Applying Human Factors to the Manufacture of Pyrotechnics

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SUMMARY

This paper outlines a case study of the Human Factors (HF) work that was undertaken for a pyrotechnics and energetics manufacturer. The work involved an initial HF review of the chemicals receipt, storage and transfer processes at the facility, followed by a more detailed assessment of workload for Team Leaders (TLs). The paper describes the application of HF techniques in a unique setting and the learning and changes that were taken forwards as a result.

KEYWORDS

Workload, pyrotechnics, performance shaping factors.

Introduction

The Health and Safety team of a pyrotechnics and energetics manufacturer contacted Risktec Solutions Ltd. (Risktec) to seek HF support following two serious accidents at its manufacturing facility. The work at the facility is manual in nature, involving the transport of materials on vehicles and the weighing, mixing and assembly of products by hand, requiring both gross and fine motor skills.

The manufacturing process involves people at every stage and, due to the properties of the materials being used, any sources of friction or ignition require stringent management to avoid escalation to major accident consequences, i.e. fire and explosion.

Method

This paper focuses on the HF activities that were undertaken between February and December 2025. These included a HF review of the chemicals receipt, storage and transfer processes and a subsequent workload assessment of Team Leaders (TLs).

The HF review was framed by a model of HF (HSG48) which considers 3 main aspects that impact on human performance – the Individual, Job/ Workplace and Organisation. Sitting under these 3 main topics are the Performance Shaping Factors (PSF) that have the potential to degrade or enhance human reliability. Figure 1 presents the PSFs considered during the review – these were tailored for the manufacturing facility.

One of the key findings emerging from the HF review was that the TL role was subject to particular pressures. A follow-on assessment of TL workload was subsequently undertaken.

The workload assessment adopted a multi-method approach which included interviews, a workload survey and on-site observations. The interviews (n=6) were carried out remotely using MS Teams. They explored the role of the TL and their experience of workload, both cognitive and physical, and potential changes that they felt should be made.

Figure 1: Model of Human Factors based on HSG48.

The workload survey was based on the Subjective Workload Assessment Technique (SWAT) (Reid et al, 1989) and was administered daily by email using MS Forms. The survey was distributed over three weeks, Monday to Thursday (site production is usually Mondays to Thursdays).

The on-site observations were held over one shift between 07:00 and 17:00. Two HF specialists shadowed two TLs on their morning rounds, including roll call and activities to get the manufacturing rooms set up and active in production. A drop-in session was hosted over the middle of the day where TLs and other key staff members could speak with the HF Specialists to further explore the themes emerging from the workload questionnaires and the interviews.

Finally, the two HF specialists shadowed a further two TLs on their final rounds of the day, including the activities to get all products and components back into overnight storage.

Findings

Through the various HF activities, it was established that the TLs regularly experience high cognitive workload resulting in them finding it difficult to manage competing demands.

Interpretation of the workload questionnaire was limited by a low response rate. Out of a possible 60 shifts, responses were only completed for 25. It could be interpreted that the low completion rate of the survey was indicative of high workload experienced by TLs at the end of their shifts. However, where workload assessments were completed the workload factor 'Time Load' (lack of spare time, as indicated by task interruption and overlap) was the main contributor to TLs' experience of high workload.

The qualitive data collected from the interviews and observations revealed that high cognitive workload was driven by:

- Limitations on licensing limits inside rooms which means that orders for 'parts' are frequently required. Orders must be completed from the TLs' office, away from the production rooms;
- Frustrations with the software which manages the site pyrotechnics and energetics inventory;
- Machine breakdowns which stop production;

- Training new team members on the line;
- Reacting to product quality issues;
- Staffing issues; and
- New product orders which impose time pressure to meet customer demands.

In relation to physical workload, this seemed manageable and TLs broadly enjoyed the active nature of their role. However, the need to walk large distances across site results in significant time loss.

Outcome

In parallel, and in response to this study, the manufacturer has been implementing a revised organisational structure to spread the responsibilities of the TL role and therefore ease the demands that are placed upon them. They have introduced a Second in Command Role, Health and Safety Champions, and individuals who can focus on training operatives.

References

HSE (1999) Reducing error and influencing behaviour (HSG48). Second edition.

Reid, G., Potter, S. and Bressler, J. (1989) Subjective Workload Assessment Technique (SWAT): A User Guide.