

What Is Prospective Ergonomics? A Reflection and a Position on the Future of Ergonomics

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Abstract. This paper presents a reflection on the future of ergonomics and a clear position for the use of prospective in this discipline. We propose to structure ergonomic activities around corrective, preventive (design) and prospective ergonomics, where the latter looks forward in time to defining human needs and activities so as to create human-centered artifacts that are useful and provide a positive user experience. The place of prospective ergonomics is upstream of projects, before a problem or request is raised by a client, and before projects exist. We describe several characteristics of prospective ergonomics and compare them with those of corrective and preventive ergonomics. We show that prospective ergonomics has major impacts on education and practice, since ergonomists should not only be trained as human factor experts but also as strategists to reflect on the future and as project managers. Prospective ergonomics requires the “intelligence analysis” of a lot of data and experts’ opinions, as well as perspicacity, intuition, creativity, motivation and initiative. It represents a huge potential for the advancement and evolution of ergonomics and for the achievement of its full maturity.

Keywords: Corrective ergonomics; Preventive ergonomics; Prospective ergonomics; Design; Human-centered projects.

1 Introduction

In this article we present a reflection on the future of ergonomics and we take a clear position for the use of prospective in this discipline. We reconsider the classification of ergonomic activities in two large categories that are commonly mentioned by authors and that correspond to corrective and preventive ergonomics. We propose to define three categories of activities around corrective, preventive, and prospective. This exercise is not only academic since we believe it may have a major impact on our discipline. Above all, it allows us to emphasize a new type of activity that should be promoted in our field: the prospective. In the new classification, we continue to use corrective ergonomics whose role is clear and consistent among authors. We use preventive ergonomics to cover all design activities that were included so far in what authors called prospective ergonomics, and we add prospective ergonomics with a new content entirely related to prospective.

In the earlier classification, there was almost complete overlap between design and prospective. Authors considered that design *is* prospective since one is searching for new ideas, concepts, and solutions that will hopefully lead to the creation of artifacts. We have reservations regarding this position because we consider that such overlap limits the scope of prospective ergonomics by leaving the prospective completely in the shadow. Prospective ergonomics should not be limited to the mining of ideas for projects that have already been decided and that exist somehow, almost always due to others' initiative. This corresponds to what we call the *defined future*. In fact, its scope is much larger than that. It should include the search for projects that have yet not been decided and that do not even exist, and that might come true due to ergonomists' initiative. This corresponds to what we call the *undefined future*. The goal of the restructuring with the addition of prospective ergonomics is to shed light on the challenge of dealing with the future and innovation.

By so doing, while preserving the current assets of ergonomics for correction and prevention (or design), we expand the field of the discipline by pushing the boundaries and discovering a new territory: the prospective. We also enlarge the roles and enrich the tasks of ergonomists by giving them new responsibilities and challenges as strategists and managers. This major change calls for a debate on the validity of doing prospective in ergonomics, and for an analysis of the impacts of this new kind of activity on education and practice. Our hope is that our reflection and position in favour of the prospective will contribute to the advancement and evolution of ergonomics, and to the achievement of its full maturity.

The article is structured as follows: we introduce and define prospective ergonomics, we describe its characteristics and compare them with those of corrective and preventive ergonomics, and we examine its impacts on education and practice.

2 Definition

Prospective is concerned with or related to the future. More precisely, it consists in looking forward in time (as opposed to retrospection) through the "intelligence analysis" of several factors (individual, social, cultural, political, economic, scientific, technological, environmental) whose relative importance depends on each line of business, and of multiple data, experts' opinions, and scenarios of the future ([3,10]). It yields uncertain results because of the difficulty to predict the future. It is used in a variety of areas such as consumption, jobs, technology, energy, financial markets, movement of people, etc. One can adopt four different attitudes and behaviours when facing the evolving future:

- Reactive: opposing the changes to come and trying to slow, stop, or even reverse it;
- Passive: taking no positive or negative actions, yielding to or accepting it;
- Active or proactive: taking positive actions to rapidly adjust and even taking advantage of the change;
- Leading: taking positive actions to initiate, orient, drive and even accelerate the change to come.

Prospective ergonomics is obviously related to the future. The scope it was given by different authors actually corresponds to that of preventive ergonomics, and it is this

restricted prospective ergonomics that they compared to corrective ergonomics. M. de Montmollin [6] talks of corrective ergonomics and preventive ergonomics, the former for correcting existing artifacts, and the latter “for systems that do not exist yet in reality; it is ergonomics at the stage of project”. He is the only author who uses the term preventive (*préventif* in French) to designate what others call prospective ergonomics. Laurig [5] associates “corrective ergonomics” with traditional ergonomics and describes it as developing “corrections through scientific studies”, whereas “prospective ergonomics” corresponds to a more modern approach that brings a more-forward looking concept of design. Later, Laurig & Vedder [7] asserted that “prospective ergonomics means searching for alternatives in work design which prevent fatigue and exhaustion on the part of the working subject in order to promote human productivity (“... for the benefit of ourselves and others”). Bubb [2] examines the difference in ergonomics between the traditional “*a posteriori*” design and the modern “*a priori*” design which uses computer-based human models. This observation leads from an earlier “corrective ergonomics” to a new “prospective ergonomics”. Finally, Karwowski [4] compares “retrospective analysis” to “prospective analysis”, where the former corresponds to past-oriented activities (e.g., root cause analysis, cognitive task analysis, ethnographic studies) and the latter corresponds to future-oriented activities (e.g., creative thinking, evaluation of consequences). The difference between them is consistent with that made by previous authors between corrective and prospective ergonomics.

On one hand, we agree with the common position of these authors concerning a broad distinction between a past-oriented corrective ergonomics and a future-oriented prospective ergonomics since it is clear enough, it has a high face validity, and it can be useful for identifying these two categories of activities. On the other hand, we are critical, but also constructive, about the position of these authors concerning the content and scope of prospective ergonomics. First, there is an overlap between design and prospective in their definitions of prospective ergonomics since both are basically perceived as looking forward for ideas and concepts. Even though design is future-oriented, it does not have the same scope and it is not concerned with the same activity as prospective. Second, the future is too short-term and the actions are too low level in their definitions of prospective ergonomics. They simply correspond to the use of modern future-oriented design methods that help designers to do their work. A good example of this is the common use of scenarios in human-computer interface design [9]. Third, there is no distinction between existing projects initiated by others where the ergonomist plays the role of a human factor expert, and non-existing projects that will be initiated by the ergonomist and where he/she will play the roles of strategist, manager, and human factor expert. Our critiques are about positions that limit too much the scope of prospective ergonomics. Our standpoint is that it is different from the design activity, it should not be too short-term nor too low level, and it should not be limited to already existing projects and to projects initiated by others. Prospective ergonomics goes far beyond that.

Thus, we propose to have a new classification of activities around corrective, preventive, and prospective ergonomics. In this classification, the content of corrective ergonomics is the same as it was in the definitions and explanations given by the above mentioned authors. The content of preventive ergonomics focuses on design and corresponds to nearly all of what the authors included in prospective ergonomics.

The content of prospective ergonomics is redefined since most design activities were transferred to preventive ergonomics and since the focus is now on prospective. This will be the scope and the niche of prospective ergonomics for the rest of the paper.

3 Prospective Ergonomics

Prospective ergonomics can be defined as the part of ergonomics that attempts to anticipate human needs and activities so as to create new artifacts that will be useful and provide positive user experience. Different criteria can be used to evaluate the user experience, namely well-being, human development, learning, entertainment, pleasure, networking, sense making, performance, satisfaction [8]. Its place is upstream of projects when there is no request or problem brought by a client, and no existing project; it corresponds to the very first step of projects such as can be found in various design disciplines (e.g., industrial design, engineering, computer science, film making).

The anticipation of human needs and activities is based on the analysis of numerous factors and data, and on scenario planning as it is done in prospective. It requires having close contacts with people in their environment in order to be able to observe and interview them and collect data on different aspects of their life.

Prospective ergonomics emphasizes the investigation of the use of artifacts to discover their strengths and flaws, and sources of satisfaction and dissatisfaction that could lead to the improvement of current artifacts or the design of new ones [1]. Furthermore it is human-centered since users should be involved in the anticipation exercise through interviews, observations, surveys, complaints analysis, usability tests, emotions evaluations, satisfaction and performance measurements, etc. Finally, prospective ergonomics requires a sharp sense of observation for ergonomists and a great deal of perspicacity, intuition, creativity, motivation (with an entrepreneurial mindset), and initiative to innovate.

Prospective ergonomic is multidisciplinary since it relies on the theories, models, methods, and tools of human and social sciences (e.g., anthropology, sociology, ethnography, demography, psychology, marketing, epidemiology) to define future human needs and activities, and on those of computer science and engineering to anticipate the evolution and cost of technology that will support future interactive artefacts.

Prospective ergonomics partially overlaps corrective ergonomics and preventive ergonomics, and these two partially overlap, as shown in Figure 1. Design is often required in corrective ergonomics to conceive and develop solutions. Correction is inevitable in preventive ergonomics to change and improve different versions of a design, and prospective may apply to both correction and design. For instance, in a specific project, one looks forward in time to finding other applications of the solution or the design, or other groups of users that could benefit from it. For instance, in a bottom-up process, a problem addressed in corrective ergonomics (e.g., sleepiness of truck drivers that causes accidents) may generate the development of an innovative solution (e.g., head movement recognition system connected to a warning system) that could apply to other groups of people with the same problem (e.g., system controllers).

Prospective ergonomics can operate both in a technology-pull mode and a technology-push mode. The former means that human needs precede, stimulate, and orient

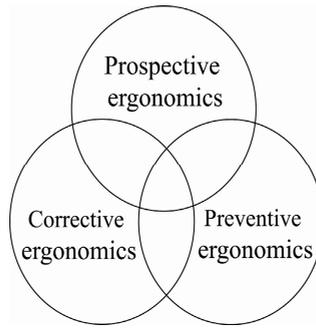


Fig. 1. Interaction between corrective, preventive, and prospective ergonomics

the development of technology, whereas the latter means that technology is available but has not found applications thus far. Considering the increasing number of computer-based interactive artifacts that people will be using in the future, and the importance of technology in innovation, it can be predicted that most projects that will emerge from prospective ergonomics will be strongly influenced by computer technology.

For obvious reasons, projects that will come out of prospective ergonomics will have to go through feasibility tests, cost/benefit analyses, and comparative studies. The projects that will be retained after selection will require financial set-up. The commercial dimension is explicit and brings to the fore the need for ergonomists to have management skills. Despite the unavoidable technical and financial evaluation criteria, since these projects are all concerned with future human activities, they should be guided by positive values that improve the quality of life.

Prospective ergonomics is explicitly associated with innovation. Its middle-term and long-term temporal coverage, high-level actions, as well as the inevitable role of technology may create favorable conditions. Even though corrective and preventive ergonomics can also lead to innovation, they are different on this point because innovation is not their primary goal, and the solution or design they propose is limited to specific projects.

Prospective ergonomics seems ready to be adopted judging from young ergonomists' reactions. In our teaching, we encounter numerous graduate students coming to human factors from different design-oriented disciplines (e.g., industrial design, graphic design, engineering, computer science, architecture, information systems). They end up with multiple competencies in human factors and in design, engineering, computer science, management, and sociology. Some of them, who are both innovative and endowed with an entrepreneurial mindset, want to pursue their design activity in human factors projects. Prospective ergonomics seems natural to them because it offers an opportunity both to innovate and have an impact on others' lives.

We end this section with Table 1, which presents a comparison of the main characteristics of corrective, preventive and prospective ergonomics. This will help to have an overview of the specificities of each branch of ergonomics.

Table 1. A comparison between Corrective, Preventive, and Prospective Ergonomics

	Corrective Ergonomics	Preventive Ergonomics	Prospective Ergonomics
<i>Temporality:</i>	Past	Present	Future
<i>Nature of work:</i>	Correction	Design	Anticipation
<i>Starting point:</i>	The request of a client (problem to correct)	The request of a client (object to design)	The initiative of the ergonomist (object to create)
<i>Main focus:</i>	The problem to correct	The artifact to design	The needs and activities to define
<i>User sample:</i>	Small	Variable (depending on the project)	Variable (usually large)
<i>Associated disciplines:</i>	Anthropometry Biomechanics Physiology Psychology Engineering Computer science Design	The same + Anthropology Ethnography Sociology Arts	The same as the two previous ones + Management Marketing
<i>Focus of data collection:</i>	Causes of losses such as accidents, incidents, errors, overload, etc.	Users' responses to prototypes and simulations	People's complaints, needs, expectations, and responses to simulations
<i>Status of the human factors:</i>	Recovering factor	Integrating factor	Innovating factor
<i>Nature of the intervention:</i>	Reactive	Active	Anticipatory
<i>Production of wealth:</i>	By reducing or eliminating losses	By optimizing performance and user experience	By creating new products or services
<i>Possibility of revenues:</i>	Low	Medium	High

4 Impacts on Education and Practice

The new scope we give to prospective ergonomics in this paper calls for a revision of current educational programs. It is no longer sufficient to train human factor experts to correct problems and design artifacts. Even though ergonomics remains their main strength, they must also be trained as strategists to look forward in time and be able to initiate projects on their own, and as managers to plan, finance, and make these projects come true. In our opinion, this requires the acquisition of new knowledge in at least five areas: prospective (e.g., strategic planning), innovation, product development, marketing (e.g., of new technology), and management (e.g., financial set-up, project management). The detailed analysis of an enriched educational program in ergonomics requires a broad discussion in the human factor community; however this falls outside the scope of this paper.

The new scope of prospective ergonomics is also expected to have a major impact on ergonomists' tasks since they may choose to become strategists and managers. With prospective ergonomics, ergonomists not only do correction and design for specific projects, but also search for new ones. They not only work on others' projects, but also on their own. They not only react to requests, but are also proactive with their own projects. They not only join design teams and provide human factor expertise, but also solicit expertise. They are not only managed by others, but also manage their own projects. With these new responsibilities, ergonomists will become more versatile and autonomous. These changes in the profession are expected to improve the status and recognition of the profession.

5 Conclusion

Prospective ergonomics provides ergonomists with the opportunity to play a constructive and active role in the definition of the future. It encourages them to be creative, innovative, and inventive, and to initiate and pilot their own human factor projects. It represents a great opportunity to expand the field, acquire new skills in prospective, innovation and management, enlarge their roles and tasks, and improve the status and recognition of the profession. Above all, it allows the discipline to make a giant step in its development and evolution and acquire its full maturity.

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References

1. Brangier, E., Bastien, J.-M.-C.: L'analyse de l'activité est elle suffisante et/ou pertinente pour innover dans le domaine des nouvelles technologies? In: Vallery, G., Amalberti, R. (eds.) *L'analyse du travail en perspectives: influences et évolutions*, pp. 143–156. Octarès, Collection "Entreprise", Travail, Emploi, Toulouse (2006)
2. Bubb, H.: Ergonomic design by means of human models. In: *Human Factors and Ergonomic Society Annual meeting Proceedings, Proceedings 6 - Multiple Session Symposia*, vol. 51, p. 814. Human Factors and Ergonomic Society (2000)
3. Godet, M., Roubelat, F.: Creating the future: The use and misuse of scenarios. *Long Range Planning* 29(2), 164–171 (1996)
4. Karwowski, W. (ed.): *International Encyclopedia of Ergonomics and Human Factors*, 3278 p. CRC Press Inc./ Taylor & Francis (2006)
5. Laurig, W.: *Prospective Ergonomics: New Approach to Industrial Ergonomics*. In: Karwowski, W. (ed.) *Trends in Ergonomics/human Factors III*. Elsevier Science Publisher B.V, North-Holland (1986)
6. Montmollin, M.(de): *Les systèmes Homme-Machine*. PUF, Paris (1967)

7. Laurig, W., Vedder, J.: Overview (section 29.2 on Ergonomics). In: Mager Stellman, J. (ed.) *Encyclopaedia of Occupational Health and Safety*, 4th edn., vol. 1, p. 29.2. International Labour Office, Geneva (1992)
8. Robert, J.-M.: Vers la plénitude de l'expérience utilisateur. In: *Proceedings of IHM 2008*. ACM International Conference Proceedings Series, Metz, September 3-5, 2008, pp. 3-10 (2008)
9. Rosson, M.B., Carroll, J.M.: Scenario-based design. In: Jacko, J., Sears, A. (eds.) *The human-computer interaction handbook: Fundamentals, Evolving technologies and Emerging applications*, LEA, pp. 1-35 (2002)
10. Roubelat, F.: Scenarios to challenge strategic paradigms: Lessons from 2025. *Futures* 38, 519-527 (2006)