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Benefits of Adopting a User Centred Design Approach to the Integration of Alarms

Nantida Wisawayodhin
Principal Human Factors Consultant
Ricardo

Aim and Objectives of this Presentation

This presentation is to present a case study on the application of Human Factors and the benefit of taking a User Centred Design (UCD) approach to improve the usability and efficiency of human-system interface.



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What is Human Factors and Why it is essential?

Human Factors (HF) is a discipline that focusses on enhancing system performance through the consideration of human elements of the system. By ensuring that a system is user friendly and error tolerant, the impact of human error on system safety is minimized and human performance is maximized. This in turn contributes to enhancing system performance and reliability.

HF is an integral part of system integration process, systematically assessing system-user interfaces to identify HF issues to be managed and resolved.



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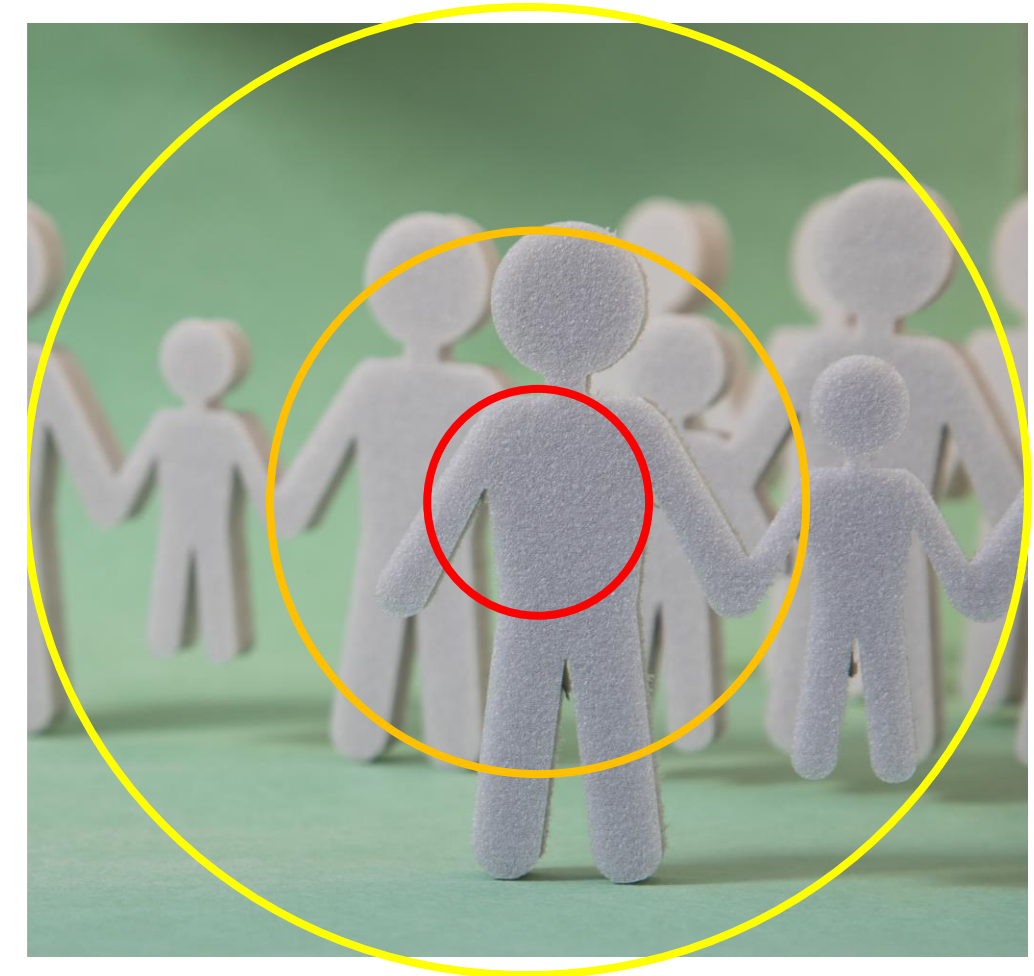
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What is User Centred Design Approach?

User Centred Design or UCD is an iterative design process that prioritizes the needs and goals of the end-users

- Focuses on the impact of design on performance of end users
- Effectiveness
- Efficiency
- Safety



Case Study: Alarm assessment of an IXL system upgrade

Scope: Conduct Human Factors assessment on the design of alarms generated by a signalling interlocking (IXL) system (within a wider signalling system upgrade scope).

HF requirements:

- To achieve maximum compatibility between the system and human performance.
- The system, when completed, shall be such that its operations do not exceed human capabilities or limitations relating to involved activities.

Limitation of scope from HF perspective:

- Limited to alarms design for one system only
- Limited HF integration scope



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Aim and Objectives

To systematically identify the wider context of use and therefore the system-wide impact. The objectives of the UCD approach are:

- To determine the differences between the existing and new systems
- To identify all systems being monitored and alarms being presented to the operator(s)
- To ensure consistency and meaningfulness of alarm presentation to the end users
- To identify potential for Human Error and HF issues



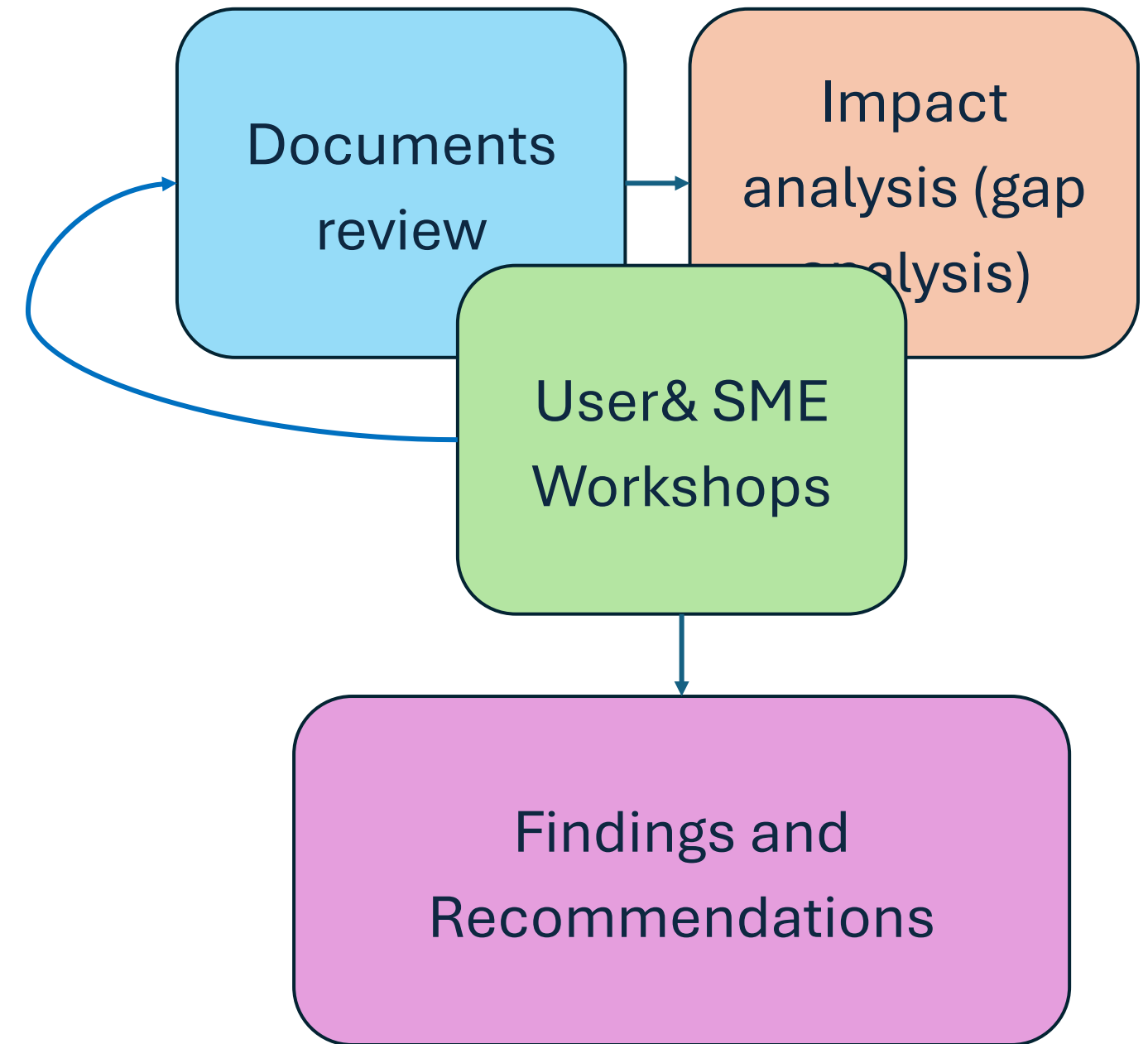
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Analysis undertaken

- Documents review of relevant HMI specification, Alarms List and O&M manuals
- Impact analysis (gap analysis)
- User workshops and SME consultations
- Alarms design and presentation analysis



End users identified

Infrastructure Controllers

- Monitor and respond to equipment alarms covering a number of signalling sub-systems including ATS, IXL, NMS and PMS.
- Monitor sub-systems on multiple lines.

Maintainers

- A team of technicians and specialists responsible for troubleshooting and rectification of faults and failures related to signalling sub-systems.
- Receive information on faults and failures from the infrastructure controller and traffic controllers.



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Expansion of scope

- Taking a UCD approach, the focus is on the impact on human performance.
- The Infrastructure Controller monitors more than just the IXL system. It is, therefore, important to consider the other alarms being generated by other systems that this role monitors to understand the impact.
- Alarms design and presentation from other systems being monitored by this role were reviewed.
- It was not possible to review alarms design and presentation for other lines not part of the wider project.



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Signalling Sub-systems alarm design and presentation reviewed

Sub-systems monitored by the infrastructure controller:

- Automatic Train Supervision System (ATSS)
- Network Management System (NMS)
- Computer-based Interlocking system (IXL)
- Points Management System (PMS)



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Results: Alarm Levels and States

		IXL 1	IXL 2	ATS	PMS	ATS NMS & IXL NMS
Alarm	Level 1 [Terminology]	✓ [Critical]	✓ [Critical]	✓ [Warning]	✓ [Criticism]	✓ [Disaster]
	Level 2 [Terminology]	✓ [Non-critical]	✓ [Non-critical]	✓ [Caution]	✓ [Major]	✓ [High]
	Level 3 [Terminology]	✓ [Warning]	X	✓ [Advisory]	✓ [Minor]	✓ [Average]
	Level 4 [Terminology]	X	X	X	✓ [Information]	✓ [Warning]
	Level 5 [Terminology]	X	X	X	X	✓ [Information]
Alarm	Active & Not Acknowledged	✓	✓	✓	✓	✓
	Active & acknowledged	✓	✓	✓	✓	✓
	Inactive	✓	✓	✓	✓	X
	Bad Quality	✓	X	X	X	X



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Results: Alarm Presentation

Alarm Saliency

- Ineffective Colour Contrast for Some Alarms
- Colour combinations for the same alarms are inconsistent across all systems:
 - Inconsistent Appearance of Active and Unacknowledged Alarm States
 - Inconsistent Appearance of Active and Acknowledged Alarm States
 - Inconsistent Appearance of Inactive Alarm States

Table A1: IXL 1

	Active & Not Acknowledged	Active & Acknowledged	Inactive	Bad Quality
Critical	Critical Active & Not Acknowledged	Critical Active & Acknowledged	Critical Inactive	Critical Bad Quality
Non-Critical	Non-Critical Active & Not Acknowledged	Non-Critical Active & Acknowledged	Non-Critical Inactive	Non-Critical Bad Quality
Warning	Warning Active & Not Acknowledged	Warning Active & Acknowledged	Warning Inactive	Warning Bad Quality
Level 4	N/A	N/A	N/A	N/A

Table A2: IXL 2

	Active & Not Acknowledged	Active & acknowledged	Inactive	Bad Quality
Critical	Critical Active & Not Acknowledged [Blinking]	Critical Active & Acknowledged	Critical Inactive	N/A
Non-Critical	Non-Critical Active & Not Acknowledged [Blinking]	Non-Critical Active & Acknowledged	Non-Critical Inactive	N/A
Level 3	N/A	N/A	N/A	N/A
Level 4	N/A	N/A	N/A	N/A

Table A3: ATS

	Active & Not Acknowledged	Active & acknowledged	Inactive	Bad Quality
Warning	Warning Not Acknowledged	Warning Acknowledged	Warning Inactive	N/A
Caution	Caution Not Acknowledged	Caution Acknowledged	Caution Inactive	N/A
Advisory	Advisory Active & Not Acknowledged	Advisory Active & Acknowledged	Advisory Inactive	N/A
Level 4	N/A	N/A	N/A	N/A

Table A4: PMS

	Active & Not Acknowledged	Active & acknowledged	Inactive	Bad Quality
Criticism	Criticism Active & Not Acknowledged	Criticism Active and Acknowledged		N/A
Major	Major Active & Not Acknowledged	Major Active & Acknowledged		N/A
Minor	Minor Active & Not Acknowledged	Minor Active & Acknowledged		N/A
Information	Information Active & Acknowledged			N/A

No Visual Cue for Inactive States are Provided in PMS (DMI) Spec

Table A5: ATS NMS & IXL NMS

	Active & Not Acknowledged	Active & acknowledged	Inactive	Bad Quality
Disaster	Disaster, Active Not Acknowledged		N/A	N/A
High	High, Active Not Acknowledged		N/A	N/A
Average	Average, Active Not Acknowledged		N/A	N/A
Warning	Warning, Active Not Acknowledged		N/A	N/A
Information	Information, Active Not Acknowledged		N/A	N/A

NOTE: Acknowledging the alarm does not change the colour of the alarm. Rather, once the alarm is acknowledged, the term 'Yes' appears in green text within the dedicated 'Ack' column of the alarms page



Summary of Findings

- Inconsistency in alarm severity naming
 - ‘Warning’ being used for a level 1 (high) alarm for ATSS, a level 3 (low) alarm for IXL and a level 4 (very low) alarm for NMS.
 - Labelling of Level 2 alarm ranges from ‘Non-critical’ to ‘Caution’, ‘Major’ and ‘High’
- Inconsistency in alarms severity levels ranging from 2 through to 5 with discrepancies in alarm level definitions.
- Inconsistency in the number of alarm states ranging from 2 – 4 states.
- Different alarm presentations for the same alarm state across different systems.



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Potential Consequences

When the **same alarm severity mean two different things**. when they are monitored by the same operator. could result in a misunderstanding of the alarm causing mode related errors where the operator makes the wrong actions based on the state that they believe the system is in, even though their belief does not match the state of the system.

Different alarm severity levels have the same naming could lead to commission errors and an incorrect response by the operator potentially leading to service delay.

Each system employs its own unique colour schemes to visually represent different types of alarms. These differences could lead to confusion and negatively impact the operators' ability to efficiently interpret and respond to alarm, leading to delayed alarm/fault response.



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Recommendation

The analysis revealed that, at systematic level, there is a lack of alarm strategy or design philosophy to govern the design and presentation of alarms for the organisation.

A recommendation was made for the organisation to undertake **a holistic review of the alarms** management strategy across all systems for operational use.

This review should focus on developing **an overarching alarm's philosophy**, aligning with current standards and best practice, to ensure alarms design across all systems are consistent and supports effective operator use.



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Conclusion

Projects are often system-focused and do not always satisfy or address users' needs (operators and maintainers) as they often interact with more than one system. UCD approach helps the project team to consider end users' needs more comprehensively early in the design process minimizing the risk of redesign or implementing a workaround resulting in delay and / or extra costs.



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