising it. Moreover, we wish to insist here on the fact that when an instrument modifies the capacity to act, this seems to be accompanied by a modification *in the actual field of phenomenal experience* (in this case, expansion or contraction of the spatial configration), and not just a modification in judgement (estimating distances) *with the same old phenomenal field.*[12] Once an instrument has been fully integrated into the lived body, the user gains access to lived experience of a whole new field of phenomena.

For Merleau-Ponty,[2] the body schema provides knowledge of this sort of lived body which is "engaged" with a familiar world of use. This is a body which is situated face-to-face with the "affordances" offered by the perceived ambient world — whether it is question of the spatial organization of the world, or of the functional meaning attributed to the various structures and objects in the world. My body, for me as I *am* that body, is thus a "capacity for a certain number of familiar actions in my surroundings, considered as a collection of entities that can be manipulated" Ref.2, p. 122). The lived body (understood as the organ of action in the world) and the ambient world together form a single system. Head and Holmes[9] quite correctly propose that the body schema can integrate instruments

or other appendages connected to the body, and so this schema can exceed the limits of the organic body. Merleau-Ponty, referring to Grünbaum,[13] further remarks that the appropriation of these extra-bodily elements has an immediate repercussion on the *meaning* to be found in the ambient world, and more generally on the structures which organize this world (typically its spatiality). For example, the internalization into the body schema of the feather in the hat that I wear — or the car that I drive - – transmute these entities into "voluminous capacities, which require a certain amount of free space"; and in strict correlation, the door of the Underground (for the feathered hat) — or the road (for the car) — present themselves to me as "constraint-bearing capacities which appear immediately as feasible or non-feasible for my body with its appendages" (Ref.2, p. 167). Merleau-Ponty calls the appropriation of an appendage into the schema of the lived body a "motor habit"; and he expresses the dual dimension of such an appropriation by saying that "every habit is concomitantly motor and perceptual because it resides (…) in between the explicit perception and the actual movement, in that fundamental functionality which limits both our field of vision and our field of action" (Ref.2, p. 177).

On the basis of the empirical observations cited above, taken together with the intuitions of Merleau-Ponty, we may suggest that the dynamics of the appropriation of an instrument involves two mechanisms, which can be distinguished analytically but which in reality are indissociable: on one hand the *incorporation* of the instrument as such, its integration into the body schema; on the other hand the *reorganisation* of the ambient world, which is perceived in reference to the possibilities for action offered by the instrument. It is this dual operation that accompanies the disappearance of the instrument from the user's field of focal attention, and the user's feeling of an immersive (i.e. non-mediated) presence in the world. It is precisely when the world is envisaged in terms of the operations made possible by using the instrument, that the latter is no longer perceived for itself.

These considerations may prove useful when it comes to describing the process of appropriation. The transparency of an instrument (i.e. its disappearance from the user's focal field of attention) is manifestly an indication of its appropriation: when I use my glasses to see with, I no longer see the glasses themselves. However, the very nature of this phenomenon, its character as a "*non-appearance*", makes it particularly difficult to observe objectively — for example in a study where in order to validate a device we may wish to measure the degree of appropriation of the instrument by a user. By contrast, the functional restructuring of the system of affordances which constitutes the perceived environment[3,12] seems to be a measure which is just as reliable, but which has the advantage of being much easier to observe objectively. The stick that I use is appropriated (i.e. integrated into my body schema, acquiring what we called above the "in-hand" status of a tool) precisely from the moment when I perceive my environment in terms of the actions that the stick makes available to me. When this is the case, the amplitude of the access provided by the stick becomes the measure for evaluating distances and the organisation of the ambient perceptual space, and in particular for distinguishing a peri-personal sector of space (those zones of the ambient space that can be reached) from an extra-personal sector of space (those zones which are out of reach). In other words, this is when the visual field is recalibrated in terms of the actions made possible by the instrument. To sum up: the way in which the user evaluates the distance of objects placed in his environment can serve here as a measure of the degree of appropriation of the instrument.

These considerations are primarily based on observations concerning the use of an extremely rudimentary instrument, a stick. However, we see no reason why they cannot be extended to the study of the process of appropriation of more sophisticated haptic technologies such as Tactos and force-feedback arms. *A priori*, there is indeed no fundamental difference between using a stick to reach and to interact physically with real distal objects, and using a stylus or a force-feedback arm to interact with virtual objects. In the case of the stick, the process of appropriation can be interpreted as the integration of this new organ of environmental intervention into the body schema: the stick has the functional meaning of an extension of the arm and the hand. Similarly, the appropriation of the haptic device will involve a certain re-organisation of the body schema, a basically adaptive and plastic system, which underlies the re-organisation of the perceptual ambient space considered as a space for the deployment of a practice.[14]

• Constitution of a distality

Grasping a tool always opens up a novel perceptual space, and the displacement from proximal interaction with the tool to distal interaction with objects in the new "world" is always an issue. The passage from the experience of proximal sensations (on the skin) to an experience of the perception of distal objects was described in the very first research with the TVSS [15]; however, this passage has until now received very little more attention. Probably the first experimental study concerning the interpretation of such perceptual experience in terms of a distal object was carried out by Epstein *et al*[16]. The situation was a "forced-choice" situation, in which subjects had to choose between several scenarios ; the scenario according to which the received signals resulted from the subject's own activity, and that they referred to a distal object, was only one among several. The main result of this fascinating study was that the "distal" scenario was *not* generally favoured by the subjects. In other words, when the subjects are not informed in advance about the working of the system, and they are not told that they have to perceive a shape "out there", they do not spontaneously interpret their experience with the device as resulting from a relation with an external distant object which is the source of the stimulation.

A new experimental study, and a reanalysis of the experiment of,Ref.16, have led Auvray *et al*[17] to refine the earlier result, and to propose a succession of stages towards "immersion"; the attribution of distality is an important step in this process. The stages are the following:

- Contact: this implies learning the sensori-motor regularities which must be mastered in order to stabilize and maintain perceptual contact with the stimulus.
- Distal attribution (this is the phenomenon which interests us here): it corresponds to understanding the origin of the sensations as resulting from an encounter with an object situated in the perceptual space opened up by the device.
- Mastery of the distal space: this corresponds to learning about variations in the point of view, and establishing distal reference points which make it possible to achieve egocentric localization of objects and events.
- Distal localization: this is defined as the impression of being "in" the perceptual space, and implies an automatized mastery of the sensory-motor coupling so as to consolidate the experience of "being there where one acts".
- Distal experience: the constitution of this stage requires sharing the perceptual experience with other persons, which allows constitution of the meaning, the emotions and the shared values which characterize this particular experience.

With reference to these stages, it is very clear that in the experiment of,Ref.16, the subjects reach stage 1, that of "contact" where they express their consciousness of a relation between their actions and reafferent sensations; however, under the conditions of this experiment, they were not able spontaneously to go further. This stage allows the constitution of the experience of a subject/object distinction. Auvray *et al.*[17] found the same result, but went on to show that if the subjects are given the opportunity to *manipulate* the object (a luminescent ball), or if they can manipulate an obstacle (a sheet of paper) which can be interposed between the source and the sensory device, that greatly favours the constitution of a distality of the object. In this particular experimental situation, the subject can actively manipulate the totality of the subject/object relation (camera and ball), and can interrupt this relation at will. These manipulations provide a basis for making a distinction, within the flow of sensations, between sensations which are related to the subject's own movements (and thus to the proprioceptive flow), which can be called *reafferences*; and sensations related to independent variations of the environment, called *exafferences.* However, this distinction alone cannot give access to distality unless the subject has the possibility of 3-dimensional actions sufficient to establish a triangulation.[18] We see here that the knowledge of one's own action that is necessary for the constitution of the perception of a distal object is not limited to knowing whether or not one is acting (simple agency), but requires in addition a knowledge of one's own *gesture.*

These experimental situations involving human subjects do not generally induce an attitude where the subject may be lead to *doubt* the existence of an external space already constituted. What the subject

has to constitute concerns the features of a particular object (distance, shape, orientation, size), but not the existence of space itself. In other words, when the subject receives a tactile stimulation, there is no reason to doubt that the origin of this stimulation is an object situated somewhere "out there" at a certain distance from the subject. Even so, these situations (and also the experiments with the Tactos device) have a particular feature, which is that the object to be perceived does not manifest its presence directly by producing a resistance (as is the case with direct touch). The "quasi resistance", and thus the tangibility of the object, must be self-engendered with reference to the kinaesthesia which is dynamically mobilized in the movements and their control.

In fact, there are signals permanently available to the organism concerning the successive spatial deformations of the body, involving what has been called "deep sensitivity". A flow of exteroceptive signals will be associated, or rather integrated, into this deep sensitivity. Guarneiro,[19] a blind person who learned to perceive with a prosthetic system (TVSS), said that: "*The first thing I had to learn was to differentiate between the situation in which the object was moving and that in which I, i.e. the camera, was moving, a skill I acquired quickly*".

4. APPROPRIATION AND INTERACTION DESIGN

From the point of view of interaction design, fully taking into account the process of appropriation leads to anticipating the disappearance of the instrument from the user's field of presence. This means that the work of the designer consists of elaborating an aesthetics of the opening on the world which the instrument will bring. To this end, we propose that the process of appropriation can be related to a form of accommodation, in the Piagetian sense of the term, which notably involves bodily plasticity. Indeed, in the case of appropriating a new tool, the user does not so much have to deal with an inadequacy of his schemes or strategies with respect to the environment; rather, he has to deal with a renewal, constrained by the tool, of his exploratory mode with respect to that environment. In other words, if the process of appropriation is considered as a form of action in its own right, it is neither an assimilation aiming at prolonging a mode of functioning, nor an accommodation aiming merely at a re-organisation of action schema necessitated by an inadequacy of the old schema to cope with environmental events. Here, the accommodation has a larger scope: it calls on the user to replay the whole process of constituting an experience of environmental events. The horizon for the designer is thus not (or no longer) the adjustment of an environment to fit the user, or the reverse; rather, it is the relational dynamics and the coupling between user and environment.

Furthermore, we suggest that the designer should have a dynamic and historical conception, including the genesis of the process of appropriation. The elements we have provided in this short text suggest that setting up a quasi-instantaneous passage between the *in-hand* and *put-down* modes of presence of a tool requires a constitution, and cannot itself occur immediately. It follows that developing the design of appropriation will require considering appropriation as a genuine process in its own right, with a characteristic temporality marked by distinct phases; these phases will have to be identified and described as an integral part of the conceptual design, and maybe written into scenarios for the stage of diffusing and marketing the product.

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