



Texte original.*

Interactive methods to involve users into workspace design process

Carolina CONCEIÇÃO¹, Ole BROBERG¹, Palle BANKE², Per ALDRICH³

¹ DTU Management Engineering, Technical University of Denmark, building 424, 2800 Kgs. Lyngby, Denmark

² Technological Institute, Gregersensvej, 2630 Taastrup, Denmark

³ COWI A / S, Parallelvej 2, 2800 Kgs. Lyngby, Denmark

casou@dtu.dk

Abstract. This paper addresses the question of whether the use of a combination of interactive methods involving workers can lead to a useful input to the (re)design of their workspace. The workbook and the layout design game methods were tested, and a comparison between their use and the ergonomic analysis carried by the researchers was done. An intervention due to the redesign of a cheese packaging production line in a dairy company was used as the case study for this analysis. The case and the methods used are presented as the basis for the discussions on top of the results obtained during the intervention. A better understanding of the current production line and suggestions on the new layout propositions are the main results. And the discussion focus on the possibility of these more “handy” and less time consuming methods, allowing the users’ involvement in the process and giving input for the workspace design, to be more easily applied by less experienced ergonomists.

Key words: workplace and equipment design ; design and development process ; work organization and sociotechnical systems.

Méthodes interactives pour impliquer les utilisateurs dans le processus de conception des espaces de travail

Résumé. Cet article aborde la question de savoir si l'utilisation d'une combinaison de méthodes interactives pour impliquer les travailleurs peut mener à une contribution utile à la (re)conception de leur espace de travail. Les méthodes du cahier de travail et du jeu de conception de disposition ont été testées, et une comparaison entre leur utilisation et l'analyse ergonomique réalisée par les chercheurs a été faite. Une intervention due à la nouvelle conception d'une ligne de production d'emballage de fromage dans une entreprise de produits laitiers a été utilisée comme étude de cas pour cette analyse. L'affaire et les méthodes utilisées sont présentées comme base pour les discussions en dessus des résultats obtenus lors de l'intervention. Une meilleure compréhension de la ligne de production actuelle et des suggestions sur les nouvelles propositions de disposition sont les principaux résultats. Et l'accent de la discussion est sur la possibilité de ces plus "pratiques" méthodes et qui consomment moins de temps, permettraient l'implication des utilisateurs dans le processus et donneraient des éléments pour la conception de l'espace de travail, d'être plus faciles à appliquer par les ergonomes moins expérimentés.

Mots-clés: conception du lieu de travail et des équipements ; processus de conception et développement ; organisation du travail et des systèmes sociotechniques.

*Ce texte original a été produit dans le cadre du congrès de la Société d'Ergonomie de Langue Française qui s'est tenu à Paris du 28 au 30 août 2013. Il est permis d'en faire une copie papier ou digitale pour un usage pédagogique ou universitaire, en citant la source exacte du document, qui est la suivante :

Conceição, C., Broberg, O., Banke, P. & Aldrich, P. (2013). Interactive methods to involve users into workspace design process.

Aucun usage commercial ne peut en être fait sans l'accord des éditeurs ou archiveurs électroniques. Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page.

INTRODUCTION

Poorly-designed workspaces result in adverse effects on occupational health and safety, as well as reduced efficiency and productivity. This is a widespread problem throughout the industrialized world today. Many problems can be solved by applying existing knowledge. However, according to Wulff (1997), there is a gap between the academic and scientific knowledge and the existing practices, arising from lack of application of this knowledge in the practical world.

Ergonomics' object of study is the work activity. This way, the workspace is a means for accomplishing work activities that can be designed in such a way so as to favor its development. It is necessary to identify existing situations with characteristics similar to those to be developed in the future workspace to be designed, in order to observe the actual variability and the strategies used to address them. Beyond observing the work as it happens every day in the reference situations (ethnographic observation), ergonomics seeks to build a global understanding of the work situation. The results will serve to guide workspaces design and specify the work conditions in general.

With the aim of introducing work logics into the workspace design process, ergonomics has been present in some projects, although sometimes only at the end of the process, when some irreversible conditions have already been created. Acting in the design phase, however, makes it possible to obtain better working conditions, by avoiding the risk of work-related illnesses, and increasing work efficiency at less cost (financial and human) than with corrective interventions.

In this sense, the ergonomic analysis aims at enlarging knowledge on work conditions, producing knowledge oriented to respond to specific demands of design and organization of production processes. And the effectiveness of ergonomics rests on the ability to provide the design team with relevant information on user activity from the beginning of the design process. Bucciarelli (1994) describes engineering design as a social process, influenced by different groups of people with different perspectives and values. However, as Meister and Farr (1967) have already reported, designers are not always able to anticipate problems in operation or maintenance associated with design items. And precisely, one of the arguments for users' participation in design processes is exactly the improvement in result quality (Granath, 2001).

The intervention presented in this paper is directly related to users' involvement during the design process as an input to engineering design. Due to the redesign of a cheese packaging production line in a dairy company, an ergonomic analysis was performed at the current production line and a combination of two interactive methods was used aiming at involving the users during the design process. Such methods as the workbook and the layout design game had a double goal: 1) help in the understanding of the actual work practices and activities at the cheese packaging production line; and 2) give input to the designers in order to define the layout of the new production line.

The research question then addressed here is if the use of a combination of interactive methods involving the users of a workspace can lead to input to redesign the place. These methods will be presented, together with the results achieved during the intervention, as well as a comparison between these results and the ones from an ergonomic analysis carried by the researchers. The aim was to test the use of these two methods, analyzing whether more "handy methods" would give useful input for the design process and, as being less time consuming than an ergonomic work analysis (EWA), be more easily applied by company ergonomists.

METHODS

The case

The redesign of a cheese packaging production line in the Danish facilities of a global dairy company is the case described in this paper. The company was in a process of expanding their main facilities area, which also included the moving of production lines previously running in other facilities sites. Part of this process was the expansion and renewal of the so called packaging line number 1. Where the production line would move to and how the process would be organized were still uncertain information when the research team started the intervention. But due to the deadlines already established, the project was already on the way.

The existent packaging line number 1 had one main production line and a secondary one. Both lines were used by the same workers, but in different days, depending on the kind of cheese coming from the salty room (where the cheeses rest into salty water after production and before being packed). There are four workers who operate in 8 hour shifts. The process is similar in both lines, but the main production line (Figure 1) was the one studied during the intervention because it was the one that would be renewed.

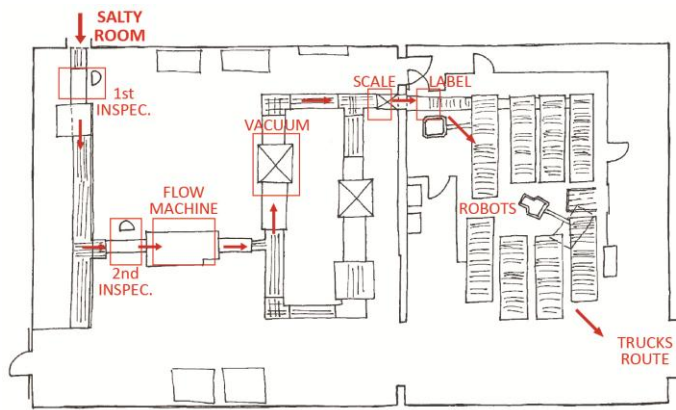


Figure 1 – Packaging line number 1

The process starts with the cheese coming from the salty room. There are two workstations for visual inspection of the cheese, in order to remove visible impurities. Then the cheese goes into the flow machine, where it receives a plastic cover, and into the vacuum machine, where the air is taken out of the plastic cover and the cheese gets sealed. The third worker takes care of both machines, and operates the cheese manually in case something goes wrong. Afterwards, the cheese is scaled and labeled before being taken by the robots that will pile it to be taken by truck to the next step in the whole production cheese process. The fourth worker takes care of the robots and also drives the truck bring the cheeses out.

In respect to the redesign of the packaging department, two other production lines would be part of the so called packaging line number 1. Both lines were also studied, but it turned out in the end that the main production line would be the one to be entirely redesigned. The project would include a change in the machinery and the technology used. This way, it was decided to stick to the observations made at the main production line, which process was described above. However, until the moment where they decided for a layout solution, it was still not clear how many workers would be working at the new line and if the new line would replace the existing one.

Testing two methods

In the case described here, the research team decided to use a combination of methods aiming at understanding the workers' activities in order to gather relevant data for the design of the new cheese packaging line. The ergonomic approach used was based on the principles of the ergonomic work analysis (Guérin et al., 2001) and the approach to future activity (Daniellou, 1992). The fundamental principle of the EWA is to emphasize the "real work" in contrast to the formal organization (Daniellou et al., 1989). This requires explaining the informal knowledge (tacit skills) of the actors, the criteria that guide their actions and the conflicting goals that shape their behavior at work. In general, such knowledge is

made accessible only after long observation and experience alongside actors in natural situations, i.e. in the context where they perform their daily activities. With this methodology, which combines observations and interviews, the activity in question can be understood before starting the process of designing the work tools and facilities.

The EWA, however, is a method that requires time and free access to the reference situations. In this case, the main reference situation was the packaging line itself that would be redesigned. However, some factors made it difficult to have the time for more detailed activities observations: 1) the long time taken to get management's approval for the intervention; 2) the redesign project's deadlines; and 3) the physical distance between the city where the dairy was located and the city where the researchers were. Nevertheless, other methods could be used in addition to the ergonomic analysis in order to achieve the results needed: better understanding of the work activities and inputs for the designers activities. This way, two other methods were applied in order to test them as sources of information and input for the design process.

The first method tested was the workbook (Horgen et al., 1999; Binder & Brandt, 2008; Broberg et al., 2011). During the first interviews with the users and observations at the production line, the researchers tried to identify some critical aspects of the workers' activities – both when the production line was operating normally and when unexpected situations happened. Some pictures were taken from these activities and then used to develop the workbook. It consists in an A3 paper format notebook with one to two pictures in each page. The workbook was presented and left with the workers for ten days with colored pens (Figure 2). They were asked to write comments on the pictures using a red pen to identify "bad situations" to be avoided in the next project, a green pen to identify "good situations" that should be kept and a yellow pen for general comments or to identify issues in which attention should be paid to.



Figure 2 – The workbook

Three workbooks were made in total: one for each of the three production lines studied. After the ten days, the researchers collected back the workbooks and an analysis was made on the comments. It was decided to classify the comments into five main categories: layout, ambiances (lighting, acoustics, thermal comfort), production line (fixed equipment), auxiliary/mobile equipment and work organization. And from the “categorized comments”, design guidelines were written, following the same “categories”, in order to facilitate the communication with the designers. Each guideline was based on the workbooks comments, but (re)written in order to lead to possible solutions for the new project.

Afterwards, the project evolved and it was decided that a completely new production line would take place. That was when a layout design game (Binder & Brandt, 2008; Broberg, 2010; Broberg et al., 2011) was introduced in a couple of workshops held with the users. By that time, the design team hasn’t opted yet for which technology would be used at the new production line; the game was then played considering both options. It consisted of an A1 sized hard game board with the drawing of the future production line area, but with no equipment placed. The equipment, instead, was provided in form of thick game pieces that could be moved around and placed by the workers where they thought would be the best solution for the layout (Figure 3). It was also brought to the workshop an A1 sized print of the first layout proposed by the design team for each of the options,

to serve as basis for the discussion, as well as the workbooks.

The result of the first workshop was a set of two layout propositions for each technological option. Pictures were taken from each of the layout options proposed during the workshop and the workers were given “homework” for the second workshop. They received a copy of these pictures and were asked to think about the comments made on the workbooks and the guidelines in relation to the layout possibilities. The goal was to make them think about their activities and the different situations during the work shift to see whether the layouts suited these activities or not. The research team had homework to do as well: besides also checking the workbooks and guidelines, a list of questions was made for the workers, making them try to “simulate” their activities in the possible new workspace.

During the second workshop, the workers presented their arguments based on the homework to the design manager. Good discussions took place around the options and the results were: one layout for one of the technologies, and still two layouts for the other technology. However, this time each layout had post-it notes placed giving reasons for each choice in positioning the equipment. Both positive and negative aspects were considered and written down. After the workshops, the research team categorized the comments, as it was made for the workbook comments, and listed them for the design team.

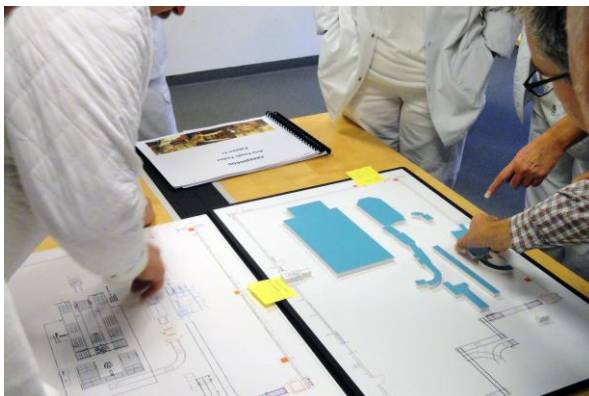


Figure 3 – The workshops and the layout design game

RESULTS

The main results achieved were, in a general terms, a better understanding of the existing production lines within the department (what was identified with the workbooks) and the use of this knowledge together with the expertise of the workers to redesign the first layout proposals for the new production line (the outcome of the layout design game). At a first stage, the results were the positive and negative aspects identified with the workbook (Figure 4), complemented by the ergonomic analysis and turned into design guidelines by the researchers.

There were very specific comments, e.g. positioning of equipment, access for the maintenance of the equipment, specific noise or light issues. And also some comments related to the production line layout, e.g. the need to go around the production line to access certain equipment or the importance to have visual contact with the whole line. In any of the cases, the workers pointed to “good” or “bad” solutions in their own work environment, based on their everyday activities. The comment of a negative aspect, identified in red in Figure 4, for example, says: “long way (to walk) and not appropriate to do things on the other side of the (production) line”.

With the guidelines, the comments were combined (in certain cases) in order to become more general and easier to apply for the new project. However, the pictures of the current situations were kept to maintain the visual reference. The comment quoted above, for example, turned into the following guideline: “it is important to make sure that all the main operations within the production line can be done without the need to go all the way around to the ‘other side’ of the line, making it a long way for the workers when they need to reach it fast”. Besides that, as already mentioned, both the comments and the guidelines were divided into five categories. The goal was to organize them from the broader to the more specific ones, trying to follow the designers’ “logics”, e.g. what the designers would need to know first.

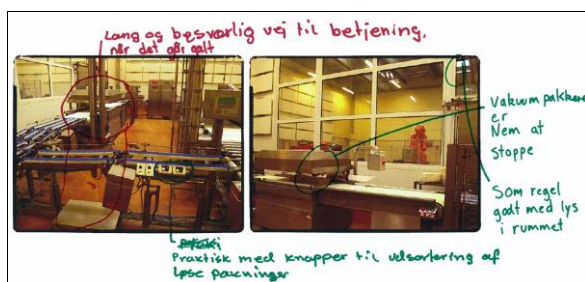


Figure 4 – Comments on one of the workbook’s page identifying positive and negative aspects

At a second stage, the main results were the layout options proposed by the workers. Not only the drawings themselves, but also the comments made identifying the positive and negative aspects of each layout option based on the previous observations and workbooks’ comments (Figure 5).

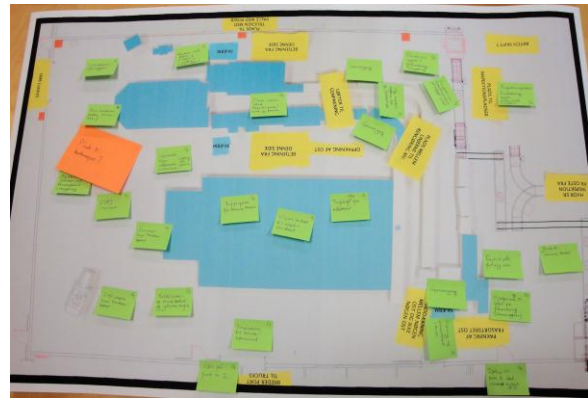


Figure 5 – One of the layout options with the post-it notes identifying positive and negative aspects

After being analyzed and compiled, the comments were kept in the drawing, but also numbered and listed in a separate spread from the most general ones to the more specific. Both the drawings and the listed comments were handed in to the project manager and the design engineer.

DISCUSSION

The positive value of taking the workers’ experience into account in the design of future workspaces is a very well-known subject in the ergonomic literature. However, getting this experience into engineering design is not easy and many are the methods discussed to achieve this goal. The aim of this paper, as mentioned before, was to test two of these methods used together during an intervention and to compare the results’ possibilities with the ones from the ergonomic work analysis methodology.

The reason for that is mainly the fact that the EWA is quite a time consuming method and not so easy to be applied by non-experienced ergonomists or company’s ergonomists (non-researchers). And the main reasons for choosing the methods tested are: 1) they are more “handy” and “easy to use” methods; 2) they are not so much time consuming; 3) they are interactive and based entirely on users’ participation and involvement ; and 4) they can give useful input for the design of new workspaces.

From the first results, directly related to the understanding of the current production line and to the identification of positive aspects (to be kept) and negative aspects (to be avoided), it was possible to see that the workbook and the ergonomic analysis complemented each other. In fact, it is worth mentioning that due to time limitations, only some observations and interviews were made, and not a full EWA. But some comparisons can still be made.

The main aspect noticed is that what was observed by the researchers and not commented by the workers on the workbooks are “broader issues”. Some examples are: the main flow/shape of the production line (if linear or in a “U” shape), the relations between the production line and the ceiling trails for the vacuum lift, or some aspects of work organization

related to double work to vacuum the cheese packs or to pile pallets. This might be explained by the fact that the workers focused on the immediate problems they face and not really in the relation among different aspects that could lead to each of the problems.

Nevertheless, one issue that should be highlighted is that, even if all the comments on the workbooks were made by the workers themselves, the pictures were taken and selected by the research team. In this way, one could argue that the researchers were, in a certain way, already guiding the workers to the situations they considered “important to be discussed”. An alternative way to apply the workbook method is to ask the workers to either take the pictures themselves, or ask them to show what they think is relevant to be photographed. This could lead to different results and differences between the researchers’ observations and the workers comments. In both ways of applying the method, however, its validity is kept in the sense that the main purpose of the pictures is to have visual (and real) situations to comment on.

From the layout design game, the results achieved are directly related to input for the design process. In this sense, new aspects emerged during the discussions at the workshops. However, much was used from the issues identified previously with the workbook and with the observations made by the researchers. In fact, the workbook was quite helpful to the users as it allowed them to “pay attention” to some details of their own activities before they were asked to suggest new layout possibilities. This left them more aware of good and bad things from their own work environment. Most of these things are part of their everyday life, including means and tools to accomplish their work tasks and the ways they actually do it (strategies, knowledge, decision criteria, real operational methods).

However, it is not always trivial to be aware of and verbalize all these aspects. That is why providing some material to guide the discussion brings fruitful results. Not only because it makes it easier for the workers to recognize the situations they face in their everyday activities, but also it makes it easier for company’s ergonomists to lead the discussion between them and the design team.

CONCLUSION

What was learnt from the ergonomic intervention presented in this paper was that the methods tested work well if applied together, allowing the users’ involvement in the design process and bringing useful input to the design of new workspaces. It can also be said that they complement each other and are also complemented by the ergonomic analysis. Even if a better comparison could not be made, as it was not possible to perform a proper EWA, the workbook and

the layout design game proved to have their validity. And more than that, as they are “easy” to apply and not so much time consuming, they could be considered as possible solutions in projects with a very short time frame or for less experienced ergonomists. In one way or another, the methods are appropriate in the practical world.

BIBLIOGRAPHY

- BINDER, T., BRANDT, E., 2008, “The Design:Lab as platform in participatory design research”, *CoDesign*, 4(2), 115-129.
- BROBERG, O., ANDERSEN, V. & SEIM, R., 2011, “Participatory ergonomics in design processes: The role of boundary objects”, *Applied Ergonomics*, 42, 464-472.
- BROBERG, O., 2010, “Workspace design: a case study applying participatory design principles of healthy workplaces in an industrial setting”, *International Journal of Technology Management*, 51(1), 39-56.
- BUCCIARELLI, L., 1994, *Design Engineers*. 1 ed. Massachusetts, Cambridge: The MIT Press.
- DANIELLOU, F. (1992). *Le Statut de la Pratique et des Connaissances dans l’Intervention Ergonomique de Conception*. Thèse d’Habilitation en Ergonomie, Université Le Mirail, Toulouse, France.
- DANIELLOU, F., LAVILLE, A. & TEIGER, C., 1989, “Ficção e realidade do trabalho operário”, *Revista Brasileira de Saúde Ocupacional*, 17(68), 7-13.
- GARRIGOU, A., DANIELLOU, F., CARBALLEDA, G. & RUAUD, S., 1995, “Activity analysis in participatory design and analysis of participatory design activity”, *International Journal of Industrial Ergonomics*, 15(5), 311-327.
- GUÉRIN, F., LAVILLE, A., DANIELLOU, F., DURAFFOURG, J. & KERGUELEN, A., 2001, *Comprender o Trabalho para Transformá-lo: a Prática da Ergonomia*. São Paulo: Editora Edgard Blücher.
- GRANATH, J., 2001, *Architecture – Participation of Users in Design Activities*, *International Encyclopedia of Ergonomics and Human Factors*. Available at: <http://www.design4change.com/researchpapers.html>.
- HORGEN, T., JOROFF, M., PORTER, W. & SCHÖN, D., 1999, *Excellence by design: Transforming workplace and work practice*. New York: John Wiley & Sons.
- MEISTER, G. & FARR, D., 1967, “The Utilization of Human Factors Information by Designers”, *Human Factors*, 9, 71-87.
- RUTH, W., 2000, “‘Dramaturgy of work life’ – Transfer of knowledge as key issue in ergonomic interventions, theoretical framework and applications”. In: *Proceedings of the International Ergonomics Association Congress (IEA)*, 655-658, San Diego, USA.
- WULFF, I., 1997, *Implementing Ergonomics in Large-Scale Engineering Design – Communicating and Negotiating Requirements in an Organizational Context*. Doctoral Thesis, Department of Industrial Economics and Technology Management – Norwegian University of Science and Technology, Trondheim, Norway.