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How to keep train loading on track: Shell improves ergonomics with help of The Observer

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Using The Observer for Ergonomics Research

Hose handling, opening and closing manholes, turning switches and coupling railway wagons by hand: this is all heavy work, and the physical load of the so-called 'movement operators' who do this job, is an important concern for their companies. Together with Shell, Fysergo conducted an ergonomic study at MFD (the Moerdijk Filling & Distribution department of Shell Chemicals in The Netherlands). Distribution at MFD takes place by train, boat and truck, and in particular during train distribution the physical load of the movement operators is considered to be high. In accordance with the Health, Safety & Environment plan of Shell the aim of the study was to draw up and justify possible plans to optimize the work situation and reduce the physical load.

Methods

Phase 1: Orientation

A literature study was conducted to better understand the physical load of movement operators, also in relation to relevant legislation. In this phase the actual work was also observed by following different operators during work. With the results from these observations, it was possible to make the right configuration in The Observer for more detailed observations.

Phase 2: Analysis

A Hierarchical Task Analysis (HTA) was conducted [1] to get the following information:

- Definition of different system functions of the operational and maintenance processes of train distribution (function analysis).
- Analysis of task content, ways of working and organization structure per function (task analysis).
- Specification of man-machine interactions (task allocation).

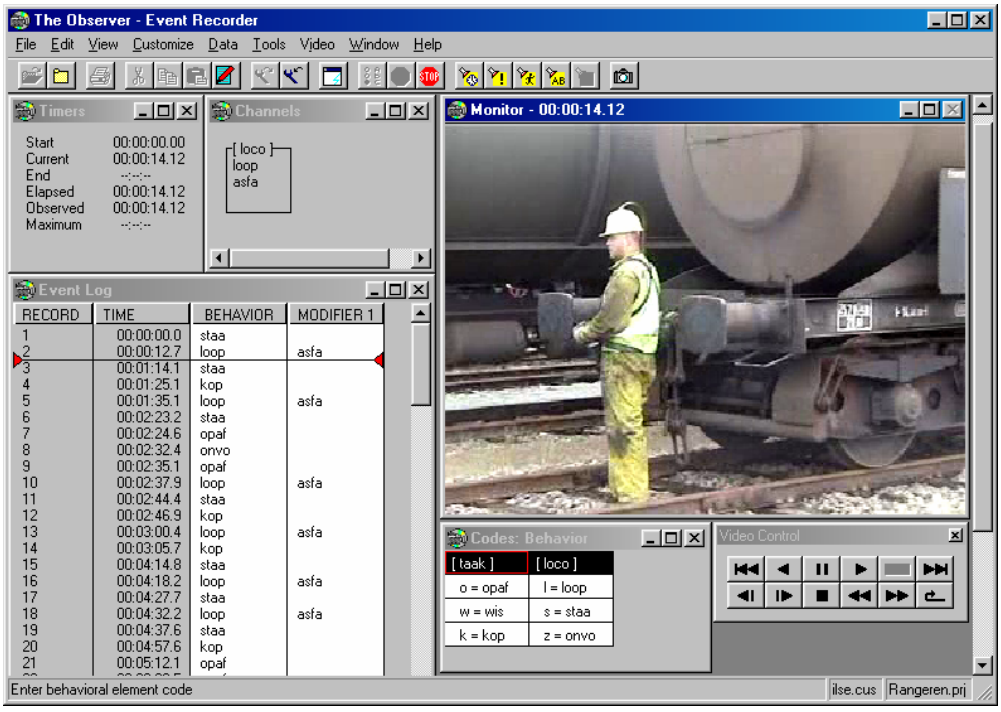
The methods for HTA are interviews with workers and management, and observation of actual operations. Observations were performed using both The Observer Mobile (with a Psion Workabout handheld computer) and The Observer Video-Pro. The Observer Mobile was used to observe the movement operators at the MDF site during their daily activities. The Observer Video-Pro was used to get more detailed information about the duration and frequency of the different functions and tasks per function, which is needed for quantifying physical load. One of the functions observed in this study was shunting. The shunt activities were observed on two random working days during 1.5 hour each, using focal sampling with a single actor and a time resolution of 0.1 second. The first behavioral class (task) contained the following behavioral elements: getting on/off the railway wagons, turning switches and coupling of railway wagons. The second class included behavioral elements related to locomotion, like walking (on grass, asphalt or gravel) and standing. To compare the physical load to results described in literature and to legislation, the revised NIOSH method (NIOSH= National Institute for Occupational Safety and Health; [2]) was used for coupling wagons and lifting the top of a manhole. Inputs for the NIOSH method were the working posture and the weight of the coupling chain and the top of a manhole. Push and pull forces were measured during hose handling.

Phase 3: Specification

Together with a project group consisting of an operator, a chief, the assistant manager, the manager of MFD and a human factors engineer, basic design assumptions, preconditions and general design specifications were laid down. These specifications lead to different possible solutions, which were discussed during brainstorm sessions with the project group and were checked with the design specifications, in order to define management recommendations to create a safe, healthy and efficient work environment.

Phase 4: Justification

Finally a cost-benefit analysis of the different design improvements was conducted according to the quantification model of benefits of ergonomic design. This model has been developed by Shell International Health Services in cooperation with relevant stakeholders like finance, engineering and line management. It is used to quantify benefits of ergonomic improvements (e.g. calculating the risk factor and the amount of increasing efficiency, safety and health).



The observation of shunting activities of the movement operators at the MFD site, using The Observer Video-Pro.

Results and conclusions

Physical load according to the results of the HTA and literature

Earlier research has shown that physical load of turning switches by hand is much higher than the prevailing health standards allow. The Dutch labor inspection has already ordered the Dutch Railways to change all frequently used hand switches into electrical switches. Because the results of the HTA show a high frequency of hand turned switches, these switches also ought to be replaced at MFD. The physical load of coupling wagons also appeared to be higher than the occupational health standards. Especially the working postures in relation to the weight of the chains that have to be lifted and the frequency of the task create a high risk for back problems.

Specification and justification

The determined basic design assumptions, preconditions and general design specifications lead to the following design solutions: to replace hand switches by electrically operated switches, to reorganize shunt activities, and to load gas by using mass flow meters (wagons can be loaded while they are coupled). The quantifying model shows that reorganizing shunt activities in combination with changing only a number of critical hand switches by electrically operated switches has more benefits than changing all hand switches. Not only because of economical benefits, but also because it reduces both the frequency of operating switches and the frequency of coupling

wagons. In order to reduce physical load during loading activities, mass flow meters might be an interesting solution on a longer term since these increase the loading capacity. On a short term, introducing an automatic coupling system on locomotives is a realistic alternative.

References

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2. Waters, T.R.; Putz-Anderson, V.; Garg, A.; Fine, L.J. (1993). Revised NIOSH equation for the design and evaluation of manual lifting tasks. *Ergonomics*, **36**, 749-776.

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