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THE CHALLENGES OF ACTIVITY ANALYSIS FOR TRAINING OBJECTIVES
DÉFIS DE L'ANALYSE DE L'ACTIVITÉ DANS UNE VISÉE DE FORMATION

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SUMMARY

This article shows how the 'course of action' research programme has enriched activity analysis with illustrations from studies in the field of vocational training. The principal hypotheses of this programme are first reviewed, after which we present the paradox at the core of any training objective to transform the activity of individuals 'from the exterior', while attributing to them an essential autonomy. We present the four main uses of activity analysis in the training context and their effects, in turn, on the analysis itself. The article next shows why the focus on transformations in activity leads to a dispositional perspective and describes the importance of understanding the conditions for constituting these dispositions (notably concerning how the situation can contribute). Some of the current challenges for activity analysis with a training objective are then reviewed: the study of trainees' activity in situations that include the trainer as one of the components, suggesting that this component should also be analysed; the widening of the time horizon for analysis and the articulation of the different time scales; the articulation of lower and higher levels in the analysis of activity conceptualised as a multilevel system; and the development of an anthropo-technological approach for designing large and complex technical, organisational, cultural and historical systems, with training being an aspect. This presentation of the theoretical and methodological advances and issues may be of interest to researchers in the field of activity analysis as it raises the provocative question of a spatial-organisational-cultural-temporal broadening of current research.

Keywords: *course of action, activity transformation, individuation/appropriation, multilevel activity analysis, anthropotechnology.*

RÉSUMÉ*

Cet article porte sur la contribution du programme « cours d'action » aux recherches en analyse de l'activité, en partant essentiellement des travaux dans

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le domaine de la formation professionnelle. Après avoir rappelé les hypothèses principales de ce programme, il en caractérise un paradoxe fondateur qui est inhérent à l'objectif de transformer « de l'extérieur » l'activité des individus tout en leur prêtant une autonomie essentielle. Il présente quatre usages principaux de l'analyse de l'activité en formation et leurs effets en retour sur l'analyse elle-même. Il indique pourquoi le fait de se centrer sur les transformations de l'activité conduit à adopter une perspective dispositionnelle, et induit un intérêt pour les conditions de constitution de dispositions (notamment sur la manière dont la situation peut y contribuer). Il expose ensuite quelques défis actuels de l'analyse de l'activité dans une visée de formation : la considération de l'activité des formés dont la situation de formation inclut celle des formateurs comme l'une de ses composantes qu'il convient aussi d'analyser ; l'élargissement de l'horizon temporel de l'analyse et l'articulation d'échelles temporelles différentes ; l'articulation des niveaux inférieurs et supérieurs d'analyse de l'activité conçue comme un système multi-niveaux ; le développement d'une démarche qualifiée « d'anthropo-technologie » visant la conception d'ensembles techniques, organisationnels, culturels et historiques larges et complexes dont la formation est un aspect. Les avancées et questionnements théoriques et méthodologiques présentés sont susceptibles d'intéresser l'ensemble du courant d'analyse de l'activité, en posant la question de l'élargissement spatio-organisationnel-culturel-temporel des recherches actuelles.

Mots-clés : *cours d'action, transformation de l'activité, individuation/appropriation, analyse multi-niveaux de l'activité, anthropotechnologie.*

INTRODUCTION

The field of vocational training has recently become open to researchers who use activity analysis, which has a long tradition in Francophone ergonomics (e.g., Amalberti, Montmollin, & Theureau, 1991; Guérin, Laville, Daniellou, Duraffourg, & Kerguelen, 2007; Valléry & Amalberti, 2006). The analysis of work that requires initial or ongoing training to perform it well is based on the conviction that, without this analysis, work-related knowledge will be vague and incomplete. A research stream today suggests that the practices for vocational training should be founded on the actual work itself and/or in relation with a work analysis. This research focuses just as much on the object of the work as the training for it, and on the modalities of constructing knowledge both in the workplace and in training (e.g., Filliettaz, Billett, Bourgeois, Durand, & Poizat, 2015). The studies document the design of training environments and promote a developmental approach whose objective is to prompt and support long-term transformations in trainees' activity (Durand, 2011; Durand, Poizat, & Goudeaux, 2015; Poizat & Durand, 2014).

Francophone ergonomists and occupational psychologists have always been interested in vocational training (e.g., de Montmollin, 1974; Ombredane & Faverge, 1955). Yet despite this interest and with few notable exceptions, they have long shown a tendency to leave issues of training – or 'adapting people to work' – to psychologists and training specialists. They

seem to have considered only the training of operators in workplace health/safety issues and the ergonomic analysis of work itself to be within their province, especially as a means to improve working conditions and prevent injuries – or 'adapting people to work' (e.g., Ouellet & Vezina, 2014; Teiger & Lacomblez, 2013; Teiger & Montreuil, 1996). The situation is changing, however, and today ergonomic psychologists no longer hesitate to become involved in training (e.g., in relation to new technologies being introduced or during technico-organisational changes) and they also, most importantly, systematically problematise issues of learning/development in work situations and in procedures of activity analysis or design (e.g., Falzon, 2015).

Trainers had for many years kept their distance from any kind of work analysis based on ergonomics (Jobert, 1993). It was only in the 1980s that these professionals began to use this approach, producing quite original works to advance the training field (e.g., Pastré, 2011). A major research trend in training today (a) focuses on real work with human activity as its object, (b) adopts and adapts tools from the occupational sciences for its analyses, (c) invents procedures to facilitate the shift from the analysis of activity to the design and anticipation of future activity in work or training, (d) makes use of participative design by taking into account professional viewpoints to adjust to the training situation, and (e) is developing a methodology for project management specific to training objectives.

We present here a Francophone research that essentially falls within the framework of the 'course of action' and is conducted in the field of training – and not in the field of ergonomics with training merely included, as was the case in the beginning of this programme. We do so by pointing out the theoretical, methodological and technological advances that this approach has helped to bring about. We begin by presenting the three assumptions of enaction, experience and semiosis that underlie this research and then address the paradox at its heart in the training field and the notions of spaces for encouraged actions (SEAs), mimesis and musement, used to resolve this paradox (Part 1). In the next section, we illustrate how activity analysis is used in vocational training by presenting illustrations from studies either past or underway (Part 2). We next explain why a focus on activity transformation over a long timescale calls for a dispositional perspective and the analysis of the conditions for constituting dispositions to act (Part 3). We further show that these transformations can be conceptualised through notions of appropriation and individuation, which supersede the usual definitions of learning and development (Part 4). The spatial, organisational, cultural and temporal broadening of research that we propose here is based on (a) the definition of new theoretical objects like the 'life course related to a practice (or project)'; (b) the analysis of different timescales of activity; (c) the examination of relationships among multiple levels of the organisation/meaning of activity and culture, summarised here as articulating two series of phenomena from lower levels (I) (the interaction between an actor or small group of actors and the material and cultural environment) and from higher levels (II) (historical, artefactual,

social, political and cultural processes); and (d) the opening of a broad and complex design perspective that takes technical, organisational, cultural and historical aspects into account – with training being one of its aspects – that has been termed anthropo-technology (Part 5).

We believe that training research based on activity analysis could both contribute to the ergonomics field and raise new challenges and questions for researchers using the activity analysis approach. The characteristics of work today suggest the need for a closer look at the targets of ergonomic interventions and for support to ergonomists in shifting their attention towards training (Beaujouan & Coutarel, 2013) without neglecting the technico-organisational conception of work. The transformative and developmental dimensions of human activity are worthy of our attention, as is evident in training research, and stand to greatly enrich research in ergonomics (Falzon, 2015), occupational psychology (Clot & Kostulski, 2011), and organisational management (Lorino, 2015). Although all fields of study and fields of practice have their specificities, we are convinced that convergences are possible between them.

I. TRAINING WITHIN THE COURSE OF ACTION RESEARCH PROGRAMME

The 'course of action' research programme (Theureau, 2003, 2006), which developed in French ergonomics, conceptualises activity on the basis of three main hypotheses: enaction, semiosis and experience (see Dieumegard, Saury, & Durand, 2004, in this journal). We review these hypotheses and then present the conceptual consequences for research on activity transformations from a training perspective (e.g., Durand, 2008; Durand & Poizat, 2015; Poizat, Salini, & Durand, 2013). The specificity of research on training practices is that the investigation focuses on how the activity of actors is transformed or influenced (in a broad sense) and how training conditions can be optimised to bring about these transformations or influences.

I.1. Main hypotheses of the 'course of action' research programme

According to the hypothesis of enaction, activity is conceptualised as a dynamic and self-organised totality that expresses and transforms an asymmetrical coupling between an actor and the social and physical environment. Activity is also thought of as an embodied and incorporated whole. It is a dynamic flow, with cognition conceptualised as the concrete activity of an entire organism whose sensory, motor and cognitive dimensions form an inseparable ensemble that make up the body's sensorimotor capacities. The unit of analysis is (a) an *interaction* between the actor and the environment (including the social), and not an action, behaviour or reaction; (b) a *dynamic* and not a subject, an agent or a stable and reified collective entity; (c) a *totality*, and not a bundle of isolated

separated processes (decision-making, regulating motivation, etc.); and (d) *asymmetric*, in the sense that the actor's internal organisation at each instant specifies potential disturbances coming from the environment and models appropriate responses.

According to the hypothesis of experience, human activity is associated with a particular mode of consciousness that is consubstantial with the activity and is the source of a first-person perspective: a self-presence or the experience of oneself acting. We define this mode as *prereflexive consciousness*. Experience is not conceptualised as a process or the product of an active introspection or exploration of one's own subjectivity or interiority, but as a natural concomitant of an actor's vital engagement in the world. It is therefore not turned towards the subject and his or her interiority, but is the permanent expression of an 'overflow into the world'.

Under the hypothesis of semiosis, activity is the production of meaning. It is the never-ending construction of meaning: to act is to construct meaning in a cultural context and in relation to others. In the 'course of action' programme, all activity is conceptualised as cognitive – that is, as the creation and manifestation of knowledge – and all cognition is part of a semiotic process in such a way that the dynamics of activity are characterised by the dynamics of meaning.

I.2. Enaction and the paradox of intervening in the activity of others

The prolonged and repeated practice of work leads to transformations: actors learn on the job, acquire experience and become expert. The transformations are part of a self-construction such that the succession of past enactions makes up the history of an activity that can be recapitulated at any instant. Thus, transformations in activity (often described as learning or development) are not isolated and separated from practice or are considered as being themselves practices (the trainees' work being somehow symmetric with that of the trainer). Transformations are inherent to here-and-now activity, which might be the practice of studying in training that follows a predominantly curricular style, or a polymorphic practice of re-elaborating the work practice (according to diverse modalities) when the training is predominantly reflective.

Enaction and/or self-construction confront trainers with a paradox: how can they claim to train others – that is, to intervene in the construction of others' activity, to modify it and support it – if they credit the assumption of autonomy? In fact, influencing the activity of others for training purposes is necessarily indirect: unable to instruct an activity, trainers modify the environment in which activity is deployed, hoping (in the strongest sense) that this modification will positively disrupt the trainees' activity, be meaningful for them, and prompt transformations that will be 'appropriative', 'equilibrating' and 'individuating'. With reference to the works of Reed (1993) and Recopé (2001), we characterise these positive disturbances as SEAs.

Peirce's semiotics is central to this research programme and provides a way to deal with the issue of transformations in activity. According to

Peirce (1887-1888/1998), all experience is describable using three universal categories: the Possible, the Actual, and the Virtual, which we interpret in terms of activity. The Possible category is the potential dimensions of a continuous present, rooted in the past and allowing one to imagine what may occur in the future. The Actual category manifests the emergence of certain elements of the Possible in relation to the here-and-now incursion of events. The Virtual category corresponds to the mediation between these two categories, where habits or dispositions towards acting are constructed, and it thus prefigures the future. These three categories are always co-present though they remain quite distinct as poles in a continuum, and they permeate all experience, which renders any attempt to define any of them apart from the others utterly impossible.

Activity is not only an accomplishment belonging to the register of the Actual, or – to put it differently – the 'being accomplished'. It is also the actualisation of certain possibles at every instant, and as such it may be the object of a generalisation, or a virtualisation. This illustrates Peirce's formula (1887-1888/1998), according to which humans do not live only by facts: human experience has substance that is made up of these three registers. Here-and-now activity emerges step by step from indeterminate possibilities. In the register of the Possible, an opening-closing operates at each instant of the possibles inherited from the actor-environment coupling, and it tends towards the future (with a simultaneous retention and protention, or anticipation) (Theureau, 2006). These possibles are circumscribed but not specified: they become specified as they are actualised. The actualisation of a possible is the definition/selection of a figure or form from the background. And on the basis of repetition and the quest for identity and invariance, these actualised figures can be typified and constitute the actor's virtual reference, from which future openings of possibles can proceed. The register of the Virtual is where habits are created; it is the heart of the transformation processes of the actor by his own activity during his whole life.

According to these hypotheses, the interventions of trainers, which we defined above as making and maintaining SEAs, are oriented towards modulating enaction using a non-instructive mode, mainly by (a) restriction – that is, the definition of impossibles or even proscription – and the opening of possibles at the centre of which trainees' activity can be self-constructed, (b) scaffolding or de-scaffolding of actualisations, and (c) the inducement of virtualisation or its encouragement. From this perspective, the interventions in trainees' activity are indirect (Durand, 2008; Perrin, 2014).

I.3. Registers of activity promoting transformation: mimesis and musement

Mimesis describes a mode of activity that we assume as propitious for the positive transformation of activity (Durand et al., 2013) and that can be distinguished from industrious, direct, serious, functional and unequivocal engagement. Mimesis involves a register of meaning that proceeds by displacing and relating based on resemblances, affective

states and a playful experiential tonality, and complex intentionality that involves pretence (never complete or gullible). These mimetic diversions or enrichments of activity bring the practices of work to the edges of uselessness and generate experiential contents that amount to a step back from reality. Peirce (1908/1990) called this type of activity 'musement' because it involves the serious project of eliminating all serious projects, or all projects. Three elements help to explain the transformative power of mimesis: multiple intentionality, saturation by metaphor, and an imaginary regime of meaning.

Mimetic activity implies a decoupling of the apprehended reality of the elements in a situation and their effective meaning; it is the structuring of an actual experience by finding resemblances with another experience (to do this *is valuable in the circumstances* to do that) but without it being reducible to this latter. This requires a particular kind of involvement; for example, in training by simulation, trainees have the simultaneous experiences of doing work and training to do work, according to a register that brings together this double negativity: *this is not work* and *this is not not-work* (Horcik, Savoldelli, Poizat, & Durand 2014). In a study of nurses training to become anesthetists through simulation at the University Hospitals of Geneva, we observed that the trainees' activity fluctuated constantly between the two extremes of work activity and training activity. At certain moments the nurses' activity was oriented towards the exclusive search for signs of the patient's status and the progress of the anesthesia procedure: ('*here I'm doing what I usually do […] it's the way I work every day […] nothing in particular […] I'm starting to be a little into it because I start watching the monitors up above […] everything is happening according to plan […] she injects the medicine and we wait […] so everything's OK […] there's good communication, everything is hanging together […] my screens are under control and things are happening as planned […] here I'm in action*'). At other moments, the nurses conducted inquiries to determine the intentional or accidental nature (i.e. provoked or not by the trainers) of the difficulties they encountered. They would also pretend to give a drug, refer to absent clinical signs, exaggerate the speed of performing an action, mime it or mention it. Thus, in the excerpt above, at one point a trainee deliberately carried out his actions for the trainers observing him through a one-way mirror: ('*well, here […] I say while laughing "OK, it's all aspirated" […] kind of like "it's all OK, you heard it, I did what I had to and aspirated everything*…"'). The trainees' experience always showed traits linked to the training situation mixed in with elements related to the real work. The trainees never forgot that they were in simulation, but even though they were at times quite far from the real work, they at all times had the experience of participating in an anesthesia procedure. It is natural for mimetism to be observed in a simulation since it is explicitly sought, but manifestations have also been identified in other types of training situations, notably video-training schemes for teachers (Ria & Leblanc, 2012).

Mimetic activity requires a special system of meaning production by the metaphorisation of the situation. The metaphors signify an experience through its re-organisation in terms of another previously typified experience, thereby demonstrating for the actors the overall coherence in the

meaning of their activity (Lakoff & Johnson, 1980). Metaphorisation is a source for appropriating or producing something unique from the usual meaning of things because (a) it allows actors to grasp the unknown and engage in new activities, and (b) although it is irrational, it provides the foundation for conventional symbolisations. The analysis of the initial informational-advisory meetings for the Accreditation of Prior Experiential Learning (APEL) has been particularly interesting on this point (Salini & Durand, 2012). The unusual nature of the APEL system makes it necessary for candidates to be assisted in appropriation, as they must anticipate the 'experience of the accreditation of experience'. In these interviews, the advisors try to help the candidates to understand this process and facilitate their engagement. They therefore structure their interventions, spontaneously and implicitly, using different metaphors that show the overall consistency in meaning between the constituents of the situation (Lakoff & Johnson, 1980).

Last, in mimetic activity, the semiosis is saturated with iconic (or imaged) signs within a relationship to the object based on resemblances. These signs are different from the indices of an object signified by a real relationship (to the tracker, tracks in the snow mean an animal has been through) or symbols like words, where the relationship to the object is conventional. The resemblance may involve a mental object or a fictional situation, and it signifies the imaginary (Fisette, 2009). The fecundity of the imagination is such that it establishes new resemblances by putting objects into relationship in novel ways. By signifying new hypothetical properties, this creation may become typical (Thibaud, 1994). The elements that the actor puts into a relationship of resemblance thus tend to merge as if they belonged to the same image, despite the vague sense of distance between them. A productive imagination can thus open on to changes in perspective and modifications in the references. It gives new meaning to the present and guides the future in new ways. The imaginary resemblance is constituted from the experience of individuals and not from a preexisting resemblance to experience resulting from objective properties: it is the fruit of an interaction and the expression of a creation.

II. FOUR USES OF ACTIVITY ANALYSIS IN TRAINING

The contribution of the 'course of action' programme to training can be summarised as four modes of research, not necessarily exclusive, opening up the conception of training.

II.1. Analysis of actual work as a didactic object

This method derives from the initial work of ergonomists, some of whom, we may recall, considered ergonomic analysis as a 'preliminary to training', as well as the technico-organisational arrangement and design of work environments (de Montmollin, 1974). In line with this idea, an

orientation developed wherein the analysis of the work performed by experienced operators informed the design of training contents. With this orientation and inspired by seminal works in professional didactics (e.g., Mayen, 2015; Pastré, 2011), the analysis of activity has the objectives of identifying and describing the shared and invariant components of work activity. The analyses yield factual data and models of work that ensure that the training will be relevant to the real work and its constraints. From our theoretical perspective, the resemblances and regularities across several operators or within the same operator under varying conditions are referenced to the typical components of the activity (see Part 3). The studies of Dieumegard et al. (2004) on the work organisation of factory managers or Aubert (2000) on painters in aircraft industry illustrate this mode of using work analysis. The latter study in particular showed that painting a plane was a collective work that was accomplished in a 'cascade' and that each painter needed to quickly stabilise his or her action to promote coordination between all the painters. This study resulted in proposals for new training programmes taking into account the collective dimension of the work.

II.2. Work analysis and the pedagogy of career trajectories

The methods for supporting career trajectories are based on research on (a) the work of novices and (b) the transformations in their work and modelling their career paths. The analyses have shown traits presenting typicality and criticality in most of these novices' work practices that were notably absent in experienced operators' work practices. These traits are interpreted as kinks in the course of career development that will need to be worked out and as sources of inspiration for the design of training programmes to foster this mastery (Ria, 2009). The empirical results have then been used in the design of programmes to support growth in professional trajectories. Thus, the design of the *Néopass@ction* platform for teacher training grew out of the analysis of the activity of novice teachers, which indicated (a) their difficulties at the beginning of their careers in taking control of the classroom in the first few minutes of the lesson and ensuring an atmosphere conducive to study (these issues rarely affect experienced teachers), and (b) the systematic and easily modelled transformation in these first few minutes of the lesson (Leblanc & Ria, 2014).

This orientation has led to the invention of methods and concepts for transforming work activity over a more or less long timescale, and not just *hic et nunc* through a technico-organisational arrangement. Retrodictive approaches can be used to track human activity over varying time spans: 'core sampling' at different points in careers and then reconstituting typical trajectories. This approach fosters a developmental perspective for analysis and training, tests a hypothesis of the rupture of idiosyncrasy not only in the *hic et nunc* activity but in its medium-term development, and ultimately documents the engineering of developmentally-oriented training that is not exclusively focused on learning (Durand et al., 2015). This approach also falls within the analysis of 'life courses related to a

practice (or project)' and contributes to the methodological and theoretical advances detailed in Part 3.

II.3. Work analysis as a source of transformation

When actors contribute to the analysis of their own work activity, they have an opportunity to transform that activity: positive effects are associated with allowing themselves to be observed during the work practice, helping to make it more understandable to the analyst, viewing the video recordings, engaging in the methods for expressing their experience or subjectivity, discussing and debating with others, and so on. Such observations are not exclusive to the vocational training field but have also been noted in work psychology and ergonomics, whether this be for the actors whose activity is being analysed or the actors who have been involved in the design. The research observatory also offers these actors greater and more reliable reflectivity as they give expression to their experience during self-confrontation interviews (and other methods) at the first level and as they participate in the analysis of their activity in the self-confrontation interviews (and other methods) at the second level.

This has an impact of participants' activity. The impact is attributed to the cognitive re-elaborations as they express their experience and to its modelling by the analyst, as well as to their greater insight into aspects of their work practice that are usually outside of conscious awareness (Lussi Borer, Ria, Durand, & Muller, 2014). We conceive of self-confrontation interviews (and other methods) both as interviews wherein actors are confronted with the traces of their past activity and, most importantly, as workshops (a) involving the immersion of actors into a dynamic situation by confronting them with the richest possible traces of their past activity, (b) helping them to express their experience of this past activity, (c) potentially opening to interpretive chains initiated during past activity, and (d) bringing to light novel interpretive chains and creating new knowledge or invalidating past knowledge (Theureau, 2010). These novel interpretive chains derive either from interpretations that were germinating in the past activity or from insignificant elements of the present situation that become significant during self-confrontation. They are encouraged by the actors' engagement in exploration and the break with the time constraints inherent to the activity in context.

The new elements that emerge do so notably because of the prompting of and/or support for those transformations in activity particularly related to the actors' participation in the analysis (Lussi Borer et al., 2014). There are several options for addressing these effects, from (a) minimising them in order to ensure an analysis as neutral as possible, to (b) dissociating research phases from phases of supporting the transformations (which is often the challenge for analyst-actor collaboration) and (c) deliberately triggering these transformations with less focus on the scientific analysis of work activity and more on the development work activity. This has also led to observations and theorising on the short-term development of activity and to the transfer (sometimes with modifications) of methods of work analysis to the engineering of training systems.

II.4. Analysis of training as interactive/collective work and iterative design

This orientation is based on two pieces of evidence: to train is work and training situations are in many cases moments of collective activity between trainers and trainees (Horcik & Durand, 2011). The first point suggests the interest of analysing the work of trainers who design, put into place and bring training environments to life; the second suggests the interest of analysing the collective articulation of trainers' and trainees' activities (Chaliès, Ria, Bertone, Trohel, & Durand, 2004).

This type of activity analysis has opened up many perspectives, especially the following three: (a) it documents an approach focused on the work of trainers and based on the analysis of trainees' activity in order to improve work situations, (b) it encourages an analysis and design approach centred on trainers' real work, as for example in situations of supervisory visits in teacher training, and (c) it leads to propositions about trainers' work didactics when the focus is on regularities in the interactivity of trainers and trainees and the conditions for the emergence of efficient interaction – that is, promising learning.

This mode of activity analysis is sometimes useful for putting into place a procedure based on relatively short iterative loops to make training work more effective, better organised, and more aligned with the stated objectives. This has much in common with the iterative design process developed in ergonomics (Pinsky, 1992). The analysis has been used to identify potential points for discussion or improvement, to model learning and the support for learning, and to nurture an innovative practice of co-design (bringing together analysts and trainers). This led to the emergence of new forms of cooperative inquiry involving researchers and practitioners, which are currently being tested in several domains (e.g., in the Radiotherapy Department of the University Hospitals of Geneva). The notion of cooperative inquiry puts the emphasis on (a) the uses of specific investigation methods that involve an active contribution from actors, (b) the introduction of new forms of partnership and structuring research as a pragmatic and pragmatist inquiry implementing a process of inter-objectification (Zacks, 2004) to facilitate the shift from 'of value to the collective' to 'objectively valued by the collective', and (c) a scientific approach not based on the distinction between facts and values (Putnam, 2002) and refusing the division between sciences and social practices.

These inquiries are not intended to be objective or neutral. They are not strictly speaking research methods, but are the collective practices of actors with expectations and questions rather than hypotheses that they share at least partially and for whom a trusting relationship is one of the guarantees of the validity of the knowledge that is produced (Poizat & Durand, 2015). These collective practices are praxeological and transformative: it is hoped that they offer each actor an opportunity to progress because they trigger transformations in activity, encourage the imagination and design of new and complementary training schemes, exploit the materials they produce for training, fuel the modelling of practices, and finally are resources for the development of practitioners and for setting the organisation in

movement. These inquiries require joint working groups of researchers and professionals and the introduction of iterative design loops (e.g., Poizat, Bailly, Seferdjeli, & Goudeaux, 2015). A peculiarity of these collaborations is that major transformations in situations, activities and/or actors are often expected, and yet these last are simultaneously the object of the research – this being especially the case in the training field. Inquiries ultimately lead to the co-conception of environments that are propitious for these transformations by fostering innovative projects and programmes and more fundamentally contributing to actors' greater control over their activity.

III. DISPOSITIONAL THOUGHT AND THE TYPIFICATION OF ACTIVITY

The dispositional perspective mentioned earlier in this article refers to the observation that what interests the trainer is less the activity than the transformations in it. Also, the multiplication of transformations that spontaneously accompanies work performance is of greater interest than the improvement in the work and its conditions. As noted in Part 2, it is both conceptually and practically important not to separate the productive and constructive components of work activity, although they are often presented as distinct. Moreover, separating the exclusively processual approaches to work from the dispositional approaches seems to overlook the central conceptual core of training (and also possibly of ergonomics improvement), which is the articulation of rapidly unfolding activity, current or present, and its insertion in long and slow processes. This articulation has often been dealt with in training by dissociating processes from aptitudes-capacities-competences, which are conceived of as relatively timeless, stable dispositions.

We insist here on three points: (a) it is difficult (and perhaps impossible) for trainers not to use dispositional thoughts, (b) there is a risk of aporia in reifying dispositional constructs, and (c) conceptualising the articulation in terms of typicalisation is a way of overriding this aporia.

III.1. Dispositions and typicalisations: between transformation and permanence of activity

Research in training has from the start been confronted with the problems of permanence and change, regularity and rupture. Many studies have underlined the tendency of activities to show resemblances across a range of environments and to reproduce them if similar conditions are present. This has been interpreted as acquisitions being transferred to new environments and as signs of real but limited plasticity (between specificity and universality).

Some of the studies focus on the power to act and investigate transformations in activities over large timescales, based on the hypothesis that dispositions are implicit in situated accomplishments (Durand, 2013;

Muller & Plazaola Giger, 2014; Theureau, 2000). The resemblances and regularities that are observable in activity are interpreted as the expression of underlying dimensions: dispositions. Human activity is conceptualised as being organised into zones with a flexible articulation between local and global levels and as both specific and generic. These dispositions are both plastic and stable. Their plasticity offers the possibility of adaptive gains, whereas their stability renders actions and events predictable, expected, fixed and immutable (Durand, 2013). As an illustration, Ria (2009) identified and modelled three dispositions to act in teachers just entering the profession: the sidelining of academic knowledge, the re-appropriation of academic knowledge for purposes of personal economy, and the ongoing legitimation of academic knowledge. These typical dispositions of beginning teachers were deployed according to very singular timescales.

The notion of hypothetical dispositions makes it possible to conceptualise the simultaneous presence of change and permanence in the course of activity. Work performance can be thought of as the actualisation of possibles, reflecting the 'possession' or 'presence' of dispositions, indicating the possibility of acting in certain ways and also the propensity to act in these ways. Dispositions are both incentive-oriented and conservative, and they foster a dynamic opening to possibles. This opening is neither infinite (not everything is possible) nor indefinite (it is limited by culture, the actor's history of past activity, the environment, and the current task), and thus at any moment only a limited and fluctuating set of possibles is actualisable. In sum, the concept of disposition condenses and articulates the already-there the emergent, the potentiality and the actuality, the conservation and the invention.

III.2. Types and typification: consensus and modalities

Dispositions express the process of emerging types (Rosch, 1978; Schütz, 1962; Theureau, 2006), which allows generalising to and from an activity at time *t* and the past experiences of the actor. The constitution of types involves identifying resemblances in the environment and grouping the objects showing resemblances according to their degrees of resemblance – that is, their 'distance' from typical examples. In Europe, to take a classical example, people often see sparrows and much more rarely hummingbirds or ostriches, and sparrows have thus become typical of a family of animals having the same air. Other animals are evaluated in terms of their distance from this type, which is taken as the best representative of the family: a blue tit is less distant than an ostrich or a hummingbird. Types help us to understand events and actions based on their family air and to make judgements of proximity/distance between one thing and another.

In addition to concrete objects and a cognitive register of knowledge and interpretations, typicalisation also relates to actions and event-types, feeling-types and sensation-types (Theureau, 2006). Actors isolate along their activity *continuum* those occurrences, once typicalised, that become 'exemplary examples'. The construction of knowledge for and in action does not involve the abstraction of logical properties but it involves the

constitution of types in relation to the effectiveness of actions: the setting up of a typical case, the constitution of relationships between types and interpretive principles, and the strengthening or weakening of the types previously created (e.g., Sève & Leblanc, 2003).

The actor signifies his unfolding activity by measuring it against a typicalised activity and by creating a personal culture that can be mobilised at time *t*. What has been 'typicalised' therefore has a propensity to be actualised if the feeling of familiarity is sufficient, or it may serve as an anchor for future activity: associated with an experience of efficiency and serenity, it fulfils its function as an attractor and concentrates future activity by strengthening the probability of reproduction and redundancy in the activity.

IV. TRANSFORMATIONS OF ACTIVITY OR THE APPROPRIATION-INDIVIDUATION COUPLING

The interest in analysing transformations in activity has been matched by an effort to expand the usual definitions of learning and development. The concept of learning is usually associated with a predefined task to which the actor has to adapt; the notion of development is often linked with a previously defined 'subject' (without regard to his or her situations). From the enactive perspective, transformations are inherent to the self-organising dynamics of activity, which means that the articulation of here-and-now performance and its inclusion in a broader constructive dynamic is precisely what must be taken into account. We now present the concepts of appropriation and individuation, which are key to this articulation.

Appropriation is the set of all transformations in activity through which the activity takes on newly significant elements for the actor (Theureau, 2011). At the phenomenal level, abstract and concrete objects change status in the practice of work or training. Depending on the circumstances, they may be (a) objects in the environment, not significant for the actor but meaningful to the observer who describes them, (b) objects that are distinct from the rest of the actor's environment by the meaning assigned to them, (c) objects that disappear from the actor's field of experience through a process of incorporation into his or her own body, or (d) permanent components – or likely to become so – that define the actor's being situated (e.g., a mode of engagement like 'being a surgeon' or 'being a patient' entering a hospital). Appropriation is thus a process of incorporating something into one's own world, one's own body, or one's own culture – that is, appropriation is the process of construction by which something will then be able to be actualised in future occurrences presenting a family resemblance with the current coupling (Poizat, 2014; Poizat, Haradji, & Adé, 2013; Theureau, 2011). These three dimensions of appropriation – incorporation into the actor's own world, own body and own culture – define the poles and not the categories radically separating the phenomena involved.

Incorporating an object into 'one's own world' (Merleau-Ponty, 1945/1962) implies allocating meaning to the object. Although merely an irrelevant component in the actor's environment up to this instant, the object instantly becomes meaningful and constitutive of the actor's own world – that is, a distinguished, identified and disruptive element (his activity has been transformed by this distinction and identification). Now a part of the actor's own world, it becomes an 'object for this actor there' at that instant. This appropriation is not stable: depending on the actor's engagement and circumstances, the object may or may not be incorporated; in other words, the object 'is – or is not – experience' for the actor.

Incorporating an object into 'one's own body' is a kind of *glissement* or slipping from the actor's own world to his own body. This transformation does not have a stable character either. Depending on the state of the actor-environment coupling, objects may or may not be incorporated into the body, whose geometry and boundaries are ever-changing. This in-corporation refers to the experiential transformations related to objects, including abstract and symbolic objects, as they become transparent for the actor. Transparency signifies that appropriation has modified their availability for the actor. These objects thus become elements that contribute to the actor's activity – that is, contribute to the actor's world and to the appropriation of other objects, whether concrete or abstract.

Last, taking an object into one's own culture, or in-culturation, is the transformation of symbolic elements into the constituents of the actor's culture for action. These constituents are also appropriated by other members of the collective and in this sense 'one's own culture' indicates (a) a culture shared by the collective, which is itself defined by a common practice and the shared culture, and (b) each member' own legacy. This collectively owned culture inherits past activities and specifies possible futures. This generalised movement characterises an instrumental function of human activity: once incorporated into the actor's own culture, abstract objects and their physical supports serve as tools for addressing real situations, specifying them, signifying them and defining them. They function as instruments for making meaning in one's own world and as means for appropriating new objects (Poizat, 2014; Poizat et al., 2013).

The appropriation process is accompanied by transformations in activity and/or transformations in the actor himself. A particularly interesting way to think about this development while remaining faithful to the enactive assumptions was proposed by Simondon (2005). This author conceives the subject – or the collective – not as a substance already there, insensitive to the environment and defined by an evolving fate, but as an unfolding process of constant contact with the environment and bearing indeterminate potentials. Thus, instead of the individual being the point of departure for individuation, this author begins with individuation and seeks to discover the individual through the process.

For Simondon (2005), individuation refers to the general dynamics of all dynamic systems, whether physical, biological, or psychological and social. The individual is a bounded and ephemeral state, with fleeting phases of stability within a constant process of transformation. These phases of being correspond to successive individuations and define diversions and

deviations, and not determined trajectories. The individuating transformations reflect the reopening of possibles in a new metastable state and not a return to the past. They are not informed by the exterior: they result from processes of equilibration and contagion by the contiguity of local micro-events that disrupted the system's previous state of individuation. The possibility of transformation means that this system is 'more than itself', since it is a transformative potential, actualisable in subsequent states. It is metastable rather than stable. Therefore, living beings are simultaneously *becoming* because of the constant transformation that characterises them, and have *becoming* in *reserve* in the sense that they are incomplete and filled with potentials waiting to be actualised: what Simondon calls the preindividual.

The individuation of the individual (or psychic individuation, according to Simondon) cannot be separated from the individuation of the collective – that is, from the self-construction of a collective of actors. Simondon (2005) thus put forth the idea that collective individuation is secondary to psychic individuation, which is itself secondary to vital individuation. In the course of individual individuation, activity systematically turns towards 'the collective', which is a resource and a constraint for individual individuation. At the same time, the individuation of the collective is itself initiated with reciprocity between the two individuation modes, as one mode produces the other and both are two extremes of a single constituting relationship. Activity is thus always both individual-social and social-individual. Moreover, human individuation (individual and collective) is intimately linked to technics and the ongoing relationship with technics. Technical objects are the 'support and the symbol' of what Simondon called the *transindividual* (Simondon, 1989, p. 247). This last point leads us to take into account the anthropologically constitutive and constituent power of technics (Steiner, 2010).

To summarise, the notion of individuation is inseparable from that of appropriation and, as such, is useful for studying human development. The introduction of this notion into the fields of education and training research has brought about a substantial change: the idea of an already constituted individual, the subject who exists before he acts and merely refines his identity, has been abandoned, to be replaced by the vision of human existence as a process of self-constitution from which a being emerges who is momentarily considered an actor (or an acting subject). The appropriation/individuation coupling thus provides a generalised genetic interpretation of transformation in the relationships between humans and their environment (Durand et al., 2015).

V. CHALLENGES FOR ACTIVITY ANALYSIS FOR TRAINING OBJECTIVES

This last section describes some of the challenges for research within this theoretical frame. The purpose is not to provide solutions, but to propose theoretical, methodological and technological directions that may

be fruitful. In this section, we deal successively with the importance of (a) broadening the time horizon and articulating different timescales, (b) taking into account culture(s) and the articulation of lower and higher levels of activity in the analysis of culture, and (c) developing an anthropotechnological approach in education that opens to the design of broad and complex technical, organisational, cultural and historical systems, within which training is only an aspect.

V.1. Expanding the time horizon and analysing activity at various timescales

One of the first challenges in this type of research is to extend the time horizon sufficiently in order to systematise the investigation of appropriation/individuation dynamics, focus on activity organisation over long timescales, and reflect a real perspective on training as a lifelong process. To this end, this research stream has adopted as the theoretical object the 'life course related to a practice' or – to avoid the static connotations of the word 'practice' – the 'life course related to a project' (Theureau, 2006, 2015). This object was first introduced into ergonomics to study practices that unfold over time concomitantly with other practices; examples include vineyard work, the control of home energy, or on-the-job training (e.g., Haué, 2004; Jourdan, 1990; Vion, 1993). The definition of this theoretical object suggests the hypothesis of coherence related to episodes of performing the practice or project over time despite their temporal discontinuity and the interruption by episodes related to other practices or projects.

The study of the 'life course related to a practice (or project)' poses methodological problems. The traditional methods by which actors express their experience, such as the self-confrontation interview, can only be used for part of the activity. Various solutions have been proposed to resolve this problem. The first is to analyse the activity from the data yielded by these methods at different time points in the actor's life course and then put these data into relationship and/or to conduct extensive interviews covering the important time periods (Haué, 2004; Hauw, 2013; Jourdan, 1990; Vion, 1993). A specific method, coming from the former biographical interview, has also been recently developed for documenting long and discontinuous periods of activity when observing behaviour is impossible: re-situating and re-enacting through material traces. As an illustration, Donin and Theureau (2007) accessed the activity of creating a musical work over several months by re-constructing with the composer the genesis of the composition. Multiple traces of the activity and artefacts (drafts, sketches, computer files, plans, written notes, reports, photos, publications, an additional log, additional notes of dates when certain additions were made to certain drafts, etc.) were used to support the composer's re-immersion in the situation. Thus, these traces replaced the usual observation and recording of behavior as a basis for the composer's expression about his meaningful activity.

For the most part, the empirical studies that used the theoretical object of the 'life course related to a practice (or project)' have not been conducted with a training objective. Accounting for the development of activity

in multiple temporalities and its transformations are additional constraints to research, especially since transformations by nature are far from easily observable (Jullien, 2009). Yet a key distinction is between transformations that are adjustments to successive environments or the effects of activity dynamics and those that are constituent and constitutive, reflecting appropriations and individuations. In order to make this distinction, indices of permanence or stabilities are needed. These might include: (a) within a corpus built up without preselection, the constitution of stable markers or possibilities for comparing phenomena in successive work episodes judged by the actors as similar; (b) the reconstitution of typical geneses (i.e. beyond individual characteristics) from episodes explored by several actors who have been involved in situations judged *a posteriori* as similar and typical (Durand, 2013); and (c) the reconstitution of these typical geneses from work episodes explored because they have been identified in advance as shared, typical and critical (Ria, 2009). This research is longitudinal and relies on several types of interview to prompt the expression of experience (self-confrontation, re-enactment through material traces of the activity, biographical interview etc.), notably: (a) with variable delays between the acquisition of experiential traces and the interview, (b) with several successive interviews on the same traces of activity, and (c) with interviews dealing with the *ad hoc* traces of activity occurrences distributed over time, prompting actors to make comparisons and express permanences and differences.

Moreover, in addition to extending the time horizon for these studies, there is the issue of articulating the different timescales. The studies on activity transformation have generally adopted single and exclusive timescales, choosing more or less longer timescales linked to the study duration. But activity behaves as a dynamic system that is organised and transformed according to multiple and interlaced temporalities, resulting in multiple levels of organisation and singular and/or shared meaning (Durand, Saury, & Sève, 2006; Lemke, 2000). Also, we assume that the study of activity transformation, particularly its collective dimension, needs to be conducted with 'multi-centred' temporalities in order to apprehend experience in a variety of durations, all of them coherent and articulated. This means combining different timescales within the same study and following the articulation of individual activities up to their emergence as collective activities (e.g., Veyrunes, Gal-Petitfaux, & Durand, 2009).

Methodologically, two orientations are available today: (a) the analysis of the material or symbolic object that establishes a link between two or more time scales (Lemke, 2000), and (b) the analysis of the collective articulation of 'life courses related to a practice (or project)'.

For Lemke (2000), technics, everyday objects, the meanings conveyed by language, and artefacts of all kinds (material and/or symbolic) are liaisons between spatial, temporal and organisational levels. They are *traversals* – that is, products and receptacles of history and offers for activity, whose meaning is deposited and potentially actualised at any instant. Studying activity at different timescales by analysing *traversals* reveals phenomena that are sometimes overlooked. As an illustration, work analyses that emphasise immediacy and insist on the utilitarian character of work sometimes miss activity sequences that seem incoherent when considered over

short timescales, but these sequences gain in a coherence characterised by anti-utilitarianism and barely explicit cycles of inter-individual relationship when studied over long timescales (Imbert & Durand, 2014).

The second methodological orientation, the analysis of the collective articulation of 'life courses related to a practice (or project)', has been productively followed in studies dealing with (a) the collective construction of a choreographic work and the collective learning in a student collective during a physical education class (Crance, Trohel, & Saury, 2014), and (b) the collective activity in the joint conception of an artwork and the development of a computer program for an augmented string quartet (Donin, Goldszmidt, & Theureau, 2009). Questions about training as it relates to collectives are many and have yet to be fully explored at this point: How can an actor's engagement in collective histories be encouraged? How can cooperation and coordination be fostered in transversal groups or projects? How should the development of dispositions to act be supported? How can the simultaneous transformations at individual, inter-individual and collective levels be supported without them becoming confused? Should we think in terms of spaces for encouraged actions and interactions?

V.2. Culture(s) and the articulation of higher and lower levels of activity analysis

Many questions about training are today formulated in terms of the construction, transmission, sharing, acquisition and transformation of individual or collective culture in organisations that are more or less structured (Poizat & Durand, 2014, 2015). We address these issues with the assumption that a change in the cultural, material or organisational conditions of activity can be used to leverage the desired transformations in the activity. Empirical research is needed to document this change while also meeting another challenge: that of articulating the 'lower' levels (i.e. those dealt with up to this point in the article) and 'higher' levels (i.e. those we will now consider) in human activity analysis (e.g., Cicourel, 1981).

Cultural dynamics operate at various levels of integration, from very broad and collective to the most restrained, limited to individuals or small groups. Analysis thus requires detecting diverse manifestations at multiple system levels. In the course of action programme, we hypothesise a 'individual/social' continuum, which allows us to detect manifestations of cultural components in individual and collective activities at different levels.

Two notions of culture are defined within this framework: the actor's own culture (or the actor's more or less organised symbolic knowledge), and culture as an aspect of the actor's environment (i.e. culture as it is generally dealt with in historical, ethnographic or sociological research). Both are defined as being composed of types, relationships between types, and principles for knowledge creation – and the same holds for symbolic expression – and are considered to be situated but partially transferable to other situations because of typicalities. One's own culture is the part of knowledge the actor possesses, and at a given moment the actor makes a selection linked with his past course of action. One's own culture is made

up of all kinds of symbolic markers like language, formalism, gestures and symbolic icons. Certain symbolic markers are shared, but many are unique to the individual, although potentially sharable. There is always a certain amount of divergence between the actor's own culture and other cultures (in the broad sense), these other cultures being sets of more or less organised symbolic knowledge shared by the different communities in which the actor participates.

We detail here the notion of the actor's own culture and the notion of culture as part of the actor's or group of actors' situation in order to point out that, in multilevel research into human activity, the latter notion of culture is the focus of research on 'higher levels' of human activity, which in turn emerges and participates in the environment of 'lower level' human activities, where the first notion of culture is the research focus. Moreover, in the higher levels, it is sometimes useful to differentiate the local culture – that is, shared by a restricted community for a limited time period – from the global culture – that is, shared by a wide community for rather long periods (Geertz, 1983).

To study cultural dynamics, it is important to deal with the theoretical objects conceived for the 'lower levels' (courses of action, 'life courses related to a practice (or project)' and their collective articulation) and their observatory by judiciously drawing on sociological, ethnographic, cultural and historical research. The theoretical objects for the 'lower levels' put aside the separations between the different branches of psychology, microsociology (including ethnomethodology), cognitive ethnography and micro-history, and instead focus on human activity as enaction, experience and semiosis. Many streams of sociological, ethnographic, cultural and historical research have developed around the notion of action (functionalist sociology, history) and the constructs of collective action (the sociology of organisations) or practice (cultural sociology, ethnography, history), and these can be recast in terms of human activity as enaction, experience and semiosis. The researchers in these same fields are increasingly stepping outside of their disciplinary boundaries at the level of individual studies. We can make use of these boundary crossings to conceive of theoretical objects for the 'higher levels' of human activity – like enaction, experience and semiosis, and their corresponding observatories – that put aside the separations between these disciplines. An additional challenge will be to articulate these two types of theoretical objects and observatories. Vaughan's study (1996) on the Challenger disaster is a source of inspiration, but the challenge now is to articulate and not just juxtapose the lower levels (I) and the higher levels (II) of activity. The concept of the 'star ⋆ statement' between levels, defined by Varela (1979) as an oriented relationship 'causing to emerge' or 'leading from' the lower level to the upper level, can be complemented by the inversely oriented relationship of 'conditioning', 'constraining' or 'contextualising' from the upper level to the lower level. Thus, multilevel empirical research on human activity has to focus on the 'star ⋆ statement' between lower level series (I) (courses of action, 'life courses related to a practice (or project)' and their collective articulations) and higher level series (II) (historical, artefactual, social, political and cultural processes). We are currently working in this direction in research that

articulates the analysis of activity and/or culture in the operating room with a team training objective and the analysis of transformations in operating room culture with a view to improving patient safety (Suva & Poizat, 2015). The aim of this research is to focus on the notion of culture as a key element, empirically document its features to give greater substance to the notion of a safety culture that has long been problematic, and devise training contents that truly target cultural changes.

Conducting research that articulates several levels of analysis of culture(s) requires, at least in the training field, that the normative components inherent to this culture be taken into account and that the generally accepted distinction between facts and values be called into question (Putnam, 2002). This essentially means measuring the studies in vocational training against an educational ideal and, in our opinion, bringing back into use the Hellenic concept of *paideia* (Jaeger, 1939-1945). This concept is interesting for our research purposes especially because it inspires (a) the conscious and deliberate pursuit of an ideal, namely that of actualising a set of values and creating new ones, (b) the association of education and culture, as broadly defined, taking care not to separate technics from culture and giving great importance to the objective and practice of lifelong learning, (c) movement towards an intergenerational cultural co-construction based on a broad sense of transmission, irreducible to an isolated process of conservative transfer controlled by a single transmitter, and (d) the operationalisation of the concept of humans as actors/inventors/heirs/transmitters, at once cultivated, autonomous, unfinished, irreducible to tasks and roles, reasonable and passionate, but not divided by these passions.

V.3. Towards an anthropo-technology in education

One of the developments today in research on human activity, in vocational training as in ergonomics, is the extension of the spatial-organisational-cultural-temporal horizon as it relates to increasingly large and complex design issues and the need for intelligibility in complex work and training systems (i.e. research on teamwork training and developing a safety culture in the operating room, research on training radiology technicians at the workplace and in school). These recent studies have been cooperative investigations with a training objective and in partnership with professionals, systematically seeking to ensure (a) the sustainability of activity transformations triggered at the workplace and/or in training; (b) the expansion, transmission, and democratisation of innovation as the object and objective of these investigations; and (c) the transfer of training systems to other fields or communities (e.g., transfer of Crew Resource Management training to surgery). The transformations encouraged in activity systems are conceptualised as bearing the potential for dynamics that may become self-perpetuating. They open up a field of research and practices that is still largely unexplored, between the design of work environments and learning organisations, and the design of training methods and contexts that cover all the hybrid forms of relationship between work and training.

These joint investigations, combined with multilevel activity analysis and the assumptions that guide our research, have led us to make a number of hypotheses about an 'anthropo-technological' perspective in education. The objective is interdisciplinary empirical studies on human activity in organic relationship with the engineering of large and complex technical, organisational, cultural and historical systems. Through the concept of anthropo-technology, we propose to generalise Wisner's (1995) seminal work on technology transfer and Geslin's (2005) extension as the technological part of what is usually grouped under the term of the 'anthropology of techniques'.

Adopting such an anthropo-technological perspective in education seems heuristic provided that researchers (a) capitalise on the contributions of cultural, historical and educational anthropology, as well as the anthropology of technology, and do not limit themselves to marginal and peripheral contributions from these disciplines, (b) propose high acceptance of the concept of 'technology' (Pinsky, 1992) and (c) elaborate their thinking on technics and technological beings. This involves in particular (a) thinking not in terms of applications but of the organic relationships between scientific/academic research and engineering, organisational, cultural and training design, (b) providing explicit foundations for training design and practices, and (c) maintaining organic relationships between empirical research and the design of training environments.

This anthropo-technological perspective makes it possible to simultaneously think about (a) the multilevel analysis of human activity, (b) the implementation of technological research programmes, and (c) the design of large and complex training situations that take into account issues of sustainability, democratisation and the transfer of technical and organisational innovations.

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