

Taking activity into account during the design process

Pascal Béguin

Laboratoire « Travail et développement », équipe d'ergonomie, CNAM, 41 rue Gay Lussac, 75 005 Paris
INRA, UMR SAD-APT, équipe Praxis.
beguin@cnam.fr

ABSTRACT

During the design process there is a disparity in the proportional attention given on the one hand to the specification of machines or organization and on the other hand to those who, through their activity, ensure the function. However, different ways can be chosen to think out and define the status and the stakes of workers' activity for the design process. It is suggested that three main positions can be chosen: namely "crystallization", "plasticity", and "development".

KEYWORDS

Activity theories, design processes, professional practices of ergonomists.

The official definition of ergonomics adopted by the IEA Council in August 2000, asserts that Ergonomics is "*a systems-oriented discipline which now extends across all aspects of human activity*" and the profession "*that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance*". In this paper, the focus is on the relationship between the workers' activities and the design processes.

During design, disproportionate attention is paid on the one hand to the specification of machines or to organization and on the other hand the care given to the workers. It is this asymmetry which ergonomics tries to correct. Let us recall the stakes at issue in France: the cumulated total cost of occupational disease and industrial accidents amounts to approximately 3% of the GDP (Larcher, 2004). Moreover, these calculations do not take into account the whole economic cost of bad working conditions (which also relates to bad quality, dissatisfaction of customers, high absenteeism, etc.).

In such a context, relationships between design and the "daily work" of workers is of the utmost importance. In this communication, I will discuss different ways to think out and to define the status and the stakes of workers' activity for the design process. But beforehand, I will make some comments on "*activity*".

1.- Activity at work

It is impossible in this short paper to discuss fully the concept of activity. Activity-oriented approaches are a vast field of developing theoretical and empirical research (see Daniellou and Rabardel (2005) for a recent discussion in ergonomics). To speak about an "activity" is, above all, to define a unit of analysis in order to grasp work practices.

In order to define how humans work, more often one focuses on a set of components or subsystems (physiological-posture, thermal regulation, etc. – or psychological-memory, attention span, etc.). Undoubtedly, this approach has produced many improvements to existing technological systems. Particularly, it allows the definition of limits beyond which choices (concerning spaces, tools or organi-

zations) are unacceptable. But activity is more than a sum of its parts (be they information-processing subsystems or physiological systems). For example, identifying the characteristics of human hearing does not tell us that the noise of a given machine constitutes a signal conveying information on the state of the machine, which the mechanic needs for maintenance. If the machine is hooded without taking this into consideration, the mechanic may well destroy the hearing protection device.

By using the term “work activity”, emphasis is placed on the person as an “intelligent” agent (and not as a component in the human machine system), with a set of skills and shared practices based on work experience with others, who has the capacity to control (to regulate and to coordinate) and to construct his or her conduct in order to reach a goal. This regulation and coordination are not in a vacuum. Activity is situated in a given context (in its material, social, and historical components), that provides resources, but that also defines constraints (which has a cost for persons). Simultaneously, this given context is affected by the subject’s life experience, and is thus constantly revised and reinvested.

2.- Workers’ activity and professional practices of ergonomists

The definition given below may lead to numerous discussions. Several theoretical and empirical research movements concerned with activity (inspired by these studies or born of autonomous approaches) have developed in parallel, sometimes over several decades. In this paper however, I would argue that the perspective adopted by a given ergonomist around an activity orients his or her professional practice and role during the design process. Three main positions can be chosen to think out and to define the status and the stakes of the workers’ activity for the design process: namely “crystallization”, “plasticity”, and “development”.

2.1.-Crystallization

The main idea is that any technical system, any device, crystallizes a knowledge, a representation, or a model of the workers and their activity. However, once crystallized or embedded in the artifact and conveyed in the work setting, these representations can be sources of difficulties (even of exclusion) for the persons if they are false or insufficient. Designing a staircase to reach upper floors in a building rests on the representation of valid workers, which once crystallized in the artifact is imposed to everyone. With the risk of excluding persons in a wheel chair: they will not be able to reach upper floors. This is a general characteristic: computers embed a psychological model of the user. Bannon (1991) postulates that this model rests on a “stupid user”. But it is sometimes the reverse: one expects exceptional skills from workers.

It is possible to generalize: a technical system embeds and conveys numerous choices made by the designers: professional choices on work activity, but also social and political choices (see for example Freyssenet, 1990). These choices are most often made through lack of knowledge regarding work activity, and how work gets accomplished. In other cases, one seeks to orient work practices, but without having obtained the means to validate or invalidate the choices in the work setting. Let me highlight three ideas on this basis.

The first idea is that it is necessary to apprehend simultaneously the characteristics of the artifact or the technical system and the work activity. It is a “work system”, or an “interacting complex system” (Wilson, 2000) that is specified during the design process, and not only a device or an artifact. Human work is situated in a given context (in its material, social and historical components) and this given context is affected by the subject’s life experience. What is required is an understanding of a *coupling* between the human and the device. Activity is a way to conceptualize such a coupling (Lep-lat, 2000). Ergonomist must help the designer to better consider and understand the workers activity, and its consequences (both in terms of performance and health).

The second idea is that an important issue is the process of problem visibilization of work (Engeström, 1999 ; Rasmussen, 2000). Visibilization is an important process during design, and particularly during problem-building (Wisner, 1995). “Problem-building”, the process during which a problem is defined, is a key question, every bit as essential as the search for a solution (Miettinen, 2000). Analysis and diagnosis of an existing work setting is a central undertaking in problem-building. All projects must take into account the (social, material, etc.) context specific to the environment to be transformed. Burns and Vicente (2000) provided a good example of these “*contextual constraints*”: if a proposed design for a control room did not accommodate the size of a pre-existing hallway, the design had to be changed. For ergonomists, it is of the utmost importance to identify the “constraints” that arise from workers’ activities. A method such as Ergonomic Work Analysis contributes to defining and identifying the nature of the “contextual constraints” encountered by workers, in their activity.

The third idea is that ergonomics must be a design science. Early work tended to focus on evaluation of existing systems and analysis of features that had been found in the work setting to be good or bad from the point of view of the worker. However, the concern is how to build a better work system. We don’t just want to know about systems after they have been built. From that point of view, Ergonomic Work Analysis is not a sufficient method. Methods such as simulation are of the utmost importance in a design science. In simulation methods, one of the questions is to identify the degree of reliability that can be assigned to the results of a simulation. Should they be regarded as heuristic outputs, or as tools making it possible to carry out a prediction? Simulation is a method that can be used to predict the consequences of decisions already made. The challenge is thus to make a prediction with a low margin of error. And this margin of error decreases as the future system is known and conceived. But it is no longer possible to reconsider the earlier decisions. Conversely, the capacity of prediction is lower with uncertainty, at the beginning of the design process. But the outcome is efficient: explorations carried out by the designers in the earlier stages will be better oriented. So, the more one gains in efficiency, the more one loses in prediction. Unsurprisingly, Theureau (1997) shows, through a review of literature, that there is a trend to develop approaches that are theoretically modest (giving a secondary importance to prediction by way of classical experimentation and statistical tools), but empirically better inscribed within design processes (by means of prototype, mock-up or scenario).

2.2.- Plasticity

The preceding approach rests on well-established data: because an insufficient knowledge of work activity causes disappointment, one needs to model activity. However, a strict model of work activity is not appropriate. A range of empirical and theoretical arguments leads to thinking that full anticipation of activity is impossible.

There is an unbridgeable gap between an activity defined during design and an activity actually carried out in situation. Activity is driven by the concrete situations that exist at any moment and is constantly changed. In work situations, the workers encounter unforeseen situations and oppositions linked to “industrial variability” – e.g. systematic deregulation of tools, instability of the matter to be transformed, etc. –, and to the fluctuation of their own state – for example due to tiredness – (Danielou, Laville, & Teiger, 1983). Thus, tasks and people fluctuate with time, and these fluctuations must be taken into account. Suchman used the term “*situated action*” to generalize this aspect. Whatever the effort put into planning (designing), performance of the action cannot be the mere execution of a plan that fully anticipates action. One must adjust to circumstances and address situation contingencies, for instance by acting at the right time and by seizing favorable opportunities. As highlighted by Suchman “*rather than attempting to abstract action away from its circumstances and represent it as a rational plan, the approach is to study how people use their circumstances to achieve intelligent action*” (Suchman, 1984, p. 50). We can extend this proposal: the aim is to design systems that allow or facilitate situated “intelligent action”. Many proposals have been made in order to support situated action during design.

Saying that anticipation (or a plan) does not allow one to specify “local interactions” does not mean that a plan is useless. It guides and helps to find the best positioning. This idea is also highlighted by Vicente (1999). On one hand, it is impossible to fully anticipate activity : one must therefore leave workers the possibility to adapt to local circumstances, “*giving workers the possibility to finish the design*”. On the other hand, anticipation is a resource that helps to find the best position. In this approach, to design is to specify “boundaries” on action.

A second approach tempts to design a “space of possible forms of future activity”, rather than the specification of the devices (Daniellou, 2004). Working with a computer may serve as an example: to provide a printer will allow use of a paper printout if necessary; without a printer, the only possibility is to use the screen. In such an approach, one stake is to model the diversity and the variability of a future setting, in order to evaluate if the “space of the future possible activity” will leave the worker the possibility for “intelligent action”.

A third approach has a more technological objective. It concerns better identifying properties that socio-technical systems should have to allow ongoing evaluation of their own functioning and potential for transformation (Robinson, 1993). Providing adaptable or modifiable artifacts offers potential for such an ongoing process (Rabardel, & Béguin, 2005).

Regardless of the diversity of these proposals (see Randall, 2003 for a more thorough discussion), the aim for ergonomists is to design “plastic” or “flexible” systems. They are “plastic” in the sense that they leave the activity sufficient freedom to manoeuvre to render technical aspects more efficient whilst remaining in good health. Identifying the characteristics that contribute to making systems flexible is a strategic direction for ergonomics research.

2.3.-Development

The third approach can be referred to as developmental. As with the first approach (crystallization), it retains the idea that it is necessary to apprehend jointly the design of artifacts and their usages. From the second approach (plasticity) it retains the idea that the efficacy of technical systems does not rest alone on artifacts, but also on activity. But it does add a further dimension: the development of artifacts and the development of activity must be considered jointly during the setting up of a project. Let us highlight three points that back this approach.

The first point is well grounded with both cognitive ethnology and technology transfer specialists (Perrin, 1983): in order to make innovation function, it must find its points of anchorage in activity. Yet, with the exception of entirely automated devices (where the question regarding maintenance persists nevertheless), all technical devices are destined to be activated.. Second idea : If we try to analyze the processes by which an worker appropriate an innovation, we can observe that they take on two distinct forms : either the operator develops new techniques stemming from those he or she already disposes of, or he/she adapts, modifies, transforms the devices to mould them to his/her own constructions. This is one of the main results from work carried out on “instrumental genesis” (Rabardel, & Béguin, 2005). During these processes we can observe either an instrumentation (an evolution in the form of actions), or an instrumentalization (a process in which the subject enriches the artifact’s properties). Third point.: these appropriation of artifact processes plot a general dimension of the activity : development by the subject, of the resources of his or her own action. This development concerns instrumental genesis, as below, but also competences (Pastré, 1999) as well as subjectively organized forms of action within collectives, such as « genre » (Clot, 1999). As a result, the stake lies in articulating, within one same movement, specification of artifacts by designers and development of their own resources by the workers.

Is this position compatible with the reality of design processes? A variety of analytical work on designer activity has shown the importance of mutual learning. Each designer, within his or her activity, is learning, as states the famous metaphor of the “*reflexive conversation with the situation*” proposed by Schön (1983). According to this author, the design process can be described as an open-ended

heuristic during which the designer, striving to reach a goal, projects ideas and knowledge. But then the situation “*replies*”, “*surprises*” the designer by presenting unexpected resistances, sources of apprenticeships. However, design is a collective process. The “*reflexive conversation with the situation*” often takes place in a “*dialogue*” with the object of design, through graphic experiments. But the object is not alone in talking back; the other actors “*reply*” and “*surprise*” too. The result of one designer’s activity is at best a hypothesis that will be set back into motion on the basis of another designer’s activity. Hence, the idea is to favour a dialogical process, where the operator is susceptible to learn from the temporary result of the designer’s work. And symmetrically, where the designer can be driven to carry out new apprenticeships resulting from the worker’s “*responses*” (Bødker, & Grønbeck, 1996 ; Béguin, 2003).

A supplementary point: this developmental approach is intrinsically participative: designers and workers participate in the design, according to their diversity and their own specificities. Is such an approach favorable to good health? Canguilhem shows that “*a Healthy man*”, is one who does not bear the constraints of an environment, but is capable of modifying it to assert his/her norms and life project (Canguilhem, 1966).

3.- Conclusion

These orientations cause distinct scientific and methodological programs. Simulation for example will be apprehended according to two extremes: either as the substitution of reality by its model, or as tools for learning within a community of experts (see Béguin, & Pastré, 2002 for such an approach). But in spite of their deep differences, they are not contradictory. They define a range of actions, which should be articulated in one cyclical process, during which the ergonomist can try:

- To identify the workers’ activity in their working situations or/and anticipate the future activity. This path consists in ensuring that the user’s activity will become a source for the designer’s activity.
- To support the design of flexible devices. This second path consists in ensuring that the result of the designer’s activity will become a source for the user’s activity, which will allow or facilitate the activity.
- To organize and facilitate dialogues between the designer’s activity and the user’s activity during the design process.

The work of ergonomists during design rests on his/her capacity to articulate these approaches, and the ability to translate them into operational proposals and methods adapted to the singularity of a given project.

REFERENCING

Béguin, P. (2007). Taking activity into account during the design process. @*activités*, 4 (2), pp. 115-121, <http://www.activites.org/v4n2/v4n2.pdf>

REFERENCES

- Bannon, L. (1991). From human Factor to Human Actor. In J. Greebaum, & M. Kyng (Eds.), *Design at Work: Cooperative Design of Computer systems* (pp. 27-44). Mahwah: LEA.
- Béguin, P. (2003). Design as a mutual learning process between users and designers. *Interacting with Computers*, 15 (5), 709-730.
- Béguin, P., & Pastré, P. (2002). Working, learning and designing through simulation. In S. Bagnara, S. Pozzi, A. Rizzo, & P. Wright (Eds.), *Proceedings of the 11th European Conference on Cognitive Ergonomics: cognition, culture and design*, pp 5-13.

- Bødker, S., & Grønboek K. (1996). Users and designers in mutual activity: an analysis of cooperative activities in systems design. In Y. Engeström, & D. Middleton (Eds.), *Cognition and communication at work* (pp. 130-158). Cambridge University Press.
- Burns, C.M., & Vicente, K.J. (2000). A participant-observer study of ergonomics in engineering design: how constraints drive design process. *Applied Ergonomics*, 31, 73-82.
- Canguilhem, G. (1966). *Le normal et le pathologique*. Paris: PUF
- Clot, Y. (1999). *La fonction psychologique du travail*. Paris: PUF.
- Daniellou, F. (2004). L'ergonomie dans la conduite de projets de conception de système de travail. In P. Falzon, P. (Ed.), *Ergonomie* (pp. 359-374). Paris: PUF.
- Daniellou, F., Laville, A., & Teiger, C. (1983). Fiction et réalité du travail ouvrier. *Cahiers Français de la Documentation Pédagogique*. N° 209, Janv./Fév., 39-45.
- Daniellou F., & Rabardel P. (2005). Activity-oriented approaches to ergonomics: Some traditions and communities. *Theoretical Issues in Ergonomics Science*, 6 (5), 353-357.
- Engeström, Y. (1999). Expansive visibilization of work: An activity theoretical perspective. *Computer Supported Cooperative Work*, 8 (3), 63-93.
- Freyssenet M. (1990). Les techniques productives sont-elles prescriptives? L'exemple des systèmes experts en entreprise. *Cahiers du GIP Mutations industrielles*, Paris.
- Larcher, G (2004). *Discours de clôture du 7° Forum international travail santé*, www.travail.gouv.fr
- Léplat, J. (2000). *L'analyse psychologique du travail en ergonomie*. Toulouse: Octarès Editions.
- Miettinen, R. (2000). Ascending from the abstract to the concrete and constructing a working hypothesis for new practices. In V. Oittinen (Ed.), *Evald Ilyenkov's philosophy revisited* (pp. 111-130). Helsinki: Kikumora Publications. Series B13.
- Pastré, P. (1999). La conceptualisation dans l'action: bilan et nouvelles perspectives. *Education permanente*. 139 (2), 13-35.
- Perrin, J. (1983). *Les transferts de technologie*. Paris: La découverte.
- Rabardel P., & Béguin, P. (2005). Instrument Mediated Activity: From Subject Development to Anthropocentric Design. *Theoretical Issues in Ergonomics Sciences*. 6 (5), 429-461
- Randell, R. (2003). User customisation of medical devices: The reality and the possibilities. *Cognition, Technology and Work*, 5 (3), pp 163-170.
- Rasmussen, J. (2000). Human Factors in a dynamic information society: Where are we heading? *Ergonomics*, 43 (7), 869-879.
- Robinson M., (1993). Design for unanticipated use ... In D. Michelis de, C. Simone, & K. Schmidt (Eds.), *Proceedings of the third European conference on C.S.C.W* (pp. 187-202). Dordrecht, The Netherlands: Kluwer Academic Press.
- Schön, D. (1983). *The reflective practitioner. How professionals think in action*. Basic Book, Harper Collins Publisher, USA.
- Suchman L. (1987). *Plans and situated actions*. Cambridge: Cambridge University Press.
- Theureau, J., (1997). L'utilisation des simulateurs de salle de contrôle de réacteur nucléaire et de cockpit d'avion à des fins autres que de formation : présentation et discussion des tendances actuelles. In P. Béguin, A. Weill-Fassina (Eds.), *La simulation en Ergonomie : connaître, agir, interagir* (pp. 104-123). Toulouse: Octarès Editions.
- Vicente, K. J. (1999). *Cognitive work analysis: toward safe productive and healthy computer-based works*. London: Lawrence Erlbaum Associates Publishers.
- Wilson, J. R. (2000). Fundamentals of ergonomics in theory and practices. *Applied Ergonomics*, 31, 557-576.

Wisner, A. (1995). The Etienne Grandjean Memorial Lecture. Situated cognition and action: Implications for ergonomic work analysis and anthropotechnology. *Ergonomics*, 38 (8), 1542-1557.

RÉSUMÉ

Durant la conception, il existe une disproportion entre les soins apportés à la fabrication des machines ou à la définition des organigrammes et l'attention portée à ceux, qui par leur travail en assurent le fonctionnement quotidien. C'est ce déséquilibre que l'ergonomie tente de corriger. Cependant, il existe différentes manières de définir et de prendre en compte l'activité de travail. Dans cet article, on propose d'en distinguer trois, respectivement : la cristallisation, la plasticité et le développement.

MOTS CLEF

activité de travail, conception, pratique professionnelle des ergonomes.

RESUMEN

Durante el diseño, existe un marcado desfazaje entre el cuidado con que se fabrican las máquinas o con el que se definen los organigramas y la atención dada a quienes, a través de su trabajo, aseguran el funcionamiento cotidiano. Es este desequilibrio el que la ergonomía intenta corregir. Sin embargo, existen diferentes maneras de definir y de tomar en consideración la actividad de trabajo. Este artículo propone distinguir tres formas, respectivamente: la cristalización, la plasticidad y el desarrollo.

PALABRAS CLAVE

Actividad de trabajo, diseño, práctica profesional de los ergónomos