The Use of Persuasive Design in Technical Solutions Supporting Safety Culture in the Production Enterprise—A Case Study

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ABSTRACT

The aim of this article is to present technical and organizational activities to prevent dangerous behaviors on the example of the work station of the stacker. In order to implement it, an analysis of the topic literature was carried out, including the presentation of basic notions of dangerous behaviors and organizational culture. The specification of the workplace and the activities performed has also been presented. The collected data were used to conduct research to characterize employee behaviors and attitudes while crossing the chain conveyor line. It has been shown that transitions are made very often, which creates a risk of falling, resulting from, for example, hooking up the transport chain. Based on the results obtained, a technical solution to eliminate dangerous transitions was developer and proposed.

INTRODUCTION

In the design of technical solutions, elements of persuasive design are used more and more often, which is aimed at directing users to undertake specific behaviors desired by designers and their clients. Such design, through the use of atypical construction solutions, leads to motivating or discouraging people from undertaking specific activities. It is noted that the parallel use of persuasive design and ethnographic design, allowing the collection of data to characterize the basis of behavior, can be helpful in finding the solution most appropriate for a given group of users. Such persuasive design can be particularly useful in the case of solutions supporting the safe behavior of employees. In many cases, more dangerous and simultaneously

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accelerating work processes are still frequent among employees. In such cases, when the motivation of employees to bypass the safety procedures is large, and its significant consequences, it is extra profitably to use persuasive solutions. These types of persuasive solutions that support a safety culture will be a pretext of this article, based on case study in a selected production company.

PROBLEMS WITH IMPLEMENTATION OF SAFETY CULTURE

The employee’s wellbeing, his commitment to work and behavior in the workplace depend largely on the level of organizational culture in the company. Organizational culture is an extremely complex concept, defined for the first time in the 1950s. It was then defined as a set of hidden and explicit patterns conveyed by symbols and learned by appropriate behavior, which are the characteristic achievements of people. Since then, there have been many definitions of organizational culture, such as Mullins, who treated it as a collection of values, attitudes and beliefs that are the basis of all activities undertaken in the organization. According to this definition, the organizational culture is built by a system of patterns and rituals of communication [1].

Organizational culture in a company is often associated with safety culture, usually defined as a set of values, attitudes, competences and behavior patterns contributing to the creation of a high level of occupational safety and hygiene in the enterprise [2]. Increasingly, it is noticed that shaping the safety culture should be dynamic and involve making organizational, technical and technological changes, but also should focus on the constant search for ways to shape attitudes that are insecure among employers and employees [3]. The implementation of safety culture in enterprises is most often associated with the building of its elements with the cooperation of both management and other employees. A number of problems can be notice in this process:

- lack of information exchange between individual company departments in accident prevention,
- failure to report accidents and potentially accidental events,
- budget cuts for HSE interventions,
- lack of awareness of threats, a sense of responsibility for security and participation in preventive actions of employees related to employment instability and low organizational culture in the enterprise,
- errors in building a safety management system and lack of reliable risk analyzes,
- lack of or low involvement of the top management in matters of security,
- a great emphasis on productivity, without paying attention to the building of safe working conditions.

It should also be noted that the safety culture should be shaped in enterprises on two levels: behavioral (shaping behaviors) and mental (shaping the way of thinking and attitudes) [4].

PERSUASIVE DESIGN AS A MEAN FOR SAFETY ENFORCEMENT

Persuasive design is usually used within digital technology to identify solutions that encourage users to specific behaviors when faced with a given application or service. Nevertheless, as an approach, it can be implemented in a number of other situations, where the user or employee should be led to a particular course of action. The precursor
of the approach indicates the need to build persuasive systems in which the reliability of data allows for the formation of attitudes, and thus encourages a change in behavior 5. The essence of convincing design lies in understanding the emotions of recipients of products and services that affect behavior, product reception and decision making, and then on the design of user interaction within created system. Persuasive design is based on the psychological principles of influencing people's behavior, data on customer engagement in relation to the brand, social strategy and psychology dominating in a given market. To aggregate such data, user surveys might be used, and help to understand the needs and motivations of users. The obtained data is used to design products and services more friendly, easier to use and emotionally desired, which allows to minimize the deficiencies in the perception of functional features of the product. In addition, such a persuasive design gives opportunity to create products visually appealing and provides a basis for planning marketing activities.

Persuasive design is understood by Fogg as 5:

− attempt to change attitudes and behaviors without coercion or deceit, or
− design, research and analysis of user interaction with the product, to change attitudes and behaviors.

The basic tool in convincing design, according to this researcher, is rhetoric, which makes it possible to establish contact with recipients and attempt to influence its decisions 5. A typical example of a convincing design is placing a fly sticker in the urinal. It causes that almost every user targets ’ insects - increasing cleanliness in public bathrooms 6.

The basic principles - the grip that this methodology uses, can be synthesized to the following fields of action 7:

1. reduction—reducing and simplifying information as much as possible,
2. keeping—informing the user what are the steps of using and operating the product,
3. customization—adapting activities and information to the requirements and capabilities of the target users,
4. suggestions—telling the user what he can do in the way he or she want to follow without hesitation,
5. soft monitoring—monitoring behavior in order to change the behavior and behavior of the user for the intended purpose,
6. observation—observation of further behavioral changes,
7. conditioning—shaping desired behaviors rewarding them.

Examples of the application of this approach indicate the possibility of significant improvement in the scope of positive actions for employees, which due to obstacles such as user's reluctance are not taken Error! Reference source not found..

Persuasive design for safety, generally can be categorized to two main courses: encourage specific pro-safe behaviors and avoiding those undesirable. It should be noted that these approaches can be used practically at every level of activity, from the most elementary ones regarding one behavior to influencing the behavior of entire communities on the meso and macro scale 9. In the case of a well-established culture of safety, the persuasive mechanism may be a sense of employee responsibility that will overcome attention to the dangerous behavior of even their superiors [10]10. In order for this level to be achieved, the work process should be analyzed and then all employees' inclinations should be counteracted, which will contribute to the growth of direct threat or persistence of unnecessary habits.
CASE STUDY

Problem Formulation within Workstation

The research was carried out in one of the Polish manufacturing companies, in which building components are manufactured. The research was carried out on the example of a stacking station consisting of two sub-stations—the main with a control panel and foiling (Fig. 1). Above the work station, the crane operator performs professional tasks. The plate is transferred to a roller conveyor, then transported towards the stacker. Every second is rotated and transported by traverse to the conveyor, onto wooden pallets lined with foamed polystyrene. The stacker marks the pile of plates printed with stickers, measures their length, then they are transported and covered with cardboard and PU cubes. Then the boards are transported to the foil's work station and foiled. This is followed by their displacement, fixing the plates with straps to the crane and transporting to another station. The production pine has been operating since 1997 and no changes have been made since then.

![Workstation layout](image.png)

Figure 1. Workstation layout.

Workers in the stacker workstation go through designated conveyor lines to perform daily activities, in particular:
- fastening the transported plates to the crane for further displacement,
- return to the control panel,
- supervising the process of foiling (Fig 2).
Transitions also occur in the event of machine breakdowns, there are also partial transitions, when workers are marking palettes with an identification number and description of delivery locations. Although the places of passage are designated, it is not a safe way to perform work because often transitions occur while the transporter is in motion and transports a stacked pile of pallets. In addition, there is the possibility of hooking the leg with rollers, which causes the risk of accident and injury to the employee. A serious accident has already occurred in the workplace - the employee was in a hurry and caught his foot on the chain, which resulted in a loss of stability and a fall that ended in a serious injury.

Materials and Methods

On the basis of data collected as part of ethnographic design, including: a workstation plan and a description of the production process, work timing and conclusions from observations and interviews with employees, hazardous behaviors at the stacker workstation, characterized by crossing the chain conveyor line, were characterized. Then, on the basis of persuasive design with the use of morphological analysis, a technical solution for the characterized problem with the elaboration of a proposed program to modify the behavior of employees was proposed.

Solution

The chosen solution is a one-part lift, with ball transport and automatic and manual control. The transition is open until the time of transport, the detection of the package is carried out by using a photocell. They were chosen for the following reasons: they are easier to perform and design, detection with a photocell will counteract closing the passage when, for example, an employee wants to go through the transporter. The idea behind the proposed solution is to break the transporter's line and shorten it, which will allow the installation of a lifted gate with a rocker, so that it can be opened and closed. The passage will be open all the time, which will allow employees to move freely. Closing will take place after the transport begins, when the photocell detects the pallets, the transition will automatically close after stopping the transport. It will also be
possible to manually close and open thanks to the button at the transition. The proposed solution is one example of a chain conveyor modification. In the literature on this subject, many projects can be found to reorganize in-house transport [11], [12], [13], using different combinations of solutions depending on the specification of processes or specific requirements of enterprises.

The advantages of the presented solution are:
- manual lifting of the handle on one side of the conveyor,
- it can be used with various types of conveyors - chain, roller, belt,
- it can be driven separately or connected to the drive of the neighboring section,
- it makes it possible to block and protect the mechanism, allowing the gate to be kept open or closed,
- the section is raised in order to make the passage available,
- the conveyor is stationary—only the section being opened moves.

Proposing and implementing technical solutions aimed at eliminating hazardous working conditions and dangerous behavior of employees does not guarantee their effectiveness and acceptance for use by employees. To a large extent it depends on their awareness and sense of security and responsibility for work performed at the workplace, which is an element of building organizational culture and safety culture in the enterprise. Therefore, it is proposed to implement the solution in cooperation with employees, in two stages (Table 1).
Table 1. Planned implementation activities.

| Stage I - presentation of implementation plans | Stage II - presentation of the solution after implementation |
|------------------------------------------------|------------------------------------------------------------|
| - presentation of results and conclusions from observations to employees, | - presentation of the solution - principles of operation, used methods, |
| - presenting the reasons for the project implementation to employees, | - presentation of changes related to the implementation of the solution (change of work organization, change of work rules), |
| - presentation of the solution design, | - feedback from employees regarding their feelings about using the implemented solution. |
| - presentation of assumptions regarding the future operation of the implemented solution, | |
| - presenting to employees implementation plans and principles of the workstation functioning during assembly works and after starting the line, | |
| - feedback from employees about their feelings about the proposed changes. | |

Detailed presentation of changes planned for implementation to employees will be conducive to a better understanding of the reasons and benefits of introducing them. It may also result in a greater involvement of employees, which may largely contribute to increasing the likelihood of a project's success.

Evaluation

On the basis of the collected data and literature review related to chain conveyors on production lines, a solution to the problem identified in the company accepted for research was proposed. An interruption of the conveyor's line at the connection point and shortening it was accepted, which allowed the installation of a lifted gate with a rocker, thanks to which it will be possible to close and open the passage. The passage will be open all the time, which will allow employees to move freely. Closing will take place after the start of transport, when the photocell detects transported pallets, the transition will automatically close after stopping transport. It will also be possible to manually close and open the passage thanks to the button at the transition. A large number of possible modifications of the solution allows it to be used in enterprises where various types of in-house transports occur.

Practical and Theoretical Implication of Persuasive Approach within Companies—Discussion

The applied approach should, in the authors' opinion, be accepted as a starting point for all actions aimed at changing employee and visitors’ attitudes. Although there may be some objections to the ethical dimension of persuasion [14], in the case of actions aimed at improving safety and elimination of dangerous behaviors such an impact is justified, all the more so that it may lead to building a strategy of employee motivation for safe behavior [15]. Currently, various types of activities are being undertaken using persuasive technologies, from single actions aimed at achieving appropriate behaviors [8], ability to get needed product [16], to more advanced situations for e.g. games [17] or software dedicated for this purpose [18].

It should also be pointed out that persuasive technologies can also be used to indirectly influence on health and safety of employees, e.g. by encouraging physical activity, healthy eating, environmental protection, and resource saving [19], which can also benefit companies using this approach. One of these benefits may be to increase the level of safety culture by developing new, repetitive, safe behaviors of employees.
This might be very important issue when the work requirements force greatly influence human performance and every mistake can cause significant human and material losses [20].

Persuasive approach should be a part of the development of social safety culture, which would result in more responsible human actions even when the physical barrier would not occur in some situations.

CONCLUSION

In most enterprises, conveyors are used for internal transport. They cause efficient operation of the entire production line and allow transport of products of considerable mass over long distances, without using human strength. Nevertheless, they can cause risks to employees, especially if the organization and method of production requires the worker to frequently move to the other side of the production line. These transitions are often performed incorrectly and cause threats, so they should be eliminated. In the case of existing lines, alternative methods of eliminating threats caused by dangerous transitions should be sought. Such solutions may be technical projects, which, on the example of the case analyzed in this study, can be enriched with elements of persuasive and ethnographic design that allow the formation of employee awareness, which is often one of the most difficult stages of introducing changes in the organization of production processes.

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