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Analyzing ergonomists' practice using ergonomics models

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This text presents a reflective view on the nature of ergonomics practice, based on socio-cognitive models of reasoning and of service interaction. More than often, ergonomists have a fuzzy or even inaccurate understanding of their own activity. This inaccurate model leads to unrealistic anticipations on the results of ergonomics practice and inadequate positioning during ergonomics interventions. This is, at least in part, a result of the history of the discipline. Ergonomics is grounded in physiology and engineering, from which we have imported models that may not apply to us in a straightforward way. This is supposing that these models were adequate for physiology and engineering, an assumption which also could be debated.
There are three reasons why we should investigate the nature of ergonomics practice : to better understand ourselves, to work better as ergonomists, and to devise appropriate training programs.
There are three candidate paradigms for characterizing ergonomists' practice, which will be considered successively :

- diagnosis : ergonomics practice as a rule-based, structure induction activity ;
- design : ergonomics practice as ill-defined problem solving ;
- service : ergonomics practice as a collaborative problem solving activity .

1. Diagnosis : Ergonomics practice as a structure induction activity

A frequent metaphor for describing ergonomists' activities is that of the physician. According to that metaphor, as the physician, the ergonomist's task consists in identifying the nature of the disorder affecting the "patient" and to choose and and apply appropriate "medications" to get rid of the problem, that is to put the system back in a satisfactory state. In more psychological terms, the task of the ergonomists and of the physician combines a structure induction process (organizing symptoms in a significant pattern) and a state transformation process (applying rules for going from one state to another one).
There are two corollaries to this paradigm. First, that the application of appropriate scientific knowledge to a problem leads to a single solution, in terms of both problem identification and problem solving. Second, that the use of the same scientific knowledge by different competent individuals yields the same solution. Thus, there is a one-to-one mapping between problem and solution.

However, this is not what empirical results show. For instance, Pollier (1992) has compared the performance of 4 ergonomists (MSc, 5 to 12 years of experience in the HCI domain) in assessing the usability of the same interface (the interface had been degraded on purpose). Subjects were given ample time. Here are some suggestive results :

- 60% of the problems are spotted only once ;
- each subject spot (in average) only 42% of the total of reported problems ;
- reported problems are related to the specific expertise of each subject

Strategies of problem identication are subject-specific. They are not pre-defined, but oriented by the problems previously identified. Globally, the overall approach is not systematic and not exhaustive. It is opportunistic.

These results cast a lot of doubts on the myth of a discipline producing diagnoses consistent across subjects and using well-established and stable procedures. These observations may worry some : subjects do not end up with the same conclusions and proceed in different ways, in spite of their good level of training and experience. How should these results be understood ? I believe they can be attributed to the nature of ergonomics activity. But a paradigm shift is now necessary.

2. Design : Ergonomics practice as ill-defined problem solving

This second paradigm considers that ergonomists' activity is a design activity. What is meant is not necessarily that the ergonomist is engaged in designing some object, but that the organization of his activity has all the characteristics of design problem-solving. Now, what are these characteristics ?

First, design problem-solving means facing ill-defined problems : the initial state is not fully known, the goal to reach is to be defined, the path towards the solution is to be built (there is no pre-defined procedure). Second, design problems are multi-dimensional : they require to take into account and coordinate many levels (technical, physical, cognitive, organizational, social). Third, solutions are multiple solutions : there is not a single solution to a design problem, but a set of possible solutions, which can be evaluated against many criteria, some of the conflicting. Lastly, contrary to other types of situations (such as e.g. mechanical maintenance), there is a simultaneous construction of the problem and of its solution. It can be also added that in many cases, design problem solving is not an individual activity, but involves multiple actors.

It is probably obvious to many that these characteristics are very similar to those of the problems addressed by ergonomists : ill-defined and multi-dimensional problems, with multiple solutions, and concurrent elaboration of the problem and of its solution. In particular, in terms of design, task analysis can be seen simultaneously as a first definition of the constraints, a restriction of the problem space and a first element of solution.

This is even more so when one adds to these observations the remarks of Schön (1982) and Visser (2002, 2004) on Simon's seminal work on design. Design problem-solving, as viewed by Simon, proceeds in two steps

- step 1 : the ill-defined problem is structured into a set of well-defined subproblems
- step 2 : the well-defined subproblems are solved

According to Visser, this two-steps model is unrealistic : observations of real-life design problem-solving do not show these two successive steps. Schön develops an interactive view of practice, in which the practitioner "dialogue" with the situation : the situation

reacts to the practitioner's action, thus providing new data, thus new possibilities for action.

For Schön, Simon pays too little attention to problem-setting, which is a crucial part of the reasoning. He states : "Problem setting is a process in which, interactively, we name the things to which we will attend and frame the context in which we will attend to them." "In real-world practice, problems do not present themselves to the practitioner as givens. They must be constructed from the materials of problematic situations which are puzzling, troubling, and uncertain."

An empirical study by F. Lamonde (2000) of the practice of an ergonomist concurs with Schön's viewpoint. Lamonde's method consists in observing an experienced ergonomist in action. Here are some of her observations (my translation):

- ergonomic intervention is "tied to the particular circumstances which, here and now, the ergonomist is facing or which (s)he constructs "
- the ergonomist's task "is not given : [the ergonomist] has to build up the contours of their own activity (task analysis, interlocutors with whom negotiation should take place, type of relationships to develop, etc.), (s)he has to build up the path (constraints included) of the intervention while (s)he discovers it."
- "the activity during an intervention is in constant construction until the intervention is completed. Thus, the understanding of what the ergonomist knows and does evolves all along the intervention […]"

Thus, Lamonde sees the ergonomist's practice as a situated, case-specific and dynamic process. For her, as for Schön, problem-setting does not precede problem-solving : it is part of it.

3. Service : Ergonomics practice as a collaborative problem-solving activity

The preceding sections could be understood as meaning that practice in ergonomics can be analyzed by itself, separated from the actions of others. This section will take an opposite view. Ergonomics practice will be seen as a joint effort of an ergonomist and of others. Another paradigm will be used, that of service situations.

Service interactions have four characteristics :

- partners (i.e. the customer and the service provider) share a common goal : satisfy the needs of the customer;
- partners have different means and competences ;
- partners both have means, of a different nature. Although service interactions are often felt as unequal, asymetrical, it is to be stressed that the customer and the service provider are complementary . Contrary to what is often, intuitively, thought the task cannot be completed by the service provider alone ;
- a socially defined relationship that implies the service provider 's acceptance to the provision of help, the sincerity of the customer's request, the obligation of both partners to make use of their means to reach the common goal.

Thus, service situations can be seen as cooperative activities. However, this also depends on the type of relationships that is negotiated between customer and service provider. Schön (1982) distinguishes between two types of (implicit) contract : traditional or explicit, as shown in table 1.

Following the same lines, Sardas (2002) indicates that economical model of relations between the service provider and the client has evolved over time, from a client-provider relation to a relation of partnership. The client-provider relation is

characterized by a "closed and complete" contract between the two sides : what the client wants is stipulated from the beginning in a contract and no discussion is to take place between the order and the provision of the service. This entails that clients need to know precisely what they want and that the service providers are sure of being able to provide the desired services. In this model, there is no way to modify the contract during task completion. No matter if the client has made a mistake, or if the provider finds unexpected difficulties (or new possibilities). Any change to the contract is perceived negatively and not as an unavoidable and positive phenomenon, which allows the partners to learn and achieve a better performance. On the contrary, as Sardas notes, incidental learning is perceived negatively, as provoked by an unavoidable gap between an ideal model of the client-provider contract and reality.

Traditional contract	***Reflective contract***
I put myself into the professional's hands and, in doing this, I gain a sense of security based on faith.	I join with the professional in making sense of my case, and in doing this, I gain a sense of increased involvement and action.
I have the comfort of being in good hands. I need only comply with his advice and all will be well.	I can exercise some control over the situation. I am not wholly dependant on him ; he is also dependant on information and action that only I can undertake.
I am pleased to be served by the best person available.	I am pleased to be able to test my judgments about his competence. I enjoy the excitement of discovery about his knowledge, about phenomena of his practice, and about myself.

Table 1 : Traditional contract and reflective contract (from Schön, 1982)

The partnership model postulates that the client's needs are unstable, may evolve in the course of the interaction with the service provider. The consequence is that providers have no guarantee that they will possess the competencies allowing them to provide the service : some of these competencies may need to be elaborated in the course of the contract. So the partnership model implies that :

- the provider must accept that clients do not know precisely what they want ;
- the client must accept that providers do not know precisely whether they will be able to complete the task

Thus the partnership relation entails the sharing of a common will to jointly elaborate needs, solution, and knowledge. Partners share cooperation rules : each agrees to let the other know their own difficulties, the problems the other may meet, to contribute as much as possible to solve them. Defining needs is no longer the client's problem, defining solutions is no longer the provider's problem. The consequence is mutual learning. Each learns through interacting with the partner, while solving an ill-defined problem.

Again, much of what is said above on service interactions can be applied to ergonomics practice. The ergonomist's action is negotiated in situation, through the interaction with service seekers. Of course, this will vary, due to several factors. Problems vary in complexity : in some cases, general rules or a memorized similar case can be used ; in others, the situation is new and multi-dimensional. Problems vary also temporally : the

intervention may be required for a short period, whereas in other cases a long-lasting intervention will allow the ergonomist to develop a partnership relation with the client.

Conclusion

As the text has shown, the representation of our own activity as ergonomists may vary. What is the genre of ergonomics practice ? Do we see ourselves as engineers ? as physicians ? Do we see ergonomics as hard science ? Do we see ergonomics practice as merely applying rules and data ? These questions are useful for all ergonomists, in order to better understand and control their own actions.

Answering these questions have a particularly important effect on the assessment of ergonomics interventions. The literature related to this issue tend to focus on quantitative measures of performance : effects on accident rates, on errors, on various economic factors, etc. This is certainly useful, but assessment cannot be limited to such measures. Assessment should also be :

- qualitative : effects can be material or immaterial (e.g. effects on knowledge development of persons involved in the action), visible or invisible (e.g. in designing an interface, or a workspace, the elimination of a *potential* problem has an instantly invisible effect : how does one assess this ?) ;
- iterative, and not only final : in a "design" or "service-based " model of assessment, assessment serves as a way to guide action (i.e. it is more an evaluation than a control, to use the distinction established in section 1) ;
- participative, in the sense that it should be the result of a negotiation with the client and that the client could be involved in the assessment process.

Finally, assessment depends on the model we have for the practice of ergonomics. If one uses a diagnosis model of ergonomics practice, it may be that a quantitative measure of performance will be appropriate. However, both for the design model and the service model, a combination of quantitative and qualitative assessments, negotiated with the client, will be better adapted.

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