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The role and positioning of observation in ergonomics approaches: A research and design project

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Abstract. Observation methods historically form a significant part of the identity of activity-oriented approaches to ergonomics, while playing a central role in the holistic approach to work activity. This paper introduces the issue of the role and positioning of observation in ergonomics approaches, and presents a current research and design project. Started two years ago, the project promotes research and practice exchanges, involving reflections on and teaching of observation methods and techniques. Its objectives are threefold: 1) design an open and stable tool for in-situ observation, 2) contribute to the research about observation and human activities, and 3) promote teaching of observation methods and techniques. The paper concludes with an outline of the next steps for research and practice.

Keywords: Activity Theory for Work Analysis and Design, Observation method, Activity analysis tool

1 Introduction

Observation is a current method in human and social sciences [1]. This method refers to experimental approaches that are exclusively inductive or that are combined with other methods (surveys, questionnaires, statistics, interviews, and so on), and that may have various objectives of description, analysis, modeling, comparison, or intervention. Observation can thus aim to: describe human behavior to analyze its development, determine its causes, or define its functions [2]; describe activity as part of a system in which it takes shape but also serves as a contributing element; or describe what makes sense and identify significant contexts for action. Observation methods can shed light on or control quantitative treatments, provide perspective on the practices mentioned in interviews, and allow participants to grasp the meaning of individual or collective behaviors and processes observed in a specific context [3]. It is also used in activity

development and training during reflexive practice workshops [3], [4]. Furthermore, observation methods have several implementations, including those that are direct or indirect, ethnographic or systematic, in the field or in a lab, participant or external, and with or without tools. These variations are employed according to the analysis conditions, goals, or theoretical foundation of the researcher.

Observation methods historically form a significant part of the identity of activity-oriented approaches to ergonomics [5], while playing a central role in the holistic approach to work activity in understanding the course of human activity and its temporal organization [6]. Observation methods are generally classified into two types [7]: *free observations* and *systematic observations*. Free observations are intended to be global, making it possible to apprehend work situations without having predefined what is to be observed (actions, postures, moves, etc.). Free observations are thus substantially similar to ethnographic observations. Conversely, systematic observations aim at collecting precise data and logging events to test the hypotheses that guide the investigations. Systematic observations are based on a predefined observation schedule. The divergence of these two approaches is linked to the epistemological and theoretical positioning of the observer-analyst and the moment at which the observation intervenes in the research, study, or intervention being conducted.

A major stake for observation methods is to reconstitute the temporal dimension of activity that extends beyond a snapshot of the current time. Activity should be reflected as a broader dynamic and evolving process. Kerguelen [8], [9] distinguished three temporal dimensions in human activity for this purpose: a) the duration that one person can measure and count, b) the temporal organization of events with simultaneity and transitions, and c) a broader production or service process within which the activity is situated. A fourth temporal dimension could also be added [10], [11], namely, the long-term relationship between individual and collective work activity and individuals' career or training paths. It thus becomes necessary to take into account the past and future work related to the current observed activity.

2 The place of observation in the analysis of activity

The place of observation in research, studies, and interventions has been the subject of extensive reflection in ergonomics literature. Many works recognize the centrality of observation for analysis [7].

The construction of an observation plan is thus a crucial step in a study or intervention. The plan's orientation depends on the goals of the research, such as: to develop understanding, reveal hidden facets, highlight specific elements, provide supporting evidence for hypotheses, explain certain aspects, and discuss ramifications, among others. Therefore, the observation plan constitutes a strategic dimension because it defines the subject, timing, and range of observation. Thus, the plan must define: 1) the categories of observable facts and events, 2) the sequence, timing, or shift of observation, and 3) the scope of observation (individual activity in current situation, collective activity, or broader technical or organizational changes, etc.).

Plan definition thus contributes to reducing the complexity of the activity observed, or even to focusing on certain elements to the detriment of others [7]. The challenge is

to control such reduction or shifts in focus by explaining what is to be observed or not, and by justifying the choices made with regard to research questions or working hypotheses. In other words, observations reflect the problematization and scope proposed by the analyst from the requests he or she receives.

In all cases, analysis of activity and work cannot be limited to observation of activity [12]. As a partially non-observable process, and as an integrative process based on a multidimensional model of human functioning (physical, cognitive, emotional, social, etc.), including multiple temporalities (generations, career pathways, actions, systems, etc.), analysis of activity requires other means of investigation. The observation method is most often used in parallel with other, measurement-based methods (physical, physiological, neurological, etc.) or data collection methods (interviews, etc.). One of the issues is then how to combine observation with these other methods.

3 Designing observation tools for activity analysis

3.1 Ergonomists' requirements for tools

Since the 1970s, researchers in ergonomics have needed to view and analyze their survey readings beyond the usual duration measures using a qualitative approach [13], [14]. Ergonomists have been looking for methods to:

- consider the complexity of the temporal organization of actions during work activity (course of actions dynamics, chronological sequences, overlays, and intertwining different schemes for action at different scales) [15]
- facilitate integration of quantitative measures and qualitative assessments, to develop a holistic approach;
- combine behavioral, contextual, metrological, physiological, and verbal data, to support a comprehensive approach;
- highlight the collective dimension of work;
- support analysis and work transformations.
- understand the greater degree of interpenetration of feedback and controls, which are more numerous and temporally shorter in human-technology interaction [16].

Thus, research has been directed towards the design of activity graphs to interpret, show (visualize), demonstrate, and convince, but also to generate comments from all stakeholders. Moreover, the product of the observation was found to be useful for debate (about the work, the diagnosis, the transformations, etc.) during ergonomics interventions. The observation was then used as a tool for the purposes of transformation. As part of a constructive approach that emphasizes reflective practices [17], the product of the observation has become a means of discussion among actors on the ground during research, studies, or interventions, or for the facilitation of working groups. A major challenge in implementing this approach, however, has always been and may still be the short timeframe of some interventions.

3.2 Foundational research approach and tool development

The current study can be placed in the context of activity-oriented research. This was especially driven by earlier design work by Alain Kerguelen and his colleagues on Actogram-Kronos® [8], [9]. This tool was developed in close cooperation with many scholars. Actogram-Kronos contributed to their research while being, at the same time, extended to meet their requirements. This joint research and design work was conducted in various industrial, transport, and service sectors [18], [19], [20]. The studies focused on different aspects of activities (production or service situations, transmission situations, training, career pathways, etc.), and included more unusual areas such as analysis of reflective practice workshops [21]. Many consultants also took advantage of this tool to support their diagnoses.

This “community of practice” adopted a common view of a holistic approach to activity, considering various observable phenomena (gestures, actions, verbalizations, physiological variables, etc.) as a whole that should be interpreted in an integrated manner [22].

Nevertheless, work is constantly evolving: It is increasingly digital, collaborative, and flexible, and it progressively involves more varied places and complex interaction modes. Based on this perspective, the present study aims to question the role and positioning of “traditional” observations but also the new roles of observation methods in ergonomics approaches today.

4 Design and development of an observation tool for research-intervention approaches in ergonomics

Two years ago, we started a research project to design and develop a new software application dedicated to in-situ human activity observation. The project’s objectives are threefold:

1. Design an open and stable tool for in-situ observation that is adapted to the current needs of ergonomists and as accessible as possible;
2. Contribute to the research about observation and human activities conducted with three main orientations: epistemological, theoretical, and methodological;
3. Promote teaching of observation methods and techniques to understand in-situ human activities, and influence the evolution of these activities based on the dual perspectives of performance and health.

For this purpose, a six-member steering committee was formed, consisting of five researchers and one software engineer (all from France), to structure a user-centered design process with a participative and iterative approach. The steering committee met monthly during the first year. The initial design phase was structured around three aspects: needs analysis, software ecosystem specifications, and recurrent evaluations to monitor and influence the design of the tool.

At the end of the first phase, the ActoGraph® ecosystem was defined as the combination of:

- The software core, which includes most of the key functionalities, such as multimedia file management, in-situ data recording, editing of observation protocols, textual and graphic data visualization, and statistical analysis;
- Additional, open-source modules to allow a high degree of customization and the development of extensions to the software;
- Multi-platform support to allow use of the tool with several current operating systems (Windows, MacOS, or Linux) and devices (computers, smartphones, and digital tablets);
- A community of users and developers to improve and provide feedback about the evolution of the software;
- Different types of targeted ActoGraph® licenses (student, education, support, ultimate) to ensure the tool is both accessible to most and sustainable over the long term.

The first prototype was evaluated for two months by three types of end-users: researchers, practitioners, and a group of graduate students while taking practical exercise courses as part of their master's degree program. These courses were centered on human-machine interaction from an activity perspective [5]. Overall, 18 appraisers tested several types of system usage, the in-situ data recording process, and the process of analyzing recorded data (audio/video, personal notes, field book, data from interviews, production process, as well as professional path). A usability test was also performed, by following an expert evaluation method [23]. These first evaluations made it possible to improve the software, but evaluations continue in an iterative design process, which makes it possible at present to produce various types of collection and analyses, as shown in the two examples below.

5 Two examples of observation-based data collection and processing

The first example comes from a study on the attrition of nursery school staff. The analysis was focused on facets of the hardships of their work, based in particular on the observation of 10 working days [24]; here is an excerpt from a chronicle treated with ActoGraph® software (cf. figure 1).

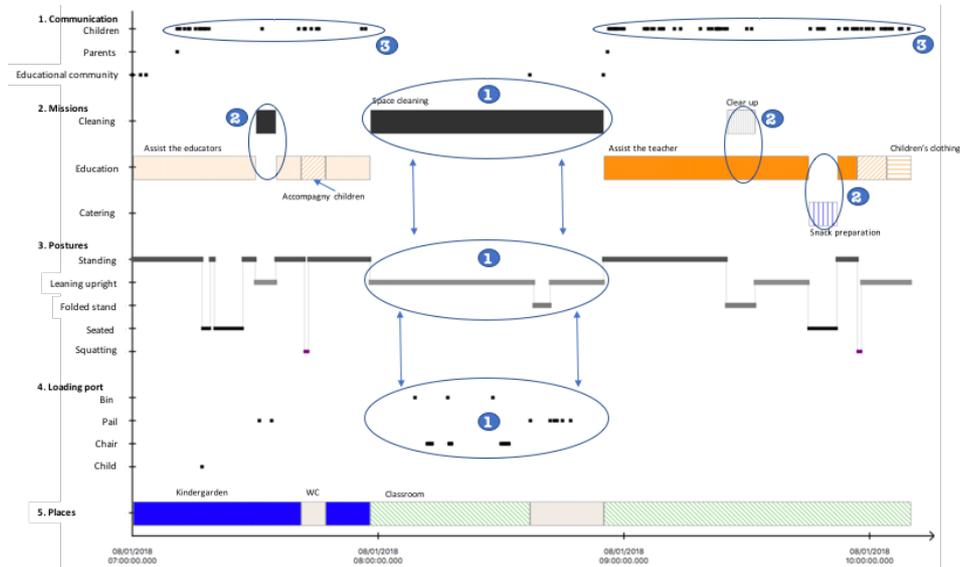


Fig. 1. Chronicle of the activity of a nursery school employee on a shift from 7am to 10am.

The analyses showed that: (1) Physical pain is concentrated around the cleaning tasks where postural and load-bearing constraints accumulate; (2) while these employees are part of the educational community, their educational mission often takes a back seat, which translates into frequent interruptions in cleaning or preparing meals, and a combination of tasks (e.g. tidying up while assisting the teacher); and (3) communication is limited to exchanges with children, and there is very little consultation with other members of the educational community (educators or teachers). The activity chronicles, combined with other data, indicate that premature attrition of these employees is thus linked to the performance of physically arduous tasks, as well as other forms of psycho-social hardship.

The second example comes from research on the profession of adult trainer (cf. figure 2). The study consisted of more than activity chronicles, as key questions were to define the diversity of the actual tasks they accomplish as well as their overtime scheduling [25]. Given the particularities of this profession, whose boundaries between work and non-work are blurred, an agenda of tasks completed during a week was developed to analyze the long periods of time in the exercise of the profession. The global data corpus, from which this example is extracted, was composed of 11 agendas.

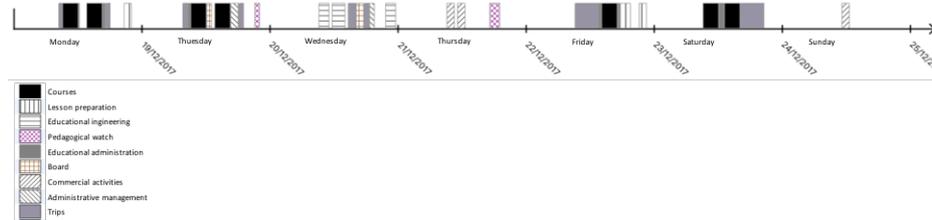


Fig. 2 Chronicle of week-long agenda of tasks for adult trainers

The set of results made it possible to identify the diversity of the tasks performed by the trainers (8 and travel), and the variability of the daily working hours (from 90 minutes to 11 hours per day) while pointing to long weeks of 6 to 7 days. Not surprisingly, the conduct of the courses occupied an important place, during condensed time periods; however, it was noted that the time devoted to professional travel was also significant (about 1/4 of the hours over a week) and had repercussions on the trainers' health.

These two examples show how: 1) chronicle analysis, by observing the synchrony of the events that make up human activity, contributes to the understanding of health-work relations and to the production of a diagnosis; 2) long-term working time analysis offers new possibilities for understanding professional activities, subject to forms of flexibility that tend to develop in today's world of work

6 Conclusion and perspectives

These two first years of the project have led to two main orientations for the next step. On one hand, we are conducting a worldwide survey to identify panel observation tools (to search and intervene) and to learn more about the uses of observation methods in ergonomics and by ergonomists. The assumption is that this survey is a means of understanding the creativity in practice within our discipline and profession. On the other hand, we plan to set up working groups of reflexive practice to examine the role and positioning of observation in ergonomics research and practice in France. The aim of these groups will be twofold: 1) to better understand the effective practice of observation in ergonomics, and 2) to orient the ongoing design process of the ActoGraph® software ecosystem.

We also have to take into account the new possibilities offered by current technological means. Indeed, the possibilities of capturing data from work activity are a challenge, because their use can enrich design choices, or conversely be used to the expense of comfort and health preservation during the activity. In addition, the computational and analytical power of algorithms opens up prospects to develop tools to support and advance activity analysis.

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