



CPS Unintended Consequences Project

Project Update and Overview

15 September 2023



MINERALS COUNCIL
SOUTH AFRICA

Project Objectives

To ensure Member Firms are suitably equipped to drive the implementation of **Collision Prevention Systems (CPS)** across their TMM fleet, the MCSA has embarked on a **human factors engineering study** to identify the **unintended consequences** (positive and negative), on the **physical and mental state of Mine Personnel** including TMM Operators, during the implementation, onboarding and use of CPS within the Member Firms operations.

The above has been achieved through a combination of:

- Desk research across the topic of automation adoption
- Interviews, focus groups and questionnaires with stakeholders to understand the implications within the context of the South African mining sector

The overall aim of this project is to prepare mines with the required knowledge, tools and frameworks to **identify and mitigate** against any detrimental effects as well as to **leverage** any positive effects that may be introduced by CPS.

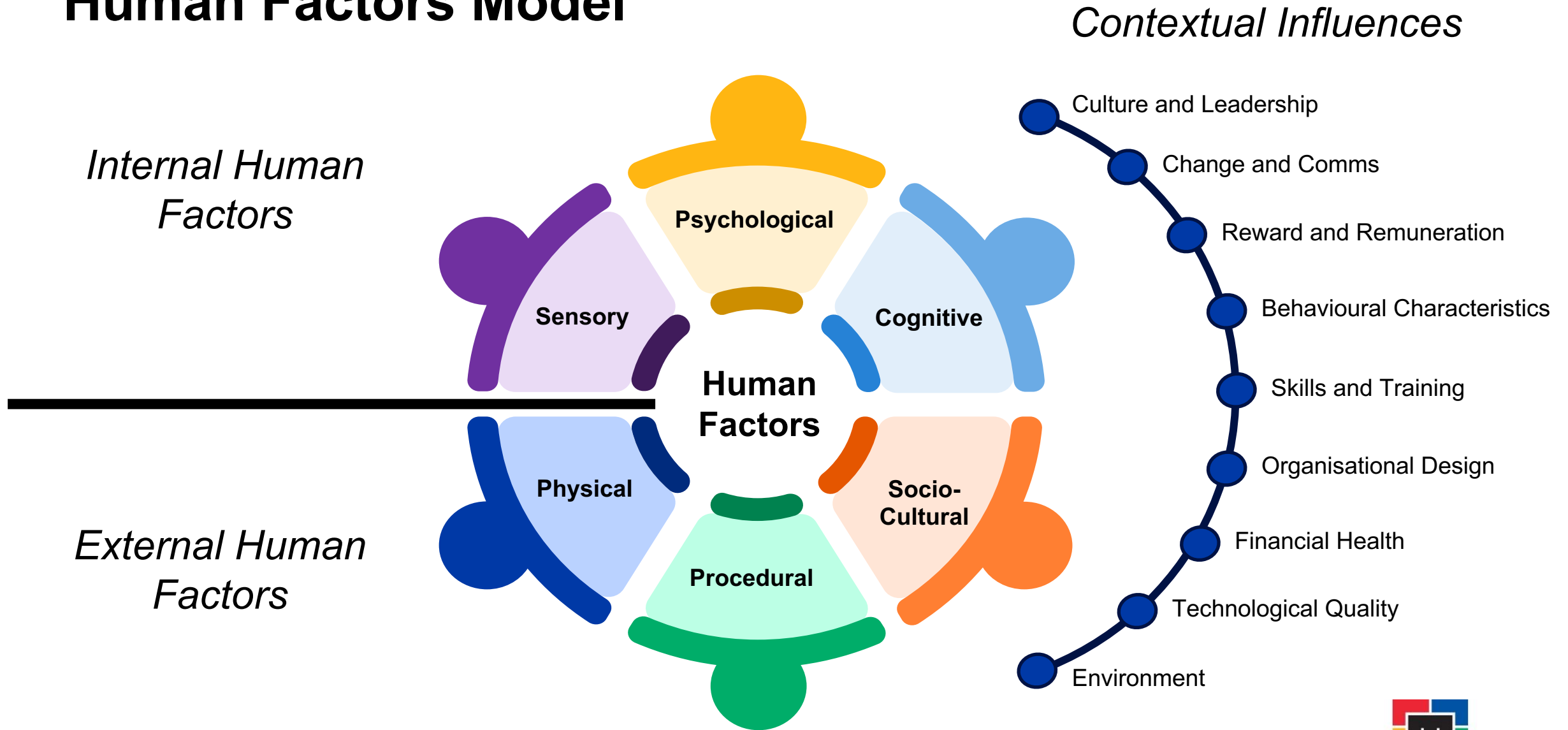
Setting the stage

- Thorough **desk research** has been conducted to understand **current research and information** related to the topic from a **global perspective**.
- *Unintended consequences* is defined as the “**outcome of purposive action that are not intended or foreseen.**” These can be positive, negative or perverse.
 - The research found that there are numerous unintended consequences related to automation within the mining sector.
- However, research in this field has mostly been conducted within the **Australian context** - little research conducted in the South African mining context.
- **Human Factors Engineering approach** - Looking at the unintended consequences of CPS in TMMs through a human factors lens is to effectively **assess where areas of concern need to be addressed** and how to address them.

Stakeholder Participation to Date

Organisation Type	Type of engagements	% response
Mining House	Interviews	62,5%
OTM	Interviews	38%
OEM	Interviews	0%
OTM	Online Questionnaire	36%
OEMs	Online Questionnaire	36%
Other (e.g., Academic institutions, consultants, etc.)	Online Questionnaire	75%

Human Factors Model



Summary of results

Human Factor	Unintended Consequence of CPS on an Operator or Pedestrian
Psychological	<ul style="list-style-type: none"> • Reduction in job stress due to perception of increased safety for operator and pedestrians • Loss of role autonomy • Risk homeostasis • Loss of trust • Role threat
Cognitive	<ul style="list-style-type: none"> • Requirement of new skills – more experienced operators may struggle more to adopt to newer technologies. • Loss of situational awareness • Cognitive overload • Operator task error - perception error / memory lapses/slip/ tech misunderstanding • Accident migration or task transition • Over-reliance • Images and diagrams easier to learn than systems that provide written information, due literacy challenges
Sensory	<ul style="list-style-type: none"> • Level 9 causes less delays than level 7 due to increased visibility • Operator alarm fatigue • Poor information absorption • Loss of visibility due to overload of monitoring / detection technology

Summary of results

Human Factor	Unintended Consequence of CPS on an Operator or Pedestrian
Physical	<ul style="list-style-type: none"> • Injuries or physical discomfort • Technology functional errors (e.g., stalemate) • Brake wear and tear
Procedural	<ul style="list-style-type: none"> • Peer enforced accountability • Procedural violations / procedural non-compliance – pedestrians knowing the vehicle will stop. • Increased adherence to traffic rules • Non-compliance due to false positives • Poor identification and understanding of issues • Lack of standardization in tech
Socio-Cultural	<ul style="list-style-type: none"> • Increase in the overall safety culture. • Job losses due to mine closures (cannot afford to install CPS) • Assumption of risk mitigation • Sabotage – nefarious and non-nefarious (creative ways established to deactivate the system) • Language and cultural barriers – this could be unique to each mine.

What does this mean for mining operations?

- Mining operations should do their **own analysis** to determine the likelihood of these outcomes occurring due to the **unique context** in which each mine operates within.
- These findings provide leaders with **likely scenarios** as well as a **framework** to consider other unintended consequences.
- Technological change will impact people in positive and negative ways, to ensure the positive is leveraged and the negative is minimized will require **effective change management**. Thanks to the work done by the Mandela Mining Precinct who have developed an excellent Change Management Blueprint specifically designed for the adoption of modern technologies.

QUESTIONS

