Holistic sustainable development: floor-laying workers' case

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Abstract. Maintaining ageing workers in the workforce and attracting new workers is an important issue for the floor laying business sector. The aim of this project is to identify solutions having a good probability of success in an ever-changing and greener reality, meaning: solutions that promote health and safety without compromising work efficiency and at an acceptable cost. Three work teams - combining expertise in ergonomics, design and engineering - were formed. In this paper, we summarize the points of views on sustainability expressed by the different actors involved, we present an example of a solution developed – a multi-function trolley -, and briefly exposes issues related to the others products under development.

Keywords. Sustainable development, floor laying, human factors engineering, design

1. Introduction

Sustainable development seeks to respond to the current needs of individuals worldwide without compromising the possibilities for future generations. In addition to the development of greener floor solutions, one must also preserve human capital and offer decent work to those who will lay these floors. This cannot be performed without striving as well to prevent occupational accidents and illnesses. As shown in the 2013 special issues published by *Ergonomics* (issue 3) on "Ergonomics and Sustainability", - sometimes referred to as "green ergonomics" - this topic may be approached with different points of view: eco-ergonomics in "green" sectors, such as the recycling industry, contribution to sustainable design to decrease the use of raw material, better implementation of ergonomics in third world countries, ergonomics design to favour the use of eco-products or behaviour, development of a systemic approach, etc. So that sustainability is defined sometimes as a target, through interaction with people involved in sustainable development, or as a perspective.

In this paper, workers targeted – the floor layers - are essentially organised in very small or even micro enterprises. The work and its conditions are difficult and demanding. The prevalence of musculoskeletal disorders is important and the trade faces a double challenge: retaining ageing workers and attracting new ones. Indeed, as can be observed in several other sectors, the younger generation is less attracted by labour intensive work, even if the salary is good. Very small businesses may be able to get creative, but they have few specialised resources and generally have limited access to university or public resources. In addition, it is more complex to work with very small enterprises than larger

ones. Finally, the type of work, tools and material used changes at a surprisingly quick pace, in particular to accommodate greener products. For example, carpet stretching, which was once at the heart of floor installation work, radically decreased over the past few years for various reasons: on recommendation of physicians (respiratory problems), come back of natural wood floors, introduction of new floor layers perceived as greener (namely bamboo or sisal), etc. Also, greener glues – more specific to each material installed – have been developed. Therefore, sustainable perspectives have various types of impacts.

As shown in Table 1, workers are exposed to a number of risk factors and several types of solutions are explored. The aim is namely to suppress the risk factors, reduce exposure or improve protection. As can be seen, focus is mainly on the knee, the most documented problem, with an emphasis on the knee kicker carpet stretcher (activated by a push from the knee). However, this tool is now less prevalent than it was since the popularity of stretched carpets has decreased. In addition, several determinants and contextual variables, such as the building site's management, play a major role and must be taken into account to develop appropriate and sustainable solutions.

Table 1. Summary of the problems documented, the risks factors identified and the solutions proposed in the literature.

Problems documented	Risk factors	Elements of solution proposed
Knee Injuries[1], Chronic disorders[2,3]: Arthrosis, bursitis, Hygroma, etc.	1. K compression: 50-75% of time in kneeling position[4]; 20% for applying glue[5] 2. K Impact[4,6]: Tool activated by the knee; may occur 100 times / h	1. Design/implementation of tools not activated with the knee[3] or less damaging[7]; better technic/training 2. ⇓ time spent in a kneeling position[8]: tools that may be used in standing positions[5] 3. Better knee protection 4. Easiness of knee work (ex. rolling plate)
Back Little documented; but could be as frequent as knee injuries[3,8]	1. Handling activities: heavy and voluminous loads 2. No trunk support when working in kneeling position. 3 Posture and movements	1. Improving back support[9] 2. ⇓ time spent in kneeling position[5] 3. Make the handling easier: better equipment, lighter weights, etc.
Upper limbs Little documented. Finger[3], shoulder/arm	1. Repetitive movements 2. Sharp tools 3. Glue viscosity	

1. Tanaka *et al.*, 1982; 2. Jensen *et al*. 2000; 3. Village *et al.,* 1991; 4. Battacharya *et a.l*, 1985 ; 5. Jensen and Friche, 2008; 6. Garstein, 1979 ; 7. Huang and Wu, 2012; 8. Burdof *et al.* 2007 ; Michaud and Lortie (2003) 9. Hartmann *et al.,* 2009

Thus, the basic purpose of this ongoing project is to identify solutions with a good probability of success in an ever-changing and greener reality, meaning solutions that promote health and safety without compromising work efficiency and at an acceptable cost. A subsidiary aim is to develop efficient strategies to cope with the small enterprise's

context. In this paper, we propose areas of reflection regarding the role of ergonomics in sustainability.

2. Methods

Considering what was previously exposed, the development of any sustainable solutions must be holistic, that is, it should take into account the multiple facets involved.

2.1 Identification of priorities

Solutions proposed in the literature or breveted were collected and submitted to 14 floor layers as well as a list of problems or situations identified from a set of interviews conducted 10 years ago. For each solution, floor layers were asked if they have already tried the solution, if it was worthy of being retained and improved, and if they wanted to be involved. They were asked to pinpoint their priorities. For the list of problems, they were asked to assess the potential for improvement (+,++,+++) and establish the level of priority.

2.2 Work process

Based on the results of the previous step, three work teams were formed combining expertise in ergonomics, design and engineering. The first team took in charge equipment requiring engineering know-how (ex. structure computation), the second, design interface know-how, and the third, transfer and knowledge management expertise.

The development process was basically the same from one team to another: floor layers were consulted several times to enhance understanding of their needs and strains, validate different ideas, and discuss possible compromises. Several software programs were used namely Catia V5 for CAD modeling.

For instance, the team working on the multi-function trolley involved three steps: (1) Meet with floor layers to document their needs and user experience; (2) Review lifting and transportation tools currently on the market. This step provided interesting insights. Trolley functions worthy of attention were identified as interesting while other designs were excluded. (3) Explore the possibility of merging the different functions needed by the workers into one tool and development of a proposal; (4) Meet with floor layers for validation and examination of the 3-D proposal to be developed/adjusted. This enabled the integration of new elements, such as the problem with static electricity. (5) Develop specifications and build a prototype for testing.

3. Results

In the first section, we summarize the points of views on sustainability expressed by the different actors involved in the project. In *section 3.2*, an example of a solution developed – the multi-function trolley is presented. Sustainability issues related to the others products under development are briefly exposed in *3.3*.

3.1 Points of view on sustainability

The responses were analysed to extract the various points of view on sustainability. In fact, sustainability was sometimes cause for rejection of a solution or considered as part of the problem.

a) Workers seek sustainability for:

- Themselves: protection of their health and safety. For example, most systems on caster (*e.g.,* mobile knee support) were rejected because the stabilization needed is tough on ankles).

- Equipment: Robustness is important. For floor installation, this was often evoked, as well as versatility needed for improving sustainability.
- Results of their work: cheap materials get damaged quickly. Working with quality floor materials is part of being recognized as being professional; it is a source of pride. This is an important issue for the attraction and recruitment process.
- Know-how developed: use of new technics, new equipment or new materiel has a cost. This cost is worthwhile if the result is to some extent sustainable.

b) Employers seek sustainability of:

- Work force: work perceived as hazardous will be avoided and lead to recruitment problems. This is presently an important problem. Experienced workers are an assurance of quality and are needed to train new recruits.
- Equipment: efficiency is an important issue; equipment that is unused or under repair is costly.

c) Researchers seek sustainability of:

- Knowledge produced: for example, the corpus of studies about knee kicker equipment is now obsolete.
- Solutions developed: when a work context evolves rapidly, solutions may quickly become obsolete.
- Efforts involved: holistic solutions need a good understanding of contexts. This involves time and commitment.

3.2 The multi-function trolley

The lack of handling equipment specifically designed to meet their needs was identified by the workers as an important issue. They have to handle heavy rolls – in particular linoleum rolls – and to unroll them. The first problem is that floor layer workers use a large variety of tools to help them in handling these rolls. They use regular trollies to move rolls around, and then lay the rolls with small unwinders set on the ground. However, for other larger and heavier rolls (some weigh up to 400kg, over a length of 2m), they have to use heavy load trollies and also very large tipping unwinders. This makes transportation of these tools in the workplace difficult and also slows the work down because workers are constantly switching rolls from one device to another. The second issue is linked to the first. Rolls are stored and transported in a vertical position with a trolley and then need to be unwinded in a horizontal position. Consequently, workers have to switch between these two positions manually. When material is more fragile, as in the case of linoleum, the rolls cannot be dropped, and workers have to control the descent. Even for "light" rolls, this task needs at least two people; the workers' backs support all the weight, a risky situation that can lead to musculoskeletal injuries.

As described in *section 2.2*, addressing these two problems required first, an assessment of the advantages and disadvantages of existing trollies and then addressing the needs of floor layer workers by merging these functions into a single and adaptable piece of equipment. The result of the first step was that products which allow an effortless transfer of rolls from vertical to horizontal position are either too big and heavy to be transported, or cannot support the weight of the heavier rolls. The link between structure resistance and accepted charge is evident, but it is interesting to underline that no medium size equipment exists. Other interesting features were seen in non-specific equipment (regular trollies), such as a convertible device, which could switch between a regular two-wheel vertical trolley, a four-wheel vertical trolley and a four-wheel horizontal trolley.

The following step was to decrease the risks of possible lower back injuries by finding an alternative to the possibly injuring task of manipulating rolls. Considering the results of the first step, the second step finally led to designing a completely new product, which was

partially inspired by the interesting features of other products. To meet the workers' needs, the new tool was designed to provide the following features: be able to handle all rolls (transportation and unwinding), have dimensions and manoeuvrability similar to a regular trolley, assure an effortless transfer from vertical to horizontal position (a hydraulic actuator supports the efforts and allows the handling of rolls by one worker instead of two). Other functionalities were added to the design. For instance, it is possible to remove the unwinding mechanism, allowing the use of the device like a regular trolley or even using the lighter unwinding device on its own. The new design is also flexible regarding wheels: it can be used with only two wheels (for maximum manoeuvrability, like a regular trolley), two other assisting wheels can be deployed to support the weight, and it is possible to use a horizontal cart position (for more versatile carrying, such as tools).

This new product will soon be tested as a prototype. It should be able to replace the many different tools currently in use by a single tool. More importantly, it should significantly decrease, if not prevent, possible musculoskeletal issues by supporting the heavy weight rolls throughout the stages of the laying process.

3.3 Other issues on sustainability

The second team worked on improving body support devices deemed too uncomfortable to be suitable and on a telescopic stick for glue application. The latter is considered important because it would enable working while standing. Workers do not use the actual telescopic trowel because they cannot see or feel small grains that would be invisible when covered by carpet, but pop out with soft material such as vinyl. The current question is: can we completely change the technic of glue application, knowing that the glues used – and specific for each type of material – are more diversified than before and change often. For the current technic, glue is applied with various types of trowels in a semi-circular pattern. This technic is sustainable since it can be adjusted to any kind of glue. Here, the sustainability of any solution developed is an important issue.

The third team worked on developing an Internet network. The floor layers have knowledge indispensable to the development of sustainable solutions. They have knowledge regarding their needs that is constantly reflected in a systemic perspective. Some key workers and small enterprises are innovative or on the lookout for new trends or equipment. They try them. The aim of the web system under development is threefold: share information, capture and circulate the floor layers' knowledge and help in developing an attractive image for recruitment.

4. Discussion and Conclusion

As stated in *Ergonomics'* editorial introducing the special issue on sustainability, there has been little ergonomics research or investigation explicitly addressing sustainability *per se*. Zinc and Fisher (2013) even ask, if we need sustainability as a new approach in human factors and ergonomics? In fact, sustainability is foremost a question of perspective and choice. Sustainability often becomes an issue when the cost of unsustainability appears too high or as can be seen with the human factor, when the recruitment of new workers becomes difficult especially in a context of an ageing work force.

The workers in this study appeared very sensitive to the issue of sustainability. However, as intermediaries, they do not define the market trends, nor the importance, or irrelevance, of using greener products. They have little impact on the type of equipment developed. Over all, they represent a small market with a limited voice. Now, the solutions to be sustainable need to be contextual and specific as well as flexible or versatile. The trolley developed is a good example of this problematic. This development was possible because

of the involvement of outside engineering resources and their motivation to work with small businesses. The fact that the Research Institute in Occupational Health and Safety is compatible with this kind of research-action context also helped. As shown briefly with the other examples, the sustainability issue needs to be addressed through a systemic approach – as stated by Zink and Fisher. However, the systemic approach is always more time consuming, at least in the short and middle term. It requires patience, the setting up of a good resource network and relay agents between researchers and workers or users.

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