Human Factors Trade-offs: A Case Study in High-Hazard Environments

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SUMMARY

Trade-offs are inevitable in HF practice and must reflect the task, environment, equipment, project and users. Poorly managed trade-offs increase human error; well-managed ones improve safety and performance. The HF specialist's role is to navigate trade-offs intelligently, using evidence, cross-disciplinary collaboration, and clear rationale to ensure user needs are not overshadowed by competing demands.

KEYWORDS

High hazard, trade-offs

Introduction

Human Factors (HF) specialists advocate for users to ensure systems are safe, efficient, and operable. This requires balancing user needs, project requirements, and system constraints. This can lead to trade-offs, deliberate compromises made using professional judgment, experience, and stakeholder engagement to optimise safety, usability and performance. We assess trade-offs using task analyses or similar methods to identify error traps and evaluate criteria such as usability, comfort, safety, cost, functionality and accessibility. Trade-offs differ from optioneering or allocation of function; each agreement seeks the best compromise across stakeholders. HF often provides the only holistic review, explaining why a trade-off may or may not work. Despite their importance, formal guidance on managing trade-offs is limited, so we use clear criteria and record agreements, especially when HF requirements are not met. The example below shows our approach in a high-hazard facility (if accepted, additional examples and detail will be provided).

Case Study

A high-hazard facility commissioned a HF review of a safety-critical search procedure. The task involved verifying that no personnel were present in a designated area prior to use. Failure of the task, i.e. a person is left in the area being searched, has a high likelihood of fatal consequences. For additional context the task is completed by two distinct user groups

- Group One: Temporary workers, many of whom were non-native English speakers.
- Group Two: Permanent facility employees.

Methodology

Our approach included:

- A task walkdown with users and managers of the system.
- Private discussions with users (without supervisors).
- Discussions with senior management.

Findings

A good procedure had been developed, and we were able to provide recommendations to further strengthen the current procedure, equipment used and training competency and assurance.

Trade-off Considerations

1. Push Buttons

Issue: Two push buttons were the same colour, but differing shades of blue, raising concerns about usability.

- Safety: No direct safety risk identified.
- Comfort: Some buttons were outside the ideal anthropometric range, but the task is short and infrequent.
- Functionality & Operability: No issues found.
- Usability: Colour shades were distinguishable, even under stress.
- Cost: Changing button colours would incur additional cost.
- Accessibility: Colour-blind users could differentiate the shades.

Trade-off Decision

A pragmatic solution was adopted. While retrofitting was deemed unnecessary, future installations would comply with relevant standards. For existing equipment, a cost-effective fix of sanding and repainting one of the sets of button, was being considered by the client. This trade-off-maintained safety and usability without incurring significant cost.

2. Sounders

Issue: Exit announcements were only in English, posing a risk for non-native speakers.

- Safety: Employees of the facility reported inconsistent English proficiency among temporary workers.
- Usability: Some temporary users, with English as a second or third language may have challenges in understanding English instructions in a high stress environment.
- Other Factors: No issues with comfort, functionality, or operability.
- Cost: Minor cost for multilingual audio implementation.

Trade-off Decision

English proficiency is not formally assessed before using the facility, they rely upon assurances from an outside source. As enforcing a specific English proficiency test would be overly onerous on the facility, HF specialists advocated for bilingual announcements. This required collaboration with sound engineers and the safety team to record and store messages in relevant languages which would be updated for each new team of users engaging with a specific area. The solution enhanced safety without disrupting other disciplines.

Findings, Outcomes and Impact

The client gained a clearer understanding of HF principles and the value of early integration in design. As a result, HF specialists were invited to participate in future design reviews. This collaboration led to:

- Improved placement of search equipment using anthropometric data.
- Greater empathy from design teams through user-centred walkthroughs.
- Clear documentation of HF decisions shared across project teams.

Conclusion

Trade-offs are an inevitable and essential part of HF practice. Each must be approached with a nuanced understanding of the task, environment, equipment, project and user population. Poorly managed trade-offs increase the risk of human error, while well-managed ones enhance system performance and safety.

The HF specialist's role is not to eliminate trade-offs but to navigate them intelligently, ensuring that user needs are not overshadowed by competing project demands. Success lies in evidence-based decisions, cross-disciplinary collaboration, and clear communication of rationale and outcomes.