Sophie Le Bellu, Saadi Lahlou, Valery Nosulenko & Elena Samoylenko

Studying manual work activity: a framework for analysis and training

Article (Accepted version) (Refereed)

Special Issue "Analyzing activity, what constants and what renewals *?*"

STUDYING MANUAL WORK ACTIVITY: A FRAMEWORK FOR ANALYSIS AND TRAINING

PAR SOPHIE LE BELLU[1], SAADI LAHLOU[2],
VALERY NOSULENKO[3] & ELENA SAMOYLENKO[4]

SUMMARY

This paper presents the methodological framework that we developed for collecting, studying and passing on tacit and explicit know-how embodied in professional gestures of expert workers. This framework is based upon the combination of an adaptation of a range of psychological theories and techniques: Activity Theory, the 'perceived quality' approach, subjective evidence-based ethnography, and verbal protocols. The application of the method, primarily based on the perspective of the expert, enables the building of a cognitive model of the professional gesture to be transmitted, by highlighting its key points. It leads to designing multimedia training products called MAP (Multimedia Platform for Apprenticeship) intended to "represent" and convey knowledge involved in the real-time performance of the expert's gesture. The methodology was developed and applied to manual operators, in actual work and training settings of the biggest power French company. The practical aim of the study was to address an organizational issue of knowledge management, for professional training purposes, in order to bridge the gap of learning by mentoring between retiring experts and novices. The method has been recently industrialised by the company in which the research occurred and could be applied to many other cases and contexts.

KEYWORDS : Professional Gesture, Video, Subjective Evidence-Based Ethnography, Verbalization, Activity Theory, Training.

[1]LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE – S.le-bellu@lse.ac.uk
[2]LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE – S.lahlou@lse.ac.uk
[3]INSTITUTE OF PSYCHOLOGY, RUSSIAN ACADEMY OF SCIENCES – Valery.nosulenko@gmail.com
[4]INSTITUTE OF PSYCHOLOGY, RUSSIAN ACADEMY OF SCIENCES – Elena.samoylenko@gmail.com

Special Issue "Analyzing activity, what constants and what renewals *?*"

STUDYING MANUAL WORK ACTIVITY: A FRAMEWORK FOR ANALYSIS AND TRAINING

PAR SOPHIE LE BELLU[1], SAADI LAHLOU[2],
VALERY NOSULENKO[3] & ELENA SAMOYLENKO[4]

RÉSUMÉ EN FRANÇAIS : Cet article présente une méthode d'étude des savoir-faire incorporés dans les activités de travail manuel, à des fins de transmission pédagogique en situation de formation professionnelle. Cette méthode s'adresse donc à une catégorie spécifique d'activité humaine, celle des gestes professionnels. Son développement est le fruit d'une recherche empirique menée au sein d'un grand groupe énergétique français, pour sa branche formation, afin de répondre au double besoin généré par le contexte organisationnel de renouvellement intergénérationnel ; à savoir, capitaliser les connaissances rares et critiques des experts, et être en capacité de les transmettre aux nouveaux arrivants par le biais de solutions de formation numériques innovantes. Le cadre d'analyse se veut avant tout centré sur la perspective de l'expert. Il propose une chaîne opérationnelle assurant le recueil, l'analyse, la formalisation et la transmission effective du savoir-faire tacite et/ou explicite sous-jacent à la réalisation d'un geste professionnel. S'appuyant sur les récents développements de l'ethnographie numérique subjective, le protocole de recueil imbrique des observations vidéo situées de l'activité, en première et troisième personne, avec plusieurs protocoles de verbalisations, dont un simultané à la réalisation du geste et orienté-but. La mise en lien des données « objectives » (observations vidéo) et « subjectives » (ce que l'expert pense et dit) est assurée sur la base : des cadres d'analyse proposés par les théories de l'activité, afin de structurer l'activité ; et d'une approche dite de « qualité perçue ». Cette dernière vise à dégager les dimensions naturelles issues de la perception des affordances du contexte par les participants dont on étudie l'activité. L'application de cette méthode globale permet à l'analyste de construire un modèle cognitif du geste à transmettre. Ce dernier, assorti du matériel vidéo et verbal recueilli, sert de structure de base à la réalisation d'un support didactique véhiculant l'expérience réelle de l'expert.

MOTS-CLES : Geste Professionnel, Vidéo, Ethnographie subjective, Verbalisation, Théorie de l'activité, Formation.

[1]LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE – S.le-bellu@lse.ac.uk
[2]LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE – S.lahlou@lse.ac.uk
[3]INSTITUTE OF PSYCHOLOGY, RUSSIAN ACADEMY OF SCIENCES – Valery.nosulenko@gmail.com
[4]INSTITUTE OF PSYCHOLOGY, RUSSIAN ACADEMY OF SCIENCES – Elena.samoylenko@gmail.com

I INTRODUCTION

In industry, manual workers develop know-how embodied in so-called "professional gestures": segments of work activity calling for expert skills and guided by motives and goals. This notion of professional gesture refers then to the idea of expertise acquired and internalized over time. The performance of expert operators is based upon attentional, cognitive and physical processes. It is convenient to distinguish such segments in order to establish collection protocols for analyzing this class of activity requiring skills "embodied in action, difficult to verbalize, much related to the context" (Leplat, 1995:101). Indeed, accessing and externalizing both tacit (Nonaka & Takeuchi, 1995; Polanyi, 1967) and explicit know-how built and shaped over years by experts within the framework of their professional practices is our primary goal, from the perspective of structuring this expertise into a suitable educational format for transmission purposes.

This paper introduces the theoretical and methodological frameworks which we have developed for the collection, analysis, and transmission of professional gestures, for novices' training and professionalization purposes, as an answer to a real organizational issue of intense intergenerational renewal in industry. The task was two-fold: to provide a solution to an organizational and societal problem of knowledge management, and to answer the needs of professional trainers for efficient up-to-date training devices and tools, based on new media, such as video. The design of this method constitutes the result of an extensive three-year empirical research project, which enabled the collection of a sample of fifteen cases of professional gestures performed by highly skilled power plant operators, either in a real work situation (power plants), or in a re-created setting (training centre). This research was carried out in the French energy industry according to the principles of the ergonomic constructivist approach (Falzon, 2005) and the experimental reality paradigm (Lahlou, Nosulenko, & Samoylenko, 2012) aiming, respectively, to develop the usage through the design process, and to design a methodology through loops of testing and refining within real work situations and environments.

Section 2 describes the methodological issue of knowledge transmission. Section 3 presents the theoretical and methodological background that we have used and adapted to our specific research needs. Section 4 presents an overview of the method we designed, and is illustrated by an example of practical application. As this method is the fruit of collaboration between French and Russian scientists, we attempt to give an international dimension to this article, by addressing the issue, at least from a double perspective, according to Russian and European references.

II STUDYING MANUAL KNOW-HOW FOR TRANSMISSION PURPOSES: A METHODOLOGICAL ISSUE FOR PRACTITIONERS.

II.1 THE ISSUE

The analysis of gestures in work situations, which has been the object of a recent literature review by (Leplat, 2013), is an important object of study in the French ergonomics and work psychology literature

Chassaing (2006) has contributed to the definition and the comprehension of professional gestures by developing a hierarchical model that describes the organization and the structure of the gestures learned on the job in the automotive sector. This work has enabled the establishment of a clear distinction between the concepts of movement and gesture. Especially, she has provided a characterization of professional gestures into four groups: (1) the gesture is mixed, as it "requires a sensory, cognitive and motor activity"; (2) the gesture is invested as it is "intentional and oriented toward different purposes: to the system, to one-self and to others"; (3) the gesture is situated; and (4) the gesture is built, as it is "the product of a history, a past and is continuously developing".

Gesture involves several dimensions: psychological, organizational, economic, biomechanical and cognitive (Bourgeois & Hubault, 2005). The study of musculoskeletal disorders, because they are often caused by repeated gestures, has led to detailed study of the cinematics and motoric aspects of gestures (Vézina, Prévost, Lajoie, & Beauchamp, 1999).

In the aviation sector, Aubert (2000) sought to understand what makes the specificity of skills linked to the gestures of aviation painters by analysing work situations, for a better understanding and recognition of this profession within an industrial process of reorganization.

In the food industry, observation of meat boners for vocational training (Ouellet, 2012) showed how the choice of variants of a gesture is linked to the nature of equipment as well as to training; for example, the quality of the tool, or variants in the material (here, whether it is a left or a right back quarter that is to be deboned). Authier, Lortie, & Gagnon (1996) described a similar variability in the work of expert handlers; how they adapted their posture to the size, weight, or placing of the objects handled. These authors insist that expertise involves this capacity of adapting an activity to context, and therefore have insisted also on the necessity to examine gesture as integrated in activity, as opposed to conducting limited musculoskeletal analyses.

Clot and Leplat's (2005) clinic of activity uses the crossed self-confrontation method as a conceptual tool for studying the development of professional gestures, and individual and collective practices through reflexivity. This method has been applied to various cases of professional gestures, such as, amongst others, the gesture of braking a train (Fernandez, 2001), the gestures of grave diggers (Simonet, Caroly, &

Clot, 2011), mainly for the prevention of musculoskeletal disorders . Those authors have observed the difficulty in accessing, analysing and transmitting the knowledge underlying such professionalized gestures. Thus, the multi-dimensional character – situated (Suchman, 1987), distributed (Brassac, 2008; Hutchins, 1995) and embodied (Varela, Thompson, & Rosch, 1991) – of the knowledge required for completing professional activity would appear to require no further demonstration. The exact nature of the experience is at the core of the issue as it is individual, unique and shaped by each individual over time and it depends on the people and situations met and experienced. It is this subjectivity, specific to each person, which renders the task of passing on professional experience so hard. Furthermore, such experience is also considered to be almost ineffable and, because of this strong tacit dimension, not easily transferable (Artemieva, 1980; Kornilov, 2014). Nevertheless, even if experience cannot be literally transmitted, it can be shared to some extent. That is why the tradition of socialisation practice (Nonaka & Takeuchi, 1995), such as professional mentoring (Castéra, 2008; Schön, 1983), is an option frequently used by the manual work sector to enable face-to-face intellectual, social, and experiential sharing between experts and novices, directly in the workplace. Unfortunately, the kind of training setting that enables long-term "covering" is increasingly less viable due to increasing time pressures and the mass retirement of experts. This demographical transition requires replacing the experts involved in the first industrial development, who started their careers in the 1960s and 1970s. The challenge for organisations is two-fold: firstly, to safeguard the intangible cultural heritage present in the minds of its experts, and, secondly, passing this knowledge on to newcomers. Thus, to search for and/or develop novel alternatives for addressing this double issue of knowledge management for professional mass-training purposes is an urgent requirement.

II.2 VERBALIZATION OF WORK ACTIVITY

Analyzing the possibilities of creating or developing training systems for the transfer of professional knowledge, Shadrikov (1974) identifies three categories of objects' features: those ones that can be verbalized, those ones that can be represented in the form of visual images, and the so-called sensory features that are difficult to verbalize or represent graphically. According to Kornilov (2014), in the case of the transfer of professional experience, a practical problem manifests itself in its different types that are more or less transferable into speech: tacit knowledge, individualized knowledge (which contains not only the features of the object but the peculiarities of actions performed on it by a certain professional), unconscious stereotyped knowledge related to skills, heuristics, evaluation strategies, knowledge related to specific context, and so on. Kornilov (2014) showed that the problems taking place in professional interaction are determined in some cases by the presence of individualized knowledge, knowledge that, while being named with a single word or phrase, has different meanings for different workers.

In Europe, as in Russia, a range of techniques of verbalization has been developed. They can be used to facilitate the verbal transfer of subjective experience at different moments of the action, and according to different types of instructions and settings. Among them, thinking-aloud protocol (Ericsson & Simon, 1980), or *post-hoc* verbalizations, of which self-confrontation interview (Theureau, 1992), crossed self-confrontation method (Clot, Faïta, Fernandez, & Scheller, 2001), "explicitation" interview (Vermersch, 1990), or subjective re-situ interview (Rix & Biache, 2004) are particularly well-known. The method of "instruction to one's double" (Oddone, Re, & Briante, 1981) is another technique that entails describing one's approach to work and instructing another operator as if he/she were a double. For further methods, the reader can refer to the book of Bisseret, Sebillotte, & Falzon (1999). Moreover, Garrigou, Carballeda, & Daniellou (1998) list commonalities in verbalizing know-how techniques:

- *"They avoid formulations involving explanation;*
- *They avoid rational and causal type questions, and therefore the use of 'why' which will require justifications from the subjects rather than descriptions of their actions;*
- *They use interview methods promoting description of the action process;*
- *They produce questions that promote the systematic description of the sensory modalities and their different components (sight, hearing, kinesthetic, olfactory and taste aspects).*"

In Russia, some other types of verbalization protocols have been developed , as, for example: firstly, giving instructions asking individuals to explain where and how objects can be used whilst prohibiting certain types of verbal description, for example, those which refer to the size, color or material of objects; secondly, giving a planning task for certain activity in a verbal form within a limited time; thirdly, the facilitation of the actualization of instrumental experience through presenting a list of functional features to be ranked, compared or classified and so on (Kornilov, 2014). The problem of the verbalization of knowledge met by professionals in their practical activity is also investigated through identifying personality traits related to the verbalization taking place in practical thinking, which is thinking related to action.

II.3 METHODOLOGICAL GAP

The psychological verbalization techniques cited above seek to investigate work activity but were not primarily developed for the practical issue of know-how transmission. They do not link the content of verbal data collected and the way to leverage it for the application above. In the field of knowledge management (Earl, 2001; Ermine, 2010; Nonaka & Takeuchi, 1995), methods have grown over the past twenty years, essentially focusing on providing tools and techniques for structuring and presenting knowledge, but the use of video as a media to convey expert knowledge remains a challenge. Some homemade videos are produced by trainers or field operators in industry in order to meet their needs for innovative teaching tools but they generally use a prescriptive approach that shows "what-must-be-done"

according to rules; this misses the variability of actual practices beyond the prescribed. Furthermore, novices also need to share, to feel and even "to live" the experience in order to be able to grasp fully an expert's cognition.

To sum up, the European literature proposes few practical methods enabling video-based collecting for transmission purposes in educational settings. The same assessment goes for the Russian literature. Knowledge transfer in the workplace is investigated in psychology in terms of the specific psychological peculiarities of practical thinking and the verbalization of its procedural characteristics, rather than in terms of an elaboration of a concrete methodology for studying professional gestures for educational transmission purposes.

On the basis of our empirical research within the main French energy producer, we argue that using real cases of gestures, collected, analyzed and transmitted through video from the direct point of view of the expert can provide an efficient alternative for both filling this methodological gap and answering the double need required by the organization. We present below a qualitative research method centered on the expert's perspective, which we have designed to render explicit the expert's tacit knowledge. Based on embodied (Varela et al., 1991), situated (Suchman, 1987), and distributed (Hutchins, 1995) cognition models, this method uses and combines principles of Activity Theory, Perceived Quality approach, visual ethnography, and verbalisation methods in order to analyze expert professional gestures for transmission purposes. The next section presents our main theoretical and methodological principles.

III THEORETICAL AND METHODOLOGICAL BACKGROUND

III.1 ACTIVITY THEORIES

In parallel to the French development of ergonomics centred on work activity (Leplat, & Cuny, 1974; Ombredanne & Faverge, 1955), activity theories, centred on the subject, appeared in the USSR in the early twentieth century.

Since then, many versions of activity theory have been developed worldwide (Bedny & Karwowski, 2004; Engeström, 2000; Nardi, 1996; Stetsenko, 2005; Von Cranach, 1982). Engeström's activity theory is particularly popular, having been developed to take into account organizational characteristics of the activity (such as the division of labour, tooling, and rules).

While theoretical work on Activity Theory is sophisticated, methodological approaches for its application in the study of work activity lag behind. Our own research leverages the psychological structure of the activity developed by the Russian stream of Activity Theory (Leontiev, 1978; Rubinstein, 1922, 1940) but

makes little use of its philosophical aspects linked to personality, conscience, or emotions.[5]

Activity Theory in its Russian tradition has been developed primarily by A.N. Leontiev (1978) and S.L. Rubinstein (1922, 1940), who elaborated two somewhat similar versions of the structure of human activity. Generally, Activity Theory aims to render explicit the relationships between the different components of an activity, namely: motives, goals, tasks, actions, and operations.

In Leontiev's version, *motives*, interpreted not as a kind of need's experiencing but as a material or ideal object of need, determine the whole activity, which is carried out by means of actions directed by conscious goals. The expected result of activity, which is the *goal*, defines the actions necessary to reach it. However, *actions* are ultimately determined by the motive of activity. Indeed one activity can be completed by means of different actions, and one action can be a component of different activities. *Operations* are concrete ways to realize an action and correspond to conditions of activity. Thus, in the Leontiev's theory, motives refer strictly to the whole activity, goals refer to actions and operations refer to concrete situations.

Rubinstein's conception of activity structure is similar to the one proposed by Leontiev in the sense that the same activity components are outlined. However, according to Rubinstein, there is no strict correspondence between the motive and activity or between the goal and action. Activity-related motives and goals, unlike action-related motives and goals, have usually an integral nature, express a subject's general orientation and, thus, are called initial motives and final goals. At different stages of activity, activity-related motives and goals generate different specific motives and goals, which characterize actions.

Both activity theories provide an efficient conceptual framework for investigating "human and environment" interactions, while Rubinstein's version is focused on the philosophical and theoretical developments of an activity linked to concepts of conscience, personality and the life of the subject.

In the context of analyzing and giving a psychological description of a practical work activity, the components being evaluated are: the motives that induce activity; the goals - conscious representations of future results to be reached; the subgoals - intermediate stages in reaching the goal; and the actions and operations carried out by a subject in order to reach the goals. To these should be added the tools used by the person or the organization to transform the external environment.

Some of the components, such as operations, can be observed and recorded while others, such as motives or goals, are invisible. These invisible components can be revealed and characterized only by means of techniques developed to analyze and evaluate subjective representations of individuals. The modes of investigation that we used to trace relationships between externally observable parameters of activity (movements) and their internal components (thoughts and so on) are presented below.

[5] Some of our theoretical choices have been guided by the wish to design a practical method that could be applied by practitioners other than only researchers.

III.2 SUBJECTIVE EVIDENCE-BASED ETHNOGRAPHY (SEBE)

One of the ways of collecting observable components of an activity is by using video ethnography. This naturalistic approach enables the capture and study of flows of activity during real practices in the field. Over the past ten years, visual ethnographic methods and techniques have been growing. They have been used by social scientists, in various disciplines (sociology, anthropology, psychology, ergonomics), in order to observe and study human activity in a qualitative way (Goldman, Pea, Barron, & Derry, 2007; Heath & Hindmarsh , 2010; Lahlou, 1999; Mondada, 2003; Pink, 2007).

As activity is distributed, the worker uses not only their embodied competence but also a series of physical tools and instruments to transform material objects (Rabardel, 1997), mediating structures to operate cognitive operations (Hutchins, 1995). Other colleagues and various non-human entities are also involved in activity. Furthermore, action emerges in context; it is situated (Lave, 1988; Suchman, 1987). Consequently, when we try to reconstruct the action and understand what the human actor did, we need to account for all the contextual elements which contributed to the action. These elements cannot be recovered easily from the operator's memory only. Therefore, we use video to bring the complete situation back to the operator at the time of recall; this enables the operator to point at the relevant elements that scaffolded the action as it happened. We use a *first-person perspective* capture to reconstruct the situation as it was seen from the operator at the moment of action, because in complex situations what was relevant for immediate action is usually what the operator paid attention to.

First-person perspective is provided by *subcams* (subjective camera) (Lahlou, 1999), which are miniature video cameras worn at eye level by the subject while he/she is performing his/her activity. In a second stage called "replay interview", the subject is asked to describe and explain her/his covert behaviour, as he/she remembers it to the researcher while watching her/his own subcam recording. The technique of replay interview is similar, in its aim, to well-known *ex-post* verbalization techniques (see II.2), as they all seek to immerse the operator *ex-post* in her/his own activity, by confronting her/him with a track (not necessarily video) of her/his activity in order to make her/him verbalize her/his cognitive processes corresponding to earlier actions. The specificity of our approach is that it integrates the principles of Activity Theory and Perceived Quality theory, and, furthermore, it uses first-person perspective recordings of the expert's activity in order to stimulate his/her memory, so as to take advantage fully of all of the elements of the techniques mentioned above. Thus, this technique, which entails the use of first person perspective digital recording as a basis for analytic *replay interviews* with participants is called *Subjective Evidence Based Ethnography (SEBE)* (Lahlou, Le Bellu, & Boesen-Mariani, 2015). Several research teams now use or have developed customized first-person perspective recording tools similar to the subcam for studying activity in extreme settings and in training contexts (Myrvang Brown, Dilley, & Marshall, 2008; Omodei & McLennan, 1994; Rix & Biache, 2004). Such wearable

devices for operators obviously provide practical advantages for practitioners and researchers who analyze work by facilitating the task of data collection. Indeed, the subcam enables the capture of activities even while the subject is moving. Regardless of the location or the bodily movements, the device inevitably follows the operator's focus of attention and action, enabling a continuously situated recording of the operator's activity. In this way, data can be collected without any outside observer; the operator is free to organise her/his activities and movements. But beyond this convenient aspect, we have noticed that the "subfilms" empower operators to recall very precisely and accurately what they did, thought and felt at the time of action, even some weeks after having real-experienced the activity; probably because they feed the viewer with the exact context of action, attention focus and motor cues. One key advantage of SEBE is therefore its introspective "power" for triggering recall of lived experience. With another important advantage being its ability to provide the analyst with a detailed step-by-step understanding of the constituents of activity: goals, subgoals, determinants of actions, decision-making processes, and so on.

III.3 The Perceived Quality approach

The perceived quality approach (Nosulenko & Samoylenko, 2001) can be used to analyze both observable and subjective components of activity. This framework is useful in the analysis of practical activities taking place in real-world contexts, and in the identification of which elements of the environment are considered by individuals to be the most valuable in the course of completing their aims. From this perspective, the definition of perceived quality can be formulated as follows: "*A set of subjectively relevant characteristics of the world and the activity, which comes about in the subject with the objective of attaining her/his goals"* (Nosulenko, 2008).

It is impossible to define *a priori* the number of so-called "objective" components to be measured in the course of observations. We can only take an interest in those that are pertinent for the subject, the features that manifest themselves in the "perceived quality" of the gesture. The goal then consists in matching those components of perceived quality (in our case, the oral explanations given by the operator of the gesture – see section IV) with the observed components of the events (the professional gesture performed within a technical context).

The perceived quality approach begins with identifying the aspects of the object or system that are subjectively valuable for a certain individual in the course of the given activity. The strategy is to elaborate and then empirically prove a number of hypotheses concerning the parameters of actions. This assumes the inclusion of these aspects into their perceived quality, and the setting up of an evaluation system based on them as they appear in open ended individual evaluations. Which aspects of the artifact construct these subjective characteristics will only appear in the course of careful examination of an activity. And it is by confronting these evaluations with moments of actual activity and their description using activity theory that this will happen. For a detailed description of how this is done in practice, please refer to (Lahlou et al., 2012) sections 10.2, 10. 3 and 12.3, and (Le Bellu, 2011).

IV FROM COLLECTION TO EFFECTIVE TRANSMISSION: METHOD AND PRACTICAL APPLICATION

This section provides an overview of the main steps and specificities of the methodological protocol we developed to study professional gestures. This method, called ECAST (Elicit, Collect, Analyze, Structure, Transfer), is presented in this section in stage order and is illustrated through its application to one of the fifteen gestures used to develop and test our methodological principles (Le Bellu, Lahlou, & Nosulenko, 2010; Le Bellu, 2011).

The gesture considered in the example, is called "plugging in a 380V valve power supply cell". It was performed by an expert operator, now an instructor, in the main training centre of the company, on a full-scale model of an installation used within the plants.

IV.1 PREPARATION STEP

This step involves organisation of the study and familiarisation with the activity to be studied. It involves collection of a range of documents (procedures, handbooks, diagrams of the installation, training documents, and so on), selection of the expert by the organisation, informal interviews with the expert(s). This stage enables the analyst to become acquainted with the aim and content of the activity to be studied. Selection of the place and time of data collection also takes place in this step.

IV.2 COLLECTION PROTOCOL

IV.2.A Principle

This step aims at collecting data that will help to approach a subjective experience embodied in the professional gesture.

To obtain a third-person perspective, a camera fixed on a tripod provides a contextual view of the setting. Given the physical constraints of the environment, the best location for the camera is selected in order to capture the working environment, the machine and tools handled by the operator, and the operator. This external camera may be manned for zooming and reframing as the activity unfolds.

This contextual recording occurs with a synchronous first-person perspective recording, based on the SEBE paradigm described above. Operators wear a subcam and as they act, a first-person perspective of the operators' visual array, soundscape (including speech), and manipulations is recorded.

Video data collection is combined with a simultaneous verbal protocol, which we adapted from existing methods. This protocol, named "goal-oriented thinking-aloud" includes: (1) an introspective dimension: what the subject's goals are; (2) a

descriptive dimension: how the subject achieves his/her goals; and (3) an explanatory dimension: what reasons lead the subject to act in a certain way. This instruction, although demanding, allows accessing the cognition of a gesture by providing the expert's rationale. In transmission, this will enable the learner to go beyond mere imitation of the gesture. The whole instruction is the following: "*Formulate the intentions that you pursue as you perform your gesture. And for each of these intentions explain both the reasons and the way you achieve this objective*". In addition, the operator is asked to verbalise his/her experiences that have led to good practice (knowledge developed over time, situations, experience, people met and other past experience) and/or critical points (hazard or risk warnings that are not formalised in any documentation) that he/she considers important for novices. Following the principle of the Perceived Quality framework, the operator is free to select whatever he/she considers necessary to comment on; the operator is also encouraged to specify how he/she decomposes the activity and to what degree.

Our field studies showed that the success of this goal-oriented thinking-aloud protocol depends on a mental preparation step completed by the operator, which occurs before the simultaneous verbalisation protocol. This mental preparation allows the operator time to consider the way to explain the gesture *in situ* (with emphasis on aspects that are usually tacit) and in a format that allows cognitive modelling of the gesture and, later, structuring of educational material. This step can be completed in pair between the expert and a colleague or another expert. It was observed that discussions help to share practices, to externalise knowledge, and to facilitate decision-making regarding how best to teach the gesture.

IV.2.B Example of application

Figure 1 illustrates the collection protocol described above by providing screenshots of the video recordings and commentary transcription extracted from the recordings of the gesture "plugging in a 380V valve power supply cell". This figure provides a view of the same scene at the same moment from an external camera (Figure 1A), from the first-person perspective provided by the subcam worn by the expert (Figure 1B), and commentary observing the instruction of goal-oriented thinking-aloud protocol (Figure 1C).

It should be noted here that this example does not involve specific manual skills, as are used in some professional gestures, such as carving or painting, or gestures involved in specific attentional or diagnostic skills, such as driving or hunting. In this case, the movements are simple (pressing a button, turning a lever, pulling a drawer) and any difficulty resides in the proper sequencing of operations. The experts focus therefore specifically on the cognitive aspects of the task since explaining how to press a button would not appear problematic. In other settings, fine control of the movement can have implications for the final result (Vézina et al., 1999) or may lead to musculoskeletal trauma (Authier et al., 1996). In such settings, fine control is then at the core of the focus of operators and analysts. This is a reminder that every

activity is different, and that descriptions should focus on what is especially critical; otherwise they may appear lengthy or irrelevant to operators.

C "*… the next step is to turn on the power circuit. To do this, I will use the black handle here; I must put it upright. There is a risk of ejection of the drawer outward, so a risk to damage the equipment and a risk for the personnel who operate around. Whenever I manoeuvre the breaker, I stand to the side to avoid any injury in case of ejection…*"

Figure 1: Extract of video and verbal data collected through the application of the data collection protocol

IV.3 ANALYSIS OF VERBAL AND VISUAL DATA COLLECTED

IV.3.A Principle

In the investigation of the subjective experience of performing gestures the analysis of verbal and visual data is an important stage. A set of practices developed within the scope of our approach ensures that the observational data (video recordings, technical parameters, analysis of prescriptions, procedures, and other data) can be placed into correspondence with data describing the operator's subjective experience (verbalizations concerning the objects and the components of the perceived activity). These practices are:

- analysis of subjective experience related to this activity: what an individual thinks about the various elements of the activity and how he/she describes them in his/her own words;
- analysis in terms of activity: making explicit components and to which objects of the world they are directed at;
- connecting the elements of activity to the subjective experience, and understanding which aspects of activity actually construct the experience.

The video recordings are used in order to trace the externally observable behavior, to interpret individual and collective tasks that determine peculiarities of use of activity tools, as well as to show specific features of professional activities and identify professional experience. Analysis of the verbalizations in relation to the video tracks shows which tasks help the operator to achieve his/her concrete goals, under which conditions or using which tools; hence, what actions and operations are carried out during these tasks.

We consider the verbal data obtained from verbalizations to be representative for highlighting perceptive qualities. The verbal data analysis we perform is a kind of a "bottom-up" approach, where important themes and categories emerge from data analysis of the texts. An advantage here is that themes are not imposed by the analyst

but extracted from what participants report. Then, this avoids missing operations or actions that are the most important for the participants in their professional activity. Our verbal data analysis is similar, to a certain extent, to the inductive content analysis (e.g., interpretative phenomenological analysis, Grounded Theory, and others (Willig, 2001)) that enables an understanding of participants' unique experience of the world. It can reveal divergence or convergence in the themes evoked by different participants. Our verbal data analysis is used to reveal the elements of the conscious subjective experience (e.g., perceptions, emotions, cognitions, actions and operations) of individuals within their particular professional activity.

With this analysis in mind (see example below), a preliminary video editing of the gesture is made by the analyst for the next step of replay interview. This provides a video of the activity in which the maximum amount of information regarding the gesture is retained, while episodes that are not directly relevant such as preparation of the equipment, discussions, and so on) are removed. Regarding the different moments of the activity, the analyst selects the perspective (first or third) that best emphasizes operations filmed. During the preparation of this video, the analyst builds a global representation of the observed activity. He/she compares the contents of the video with the information gathered from the preliminary verbalizations of the expert (during the preparation and collecting steps) and from the analysis of available documents or training manuals. Thus, this analysis allows him/her to build some initial hypotheses regarding the cognitive structure of the gesture and the importance of the various operations that constitute it. These hypotheses provide a basis on which to list questions that could be asked during the replay interview. The duration of the video edit should not be very different from the actual length of the gesture. It is only after the replay interview (see next section) that the analyst will be able to go into the video editing of episodes and scenes in depth, based on the perception of the expert.

IV.3.B Example of application

The subsequent tasks and operations are encoded regarding the semantics and vocabulary used by the operator in his/her commentary.

The main goal

According to the expert's comments, the overall goal of the gesture analysed is *"to close a valve located on a remote site"*. This valve is operated by a nearby motor, but this motor is powered by cells whose controls are in a remote room: those controls are the objects of the current gesture. This *main goal* is broken down into a series of six *tasks* carried out by means of *operations* with/on *objects* of the system. And, for each operation, we identified the system area and control objects involved as well as the system feedback, critical points and/or good practices, wherever applicable. Below, we set forth an extract of the second task's structure, derived from analysis of the verbalisations.

Task 2: Power down the control circuit

This task requires four consecutive operations with/on the objects of the control unit area. Two of them are as follows:

Operation 2.2: Press the red buttons of the circuit breakers;
Area 2:2: Control unit;
Object 2.2: Two circuit breakers;
Critical point 2.2: Press the two circuit breakers one after the other (verbal explanations are provided within the video);
System feedback 2.2: The three indicator lights go off (success);
Operation 2.3: Press the thermal relay button;
Area 2:3: Control unit;
Object 2.3: Thermal relay;
Good practice 2.3: Check the operating condition of the thermal relay.
The expected result upon completion of task 2 is the following: "the power cut-out switch can be operated safely".

The whole analysis provides a first hypothesis regarding the cognitive model of the gesture (see Figure 2 for the final model of this example-gesture).

IV.4 REPLAY INTERVIEW

IV.4.A Principle

The initial aim of the replay interview technique (see section III.2) is to allow an accurate reconstruction of the operator's activity, by obtaining verbal information about the content of his/her activity's components (goals, tasks, actions, operations) and the tools employed. In the case of its application for studying professional gestures, two specificities of the technique need to be noted.

First, the video track of the expert's activity used as a medium to support the recall of the expert should be a mixture between first and third-person perspectives, selected and edited on the basis of the previous analysis step. A visualization of certain aspects of the activity provides to the operator, through language, the psychological tool needed to mobilize his/her attention, memory, representations and other cognitive functions. Moreover, in addition to this video-track, the cognitive model of the gesture, also based on the initial analysis, is submitted to the expert for feedback. The interview is video-recorded so that it can be reviewed to determine exactly to what the participant refers during the commentary.

Second, as the externalisation process of knowledge and the reconstruction of activity has started during the data collection step, at this point of the method, the objective is primarily: (1) to obtain additional information from the expert, and (2) to ensure that the initial hypothesis of the gesture's cognitive structure matches with the knowledge the operator wishes to transmit. Furthermore, a series of elements, not explicit in the operating instructions, but which are part of the local culture and of the subjective experience of the gesture, can be cropped. One such good practice is to

stand to the side of the drawer: this ensures that, in case of a violent ejection, the operator will not be injured (see expert's comment in Figure 1C). The operator mentioned that one operator once was killed in this operation, and that this case is systematically mentioned to novices during training; in fact, the expert who explained the gesture to the authors showed them a distressing picture of the setting taken after that accident. This explanation was therefore incorporated in the educational resource we designed. We see here how the material obtained in our process can be re-used for transmitting culture in the training. Thus, the data obtained subsequently, at the term of this interview, are then analysed (partial transcription and potentially, selection of audio extracts to be added in the video editing) in order to contribute to the improvement of the cognitive model and the final video editing.

This whole process provides an instrument to the analyst/expert operator dyad to highlight the most important components and distinctive features (the perceived quality) of the gesture to be transmitted. The output cognitive model of the gesture, called a "tree of goals" (Figure 2), provides the foundation for structuring educational transmission.

IV.4.A Example of application

After having presented the hypothesis of cognitive analysis and the pre-video editing to the expert during a replay interview, the model is adjusted according to the expert's comments. In the application to the "plug in" gesture, the below cognitive model was built (Figure 2).

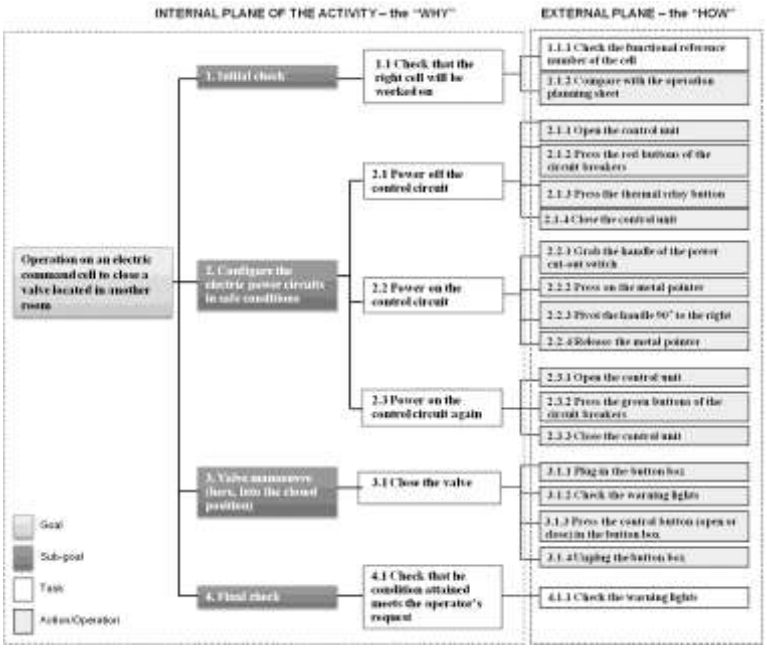


Figure 2: The cognitive model, called "tree of goals", of the gesture "plugging in a 380V valve power supply cell"

IV.5 THE BUILDING OF AN EDUCATIONAL REAL EXPERIENCE-BASED RESOURCE

IV.5.A Principle

The last step of the method entails formalising and presenting knowledge underlying the manual activity in a suitable format for both the learning of apprentices and supporting the teaching activity of instructors in the framework of knowledge transferring situations, such as professional training settings. To achieve this aim, we designed a piece of educational software called Multimedia Platform for Apprenticeship (MAP). Its structure is the same as the structure of the activity (the tree of goals) that was derived from the gesture analysis. Through this structure and its content, the MAP allows an exposition of the essential points of the gesture, from the expert's point of view. Thus, the apprentice using the MAP is put in a psychological posture of receiving the expert's perspective and can gain insight into the expert's process of reasoning and doing.

The MAP is organized into a series of three chapters. Each one focuses on a different dimension and level of detail of the professional gesture to be transmitted. The general purpose is to enable the learner to build a good mental model of the gesture, and to connect it with the sequence of operations as seen from a first-person perspective, re-situated in the framework of the rationale of the gesture.

The tree of goals chapter (Figure 3) provides a detailed view of the activity by linking the subjective and the objective components structuring the gesture: from the goals pursued by the expert to the finest and basic level of operations performed in order to achieve those goals. Each operation is illustrated by a video clip from either a first-person or a third-person perspective or from an edited version of both of these views. Each video clip includes the commentary of the expert collected during the steps of verbalization. The learner can therefore "dissect" and learn the gesture step-by-step, by "walking" through the tree of goals on his/her own accord and by "zooming in" on the various segments of the activity, in order to connect more detailed information to the larger bird's eye view that carries the rationale and structure. In addition to this structure, good practices and vigilance points are identified and emphasised by specific icons. The experts' good practices, informally "the tricks of the trade", correspond with the subtleties of the gesture developed by the expert over time. Vigilance points are complex and challenging aspects of the gesture; they require increased attention because experts consider them necessary for the smooth running of the activity. It is essential to acquire skills to manage them for the successful and safe performance of the gesture. Finally, control points corresponding to feedbacks of the technical system are pointed out and described in the analysis, as they are clues for situation awareness (e.g., lights giving information on the status of the system) and for ensuring the proper progression of the activity.

The "full video" chapter gives an overview of a gesture carried out without interruption. This video has commentary, from both first-person and third-person perspectives, and provides textual data corresponding to sub-goals, tasks, good

practices and vigilance points. In this MAP chapter, the operation level is not taken into account. This resource is available in two forms, either as a self-supportive video, which could be viewed on a laptop, tablet or smartphone, or as a chapter integrated in the MAP software.

Finally, a third resource, called "silent review video" shows the completion of a gesture without sound and at regular speed. It allows the apprentice to (re)view the gesture without any additional explanations. Thus, the rhythm of the activity can be learned, and such a resource enables a focus on the physical operations and the sounds of the tools and machines. This chapter can be used either to discover the activity or review a gesture.

IV.5.B Example of application

All the raw data collected and analysed provided base material for building a MAP organised around the cognitive structure of the gesture (Figure 3).

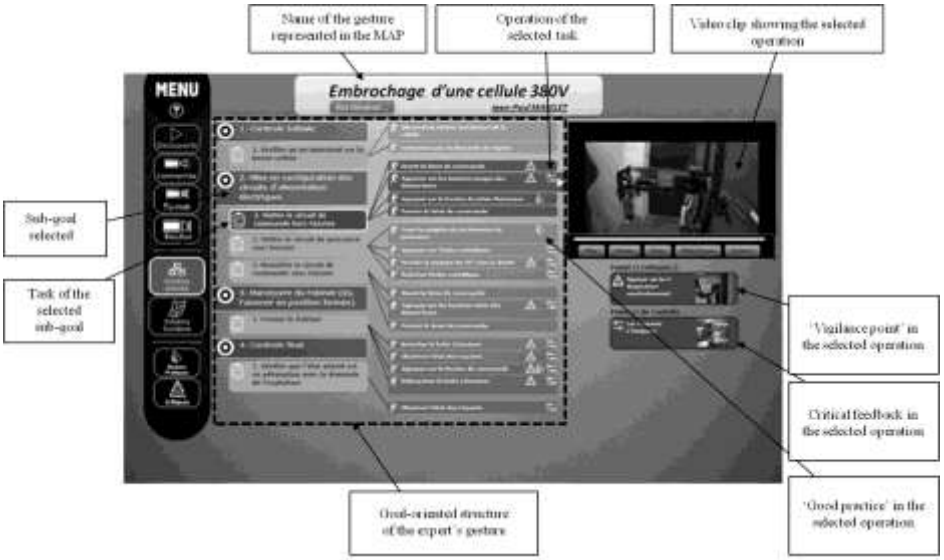


Figure 3: The "tree of goals" chapter in the Multimedia Platform for Apprenticeship (MAP)

V DISCUSSION AND CONCLUSION

The primary goal of the research was to provide an answer to the real-world organisational problem of experts' mass-retirement in energy sector, leading to an urgent issue regarding skills capitalisation and transfer. A secondary request was to provide a solution that could answer the needs of professional trainers to have efficient up-to-date training devices and tools, relayed via innovative media. Having we examined current approaches to this question, it was evident that there was a lack of a practical or concrete methodology providing an off-the-shelf solution for studying manual work practices for professional training purposes. On the basis of

our analysis and drawing on a multi-disciplinary approach (ergonomics, psychology, video ethnography, knowledge management), we have designed a method that adapts and combines the principles of verbal protocols, activity theory, perceived quality approach and subjective evidence-based ethnography. This has resulted in the development of a constructivist framework for collecting, analysing, and passing on experiential knowledge embodied in manual work activities (evidencing good and hard practices, risky situations, and expert tacit knowledge), through video media, for professional training settings.

The method was designed in the context of empirical research within the largest French electricity supplier. It is called ECAST (Elicit, Collect, Analyse, Structure, Transfer) and was designed to be centered on the expert's perspective. It provides theoretical, methodological and practical tools for allowing practitioners to apply the whole process, from capture of knowledge, to its effective transfer, in training settings, through structured educational media to conveying the knowledge collected. The completion of each step of the method provides outputs useful for the completion of the next step, much like a chain reaction. As a result, its originality stands in its capacity to use the raw material collected (videos, verbalizations, documents) both for analysis of the know-how underlying the activity and for the creation of a training product based on the expert's experience. This educational resource, called MAP (Multimedia Platform for Apprenticeship), does not aim to collect a one and right way of performing actions, but to provide a new kind of representation of professional experience for transfer, by enabling a novice to share the real-time experience of an expert through the first-person perspective provided by the subcam and accompanying explanations. MAP does not replace traditional professional craft mentoring practices, but in cases where such mentoring is no longer possible, it provides an overview of the know-how that would have been transmitted from the expert to the apprentice. Thus, we compensate for the loss of traditional socialisation practices but complimenting such practices with another learning method (Fauquet-Alekhine & Pehuet, 2011; Pastré, 2005) in applied contexts.

The test of MAPs in the company's training centres was a success. Improvement in the practical sessions was noted. Greater speed of execution was observed by trainers: the gesture could be performed twice by learners during the session with MAP, *versus* only once during the session without MAP. Furthermore, the method has been adopted and industrialized by the company. Five years after the first pilot was made, about a hundred gestures have now been captured by our method, which is now part of the standard toolbox of the corporate training division. The MAPs are increasingly being used within the company for training of power plant operators. They could also be used as a basis for the development of local and national community platforms that would allow the reflection, discussion, clarification and exchange of work practices both between experts but also between novices and experts. This idea of collecting diverse ways of resolving situations and performing gestures should be a mean to feed the processes of know-how internalization, and the identity development of novices, to some extent, according to the principles of communities of practice (Wenger, 1998). Diversity of practices, however, is an issue.

It is not an issue for the MAP method itself, which can accommodate any practice and could present variants; but it is an organisational one. There are many ways of executing a specific activity, as noted in the literature (Authier et al., 1996; Garrigou et al., 1998; Vézina et al., 1999). It is not only gestures that are adapted to a specific context (for example, in our case, some small differences in the equipment and local culture were noticed between different power plants): there may even be disagreement between experts regarding what is a "good practice". While this does not seem to be a problem for operators, who adapt a gesture to a situation, it is problematic for trainers and the training department, who are supposed to present "good practice". This becomes especially touchy when the gesture is taught in the context of a risky process in an industry that is under intense external scrutiny for safety management. We suggest showing trainees a variety of ways to execute the same gesture, in order to explain that reaching the goal is more important than the detail of the process and that professionalism is precisely the capacity to adapt to local contexts intelligently.

We adopted an inclusive approach of the "subjects". Involving a person, whose the activity is studied and video-recorded is essential because only he/she knows his/her internal states: this is why the SEBE approach argues for the term "participants" rather than "subjects" (Lahlou et al., 2015; Le Bellu, 2011), in order to emphasize participants' roles as true contributors to and collaborators in the process of analysis. The MAPs are signed by expert(s), as this contributes to a reinforcement of the feeling of organisational acknowledgement. This organisational dimension constitutes the keystone of the new MAP-based training system, since it conditions the physical and psychological involvement of experts into the ECAST method. The analyst has the role of a facilitator who provides the setting to initiate and facilitate the internal process of expert knowledge externalisation. Thus, to establish a strong collaborative and trust relationship is a second key element of this approach.

We think that this qualitative research method for capitalising and transferring know-how embodied in professional gestures could be applied by other practitioners in many other sectors than the specific high-risk industrial context of a power plant. Our method provides an efficient and practical framework for real-world research (Gray, 2013; Robson, 1993), enabling the modelling of work activity *in situ*, from the perspective of the actor of the activity, through video-based technique associated with specific verbalisation protocols. From that perspective, the method presented in this paper provides an original point of view and framework, both of which could hopefully contribute to renew more traditional approaches of activity analysis, especially for skills development and transfer. Its main limitation of application lies in the type of gestures considered. It is indeed well suited to sequential and motor gestures, but more complex gestures require further work. This is particularly true of joint activities requiring a strong decisional component. The current method does not allow a proper consideration of tasks distributed over time and between individuals. Thus, future research should consider how those kinds of activities could be approached both methodologically and theoretically by researchers using our method.

BIBLIOGRAPHY

Artemieva, E. Y. (1980). *Psykhologiya subektivnoj semantiki (Psychology of subjective semantics)*. Moscow: Moscow University Press.

Aubert, S. (2000). Transformer la formation par l'analyse du travail: le cas des peintres aéronautiques. *Education Permanente*, (143), 51–63.

Authier, M., Lortie, M., & Gagnon, M. (1996). Manual handling techniques: comparing novices and experts. *International Journal of Industrial Ergonomics*, *17*(5), 419–429.

Bedny, G., & Karwowski, W. (2004). Activity theory as a basis for the study of work. *Ergonomics*, *47*(2), 134–53.

Bisseret, A., Sebillotte, S., & Falzon, P. (1999). *Techniques pratiques pour l'étude des activités expertes*. Toulouse: Octarès.

Bourgeois, F., & Hubault, F. (2005). Prévenir les TMS. De la biomécanique à la revalorisation du travail, l'analyse du geste dans toutes ses dimensions - bourgeois.pdf. *Activités*, *2*(1), 20–36.

Brassac, C. (2008). Apprendre pour (et à) capitaliser des connaissances : une étude de cas. *Travail et Apprentissages*, *2*, 9–24.

Castéra, B. de. (2008). *Le compagnonnage : culture ouvrière*. Paris: PUF.

Chassaing, K. (2006). Elaboration, structuration et réalisation des gestuelles de travail : les gestes dans l'assemblage automobile et dans le coffrage des ponts d'autoroute. http://www.theses.fr/2006CNAM0539: CNAM, Paris.

Clot, Y., Faïta, D., Fernandez, G., & Scheller, L. (2001). Entretiens en auto-confrontation croisée : une méthode en clinique de l'activité. *Education Permanente*, *146*(1), 17–25.

Clot, Y., Leplat, J. (2005). La méthode clinique en ergonomie et en psychologie du travail. *Le Travail Humain*, *68*, 289–316.

Earl, M. (2001). Knowledge management strategies: toward a taxonomy. *Journal of Management Information Systems*, *18*(1), 215–242.

Engeström, Y. (2000). Activity theory as a framework for analyzing and redesigning work. *Ergonomics*, *43*(7), 960–74.

Ericsson, K. A., & Simon, H. A. (1980). Verbal reports as data. *Psychological Review*, *87*, 215–251.

Ermine, J. (2010). Knowledge Crash and Knowledge Management. *International Journal of Knowledge and Systems Science*, *1*(4), 79–95.

Falzon, P. (2005). Ergonomie, conception et développement. In *Conférence introductive, 40ème Congrès de la SELF*. Saint-Denis, La Réunion.

Fauquet-Alekhine, P., & Pehuet, N. (2011). *Améliorer la pratique professionnelle par la simulation*. Toulouse: Octares.

Fernandez, G. (2001). Le corps, le collectif et le développement du métier: étude clinique d'un geste de métier à la SNCF. *Education Permanente*, *146*, 27–34.

Garrigou, A., Carballeda, G., & Daniellou, F. (1998). The role of "know-how" in maintenance activities and reliability in a high-risk process control plant. *Applied Ergonomics*, *29*(2), 127–131.

Goldman, R., Pea, R., Barron, B., & Derry, S. (2007). *Video research in the learning sciences*. Mahwah: NJ: Lawrence Erlbaum Associates.

Gray, D. E. (2013). *Doing Research in the Real World*. Sage.

Heath C, Hindmarsh J, L. P. (2010). *Video in qualitative research. Analysing social interaction in everyday life*. Sage Publications.

Hutchins, E. (1995). How a cockpit remembers its speed. *Cognitive Science*, *19*, 265–288.

Kornilov, Y. K. (2014). *Na puti k psykhologii prakticheskogo myshleniya (Towards psychology of practical thhinking)*. Moscow: Institute of Psychology, RAS.

Lahlou, S. (1999). Observing Cognitive Work in Offices. In N. Streitz, J. Siegel, V. Hartkopf, & S. Konomi (Eds.), *Cooperative Buildings. Integrating Information, Organizations and Architecture* (Vol. 1670, pp. 150–163). Heidelberg: Springer, Lecture Notes in Computer Science.

Lahlou, S., Le Bellu, S., & Boesen-Mariani, S. (2015). Subjective Evidence Based Ethnography: Theory and Case Studies. *Integrative Psychological and Behavioral Science*.

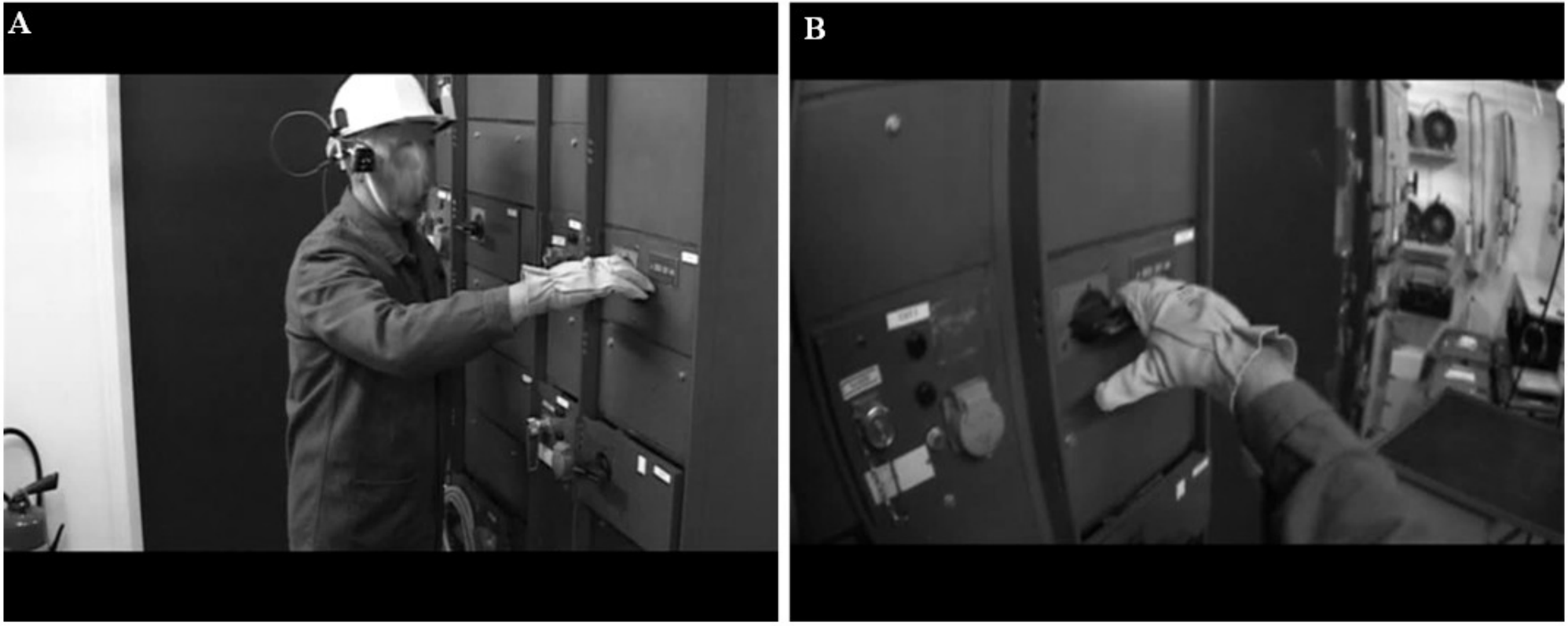
Lahlou, S., Nosulenko, V., & Samoylenko, E. (2012). *Numériser le travail : Théories, méthodes et expérimentations*. Paris: Lavoisier, coll. EDF R&D.
Lave, J. (1988). *Cognition in practice*. Cambridge, MA: Cambridge University Press.
Le Bellu, S. (2011). Capitalisation des savoir-faire et des gestes professionnels dans le milieu industriel. Mise en place d'une aide numérique au compagnonnage métier dans le secteur de l'énergie. http://www.theses.fr/2011BOR21825: Université de Bordeaux.
Le Bellu, S., Lahlou, S., & Nosulenko, V. (2010). Capter et transférer le savoir incorporé dans un geste professionnel. *Social Science Information*, *49*(3), 371–413.
Leontiev, A. N. (1978). *Activity, Consciousness, and Personality*. Englewood Cliffs, NJ: Prentice-Hall.
Leplat, J. (1995). A propos des compétences incorporées. *Education Permanente*, *123*, 101–114.
Leplat, J. (2013). Les gestes dans l'activité en situation de travail. *Perspectives Interdisciplinaires Sur Le Travail et La Santé (PISTES)*, *15*(1).
Leplat, J., Cuny, X. (1974). *Les accidents du travail.* Paris: PUF.
Mondada, L. (2003). Working with video: how surgeons produce video records of their actions. *Visual Studies*, *18*(1), 58–73.
Myrvang Brown, K., Dilley, R., & Marshall, K. (2008). Using a Head-Mounted Video Camera to Understand Social Worlds and Experiences. *Sociological Research Online*, *13*(6).
Nardi, B. (1996). *Context and consciousness: Activity theory and Human Computer Interaction*. MIT Press.
Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: how japanese companies create the dynamics of innovation*. Oxford: Oxford University Press.
Nosulenko, V. (2008). Mesurer les activités numérisées par leur qualité perçue. *Social Science Information*, *47*(3), 391–417.
Nosulenko, V., & Samoylenko, E. (2001). Evaluation de la qualité perçue des produits et services : approche interdisciplinaire. *International Journal of Design and Innovation Research*, *2*(2), 35–60.
Oddone, I., Re, A., & Briante, G. (1981). *Redécouvrir l'expérience ouvrière: vers une autre psychologie du travail ?* Paris: Editions sociales.
Ombredanne, A., & Faverge, J.-M. (1955). *L'analyse du travail. Facteur d'économie humaine et de productivité*. Paris: PUF.
Omodei, M. M., & McLennan, J. (1994). Studying complex decision making in natural settings: using a head-mounted video camera to study competitive orienteering. *Perceptual and Motor Skills*, *Vol 79*(3, Pt 2), 1411–1425.
Ouellet, S. (2012). Ergonomic analysis of work activity for the purpose of developing training programs: the contribution of ergonomics to vocational didactics. *Work*, *41 Suppl 1*, 4572–6.
Pastré, P. (2005). *Apprendre par la simulation. De l'analyse du travail aux apprentissages professionnels*. Octares Editions.
Pink, S. (2007). *Doing visual ethnography: images, media and representation in research* (2nd ed.). London: Sage.
Polanyi, M. (1967). *The tacit dimension*. Garden City, New York: Anchor Books.
Rabardel, P. (1997). Des instruments et des hommes : propositions pour une conception centrée utilisateurs. *International Journal of Design and Innovation Research*, *10*, 7–20.
Rix, G., & Biache, M.-J. (2004). Enregistrement en perspective subjective située et entretien en re situ subjectif : une méthodologie de constitution de l'expérience. *Intellectica*, 363–396.
Robson, C. (1993). *Real world research : a resource for social scientists and practitioners-researchers*. Massachusetts: Blackwell Pushers.
Rubinstein, S. L. (1922). Le principe de l'activité du sujet dans sa dimension créative. In V. Nosulenko & P. Rabardel (Eds.), *Rubinstein aujourd'hui. Nouvelles figure de l'activité humaine.* (pp. 129–140). Toulouse - Paris: Octarès - Maison des sciences de l'homme.
Rubinstein, S. L. (1940). *Osnovy obshej psikhologii (Foundations of General Psychology)*. *Génie logiciel et système expert*. Moscou: Edition "Utchpedgiz."
Schön, D. (1983). *The reflexive practitioner. How professional think in action.* Basic Books.

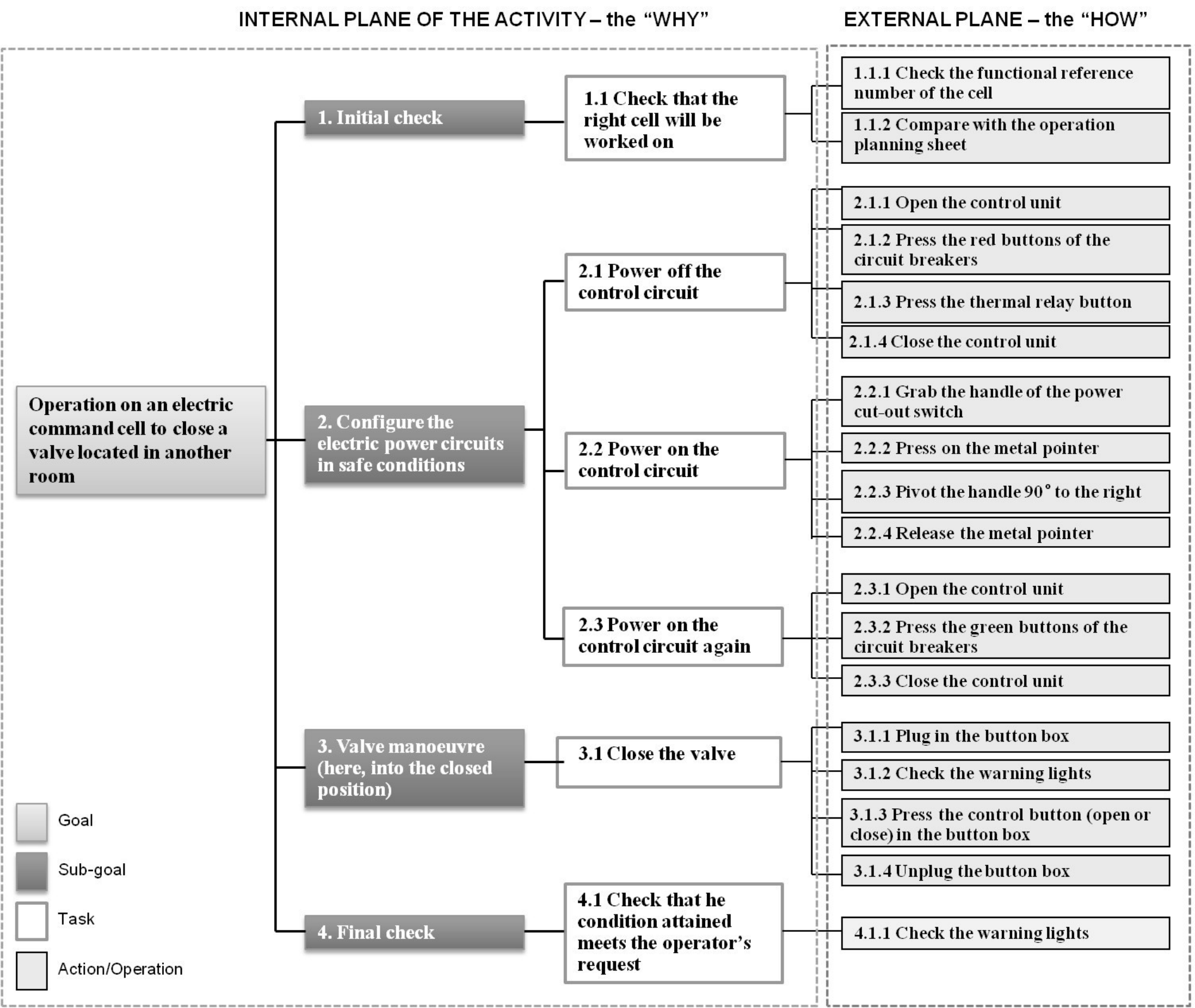
Shadrikov, V. D. (1974). *Psykhologiya proizvodstvennogo obutcheniya: printsipy i upravlenie (Psychology of job training: principles and management)*. Yaroslavl: YarGU.
Simonet, Caroly, & Clot. (2011). Méthodes d'observation de l'activité de travail et prévention durable des TMS: action et discussion interdisciplinaire entre clinique de l'activité et ergonomie. *Activités*, *8*(1), 104.
Stetsenko, A. (2005). Activity as object-related: Resolving the dichotomy of individual and collective planes of activity. *Mind, Culture, and Activity*, *12*(1), 70–88.
Suchman, L. (1987). *Plans and situated actions. The problem of human-machine communication*. Cambridge: Cambridge University Press.
Theureau, J. (1992). *Le cours d'action, analyse sémio-logique: essai d'une anthropologie cognitive située*. Berne: Peter Lang Verlag.
Varela, F., Thompson, E., & Rosch, E. (1991). *The Embodied Mind*. Cambridge, MA: MIT Press.
Vermersch, P. (1990). Questionner l'action : l'entretien d'explication. *Psychologie Française*, *35*(3), 227–235.
Vézina, N., Prévost, J., Lajoie, A., & Beauchamp, Y. (1999). Élaboration d'une formation à l'affilage des couteaux : Le travail d'un collectif, travailleurs et ergonomes. *Perspectives interdisciplinaires sur le travail et la santé (PISTES)*, *1*(1).
Von Cranach, M. (1982). *Goal-directed action*. London: Academic Press.
Wenger, E. (1998). *Communities of Practice: Learning, Meaning, and Identity*. Cambridge, U.K.: Cambridge University Press.
Willig, C. (2001). *Introducing Qualitative Research in Psychology. Adventures in Theory and Method*. Buckingham: Open University Press.

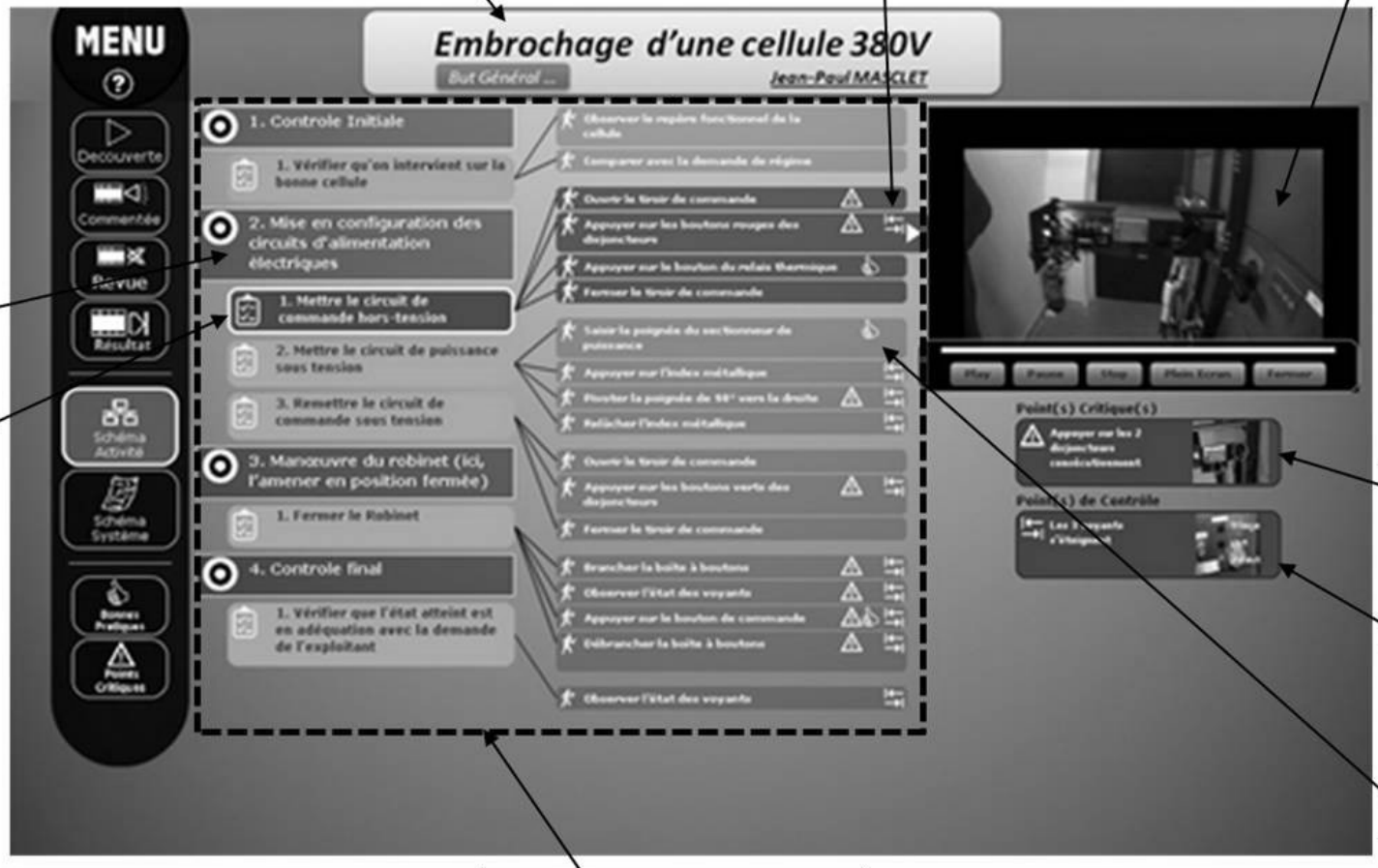
SUMMARY

This paper presents the methodological framework that we developed for collecting, studying and passing on tacit and explicit know-how embodied in professional gestures of expert workers. This framework is based upon the combination of an adaptation of a range of psychological theories and techniques: Activity Theory, the 'perceived quality' approach, subjective evidence-based ethnography, and verbal protocols. The application of the method, primarily based on the perspective of the expert, enables the building of a cognitive model of the professional gesture to be transmitted, by highlighting its key points. It leads to designing multimedia training products called MAP (Multimedia Platform for Apprenticeship) intended to "represent" and convey knowledge involved in the real-time performance of the expert's gesture. The methodology was developed and applied to manual operators, in actual work and training settings of the biggest power French company. The practical aim of the study was to address an organizational issue of knowledge management, for professional training purposes, in order to bridge the gap of learning by mentoring between retiring experts and novices. The method has been recently industrialised by the company in which the research occurred and could be applied to many other cases and contexts.

KEYWORDS : Professional Gesture, Video, Subjective Evidence-Based Ethnography, Verbalization, Activity Theory, Training.


A
B


INTERNAL PLANE OF THE ACTIVITY – the "WHY"
EXTERNAL PLANE – the "HOW"
Operation on an electric command cell to close a valve located in another room
1. Initial check
1.1 Check that the right cell will be worked on
1.1.1 Check the functional reference number of the cell
1.1.2 Compare with the operation planning sheet
2. Configure the electric power circuits in safe conditions
2.1 Power off the control circuit
2.1.1 Open the control unit
2.1.2 Press the red buttons of the circuit breakers
2.1.3 Press the thermal relay button
2.1.4 Close the control unit
2.2 Power on the control circuit
2.2.1 Grab the handle of the power cut-out switch
2.2.2 Press on the metal pointer
2.2.3 Pivot the handle 90° to the right
2.2.4 Release the metal pointer
2.3 Power on the control circuit again
2.3.1 Open the control unit
2.3.2 Press the green buttons of the circuit breakers
2.3.3 Close the control unit
3. Valve manoeuvre (here, into the closed position)
3.1 Close the valve
3.1.1 Plug in the button box
3.1.2 Check the warning lights
3.1.3 Press the control button (open or close) in the button box
3.1.4 Unplug the button box
4. Final check
4.1 Check that he condition attained meets the operator's request
4.1.1 Check the warning lights
Goal
Sub-goal
Task
Action/Operation



Name of the gesture represented in the MAP

Operation of the selected task

Video clip showing the selected operation

Sub-goal selected

Task of the selected sub-goal

'Vigilance point' in the selected operation

Critical feedback in the selected operation

'Good practice' in the selected operation

Goal-oriented structure of the expert's gesture