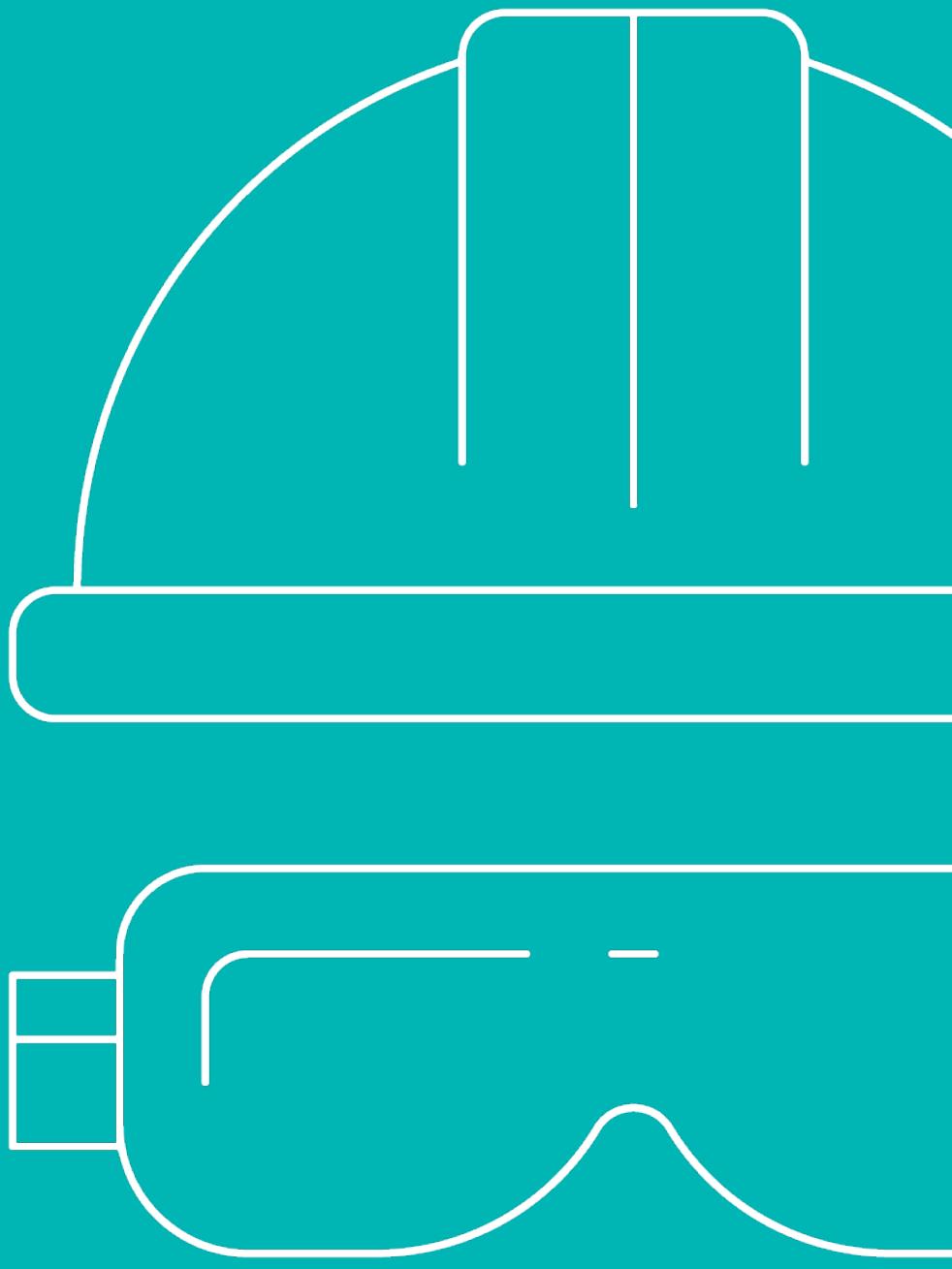
# Achieving High-Performance in High-Reliability Industries: Hearts, Minds and Countermeasures

*A whitepaper on the influence and importance of understanding human performance in front-line operations*



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# Achieving High-Performance in High-Reliability Industries: Hearts, Minds and Countermeasures

*A whitepaper on the influence and importance of understanding human performance in front-line operations*

CORTEXIA
HUMAN FACTORS & SAFETY

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# A Word From Our Director

The fields of human factors and human performance have given rise to a number of methods that have served safety-critical industries well for at least the last 50 years.

Though we have seen increased attention being placed on our craft, the majority of human factors practitioners are still fairly siloed within their own industry; be it Defence, Aviation, Oil and Gas, or Transportation. The unfortunate byproduct of this is that new and effective methods developed for one industry often do not receive enough attention from other industries to promote cross-application, validation and the critical mass of adopters.

Having worked extensively within the Defence and Aviation sectors, I have seen the benefits of applying a number of methods such as mental skills training for special forces personnel, threat and error management for pilots and normal operations safety survey (NOSS) for air traffic controllers. These methods have proven their effectiveness not only in terms of operational safety, but also in terms of operational effectiveness and efficiency.

Our point of difference we take pride in is to leverage from such evidence-based interventions, taking a more holistic approach to our inquiry. We see the problem space with a greater number of lenses and design our interventions based on an in-depth understanding of the latest research.

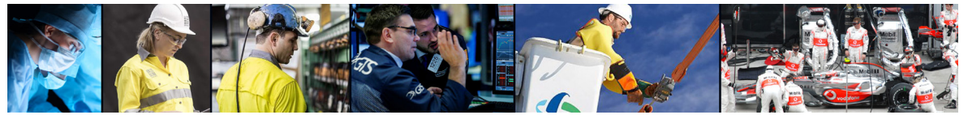
This whitepaper is our attempt to convey our philosophy and approach to operator performance in high-reliability and high-risk industries. Our approach has been successful in a number of industries including Mining, Power Distribution, Oil and Gas, and Air Traffic Control; positively impacting the performance of over 1,500 front-line operators.

# Contents

# Managing Threats and Errors

*High-reliability industries are characterised by high-risk, complexity and dynamic operational demands. These characteristics can have a profound impact on operational performance and safety.*

WITHIN HIGH-RELIABILITY INDUSTRIES, TEAMS INTERACT WITH TECHNOLOGY AND OPERATE IN COMPLEX ENVIRONMENTS. RISK VARIES FROM LOW TO HIGH WITH THREATS COMING FROM A VARIETY OF SOURCES IN THE ENVIRONMENT[1]. SAFETY IS PARAMOUNT IN THESE HIGH-RISK INDUSTRIES AS INCIDENTS CAN AND SOMETIMES DO INVOLVE LOSS OF LIFE.



» *High-reliability industries are characterised by risk, complexity and high-stakes operations*

Organisations that succeed in avoiding disasters in an environment where accidents can be expected due to the high level of risk and complexity are labeled as High Reliability Organisations (HROs). Weick and Sutcliffe[2] describe that HROs share five characteristics in assuring high-performance, which are shown below. Traditional methods of safety have focused on compliance towards company policies and the punishment of unsafe behaviour with the organisation taking action when accidents or injury occur[3].


» *The five HRO characteristics*



HIGH-PERFORMANCE IN HIGH-RELIABILITY INDUSTRIES

In this paper, we argue that traditional approaches to safety behaviour change using conventional methods of teaching often fail at achieving persistent and lasting behaviour change and instead propose the utilisation of Threat and Error Management (TEM) in safety training. In the next section, we explain why traditional safety approaches are less effective and then describe how TEM can be applied in high-reliability industries for the production of persistent behaviour change and the high transfer of training for frontline operators.

TEM is widely used in aviation to improve safety and is being adapted for use in medical settings[4,5]. TEM describes adverse events in terms of risks present in an operational environment (i.e. threats) and the actions of operators that give potential to or exacerbate those threats (i.e. errors)[6]. There are four major forms of human error[7]:

1. Slips (actions not carried out as intended, such as pressing the wrong button)
2. Lapses (missed actions and omissions, such as forgetting to lower the undercarriage on landing)
3. Mistakes (an error brought about by a faulty plan with the individual believing that they are doing the right thing)
4. Violations (unintentional or deliberate deviations from rules, procedures, instructions and regulations with the breaches in these rules

**Fit for industry countermeasures are key to effectively managing threats and errors.**

TEM classifies threats as events or errors that increase operational complexity and which must be managed to maintain the margins of safety and performance[1]. Threats can be present in the environment (distraction, faulty equipment or poor weather for example), reside in the operator's decision making processes (cognitive biases, incorrect information, or poor communication for example), or relate to organisational factors such as high workload. Threats increase the likelihood that operators will make an error[8]. Common causes of errors include fatigue, workload, poor interpersonal communications and flawed decision making[9]. Given the ubiquity and inevitability of threats and errors, the key to safe outcomes is their effective management rather than prevention[10]. This involves training personnel to understand the nature and extent of errors, changing the conditions that induce errors and determining behaviours that prevent or mitigate errors; 'countermeasures'.

Traditional approaches to improving safety presume that things go wrong because of identifiable failures or malfunctions of specific components:

technology, procedures, operators and the organization[3]. While adverse events may be treated by a traditional approach, there are a growing number of situations where this approach is insufficient and leaves us unaware of how everyday actions achieve safety outcomes. Importantly, new methods focus on the encouragement of safe behaviour and how performance goes right in spite of uncertainties and ambiguities that pervade complex work situations. That is, the focus has moved from soley ensuring that as few things as possible go wrong to also ensuring that as many things as possible go right[11]. Such approaches incorporate a proactive stance by continuously trying to anticipate events while more traditional approaches are reactive by responding when something happens (e.g. accident) or when an unacceptable risk exists. It is important to attempt to understand the conditions where performance becomes difficult to monitor and control in addition to carrying out investigations to identify causes and contributory factors of accidents. TEM is a proactive approach that has a focus on self-improvement whereby operators manage operational threats and errors with the use of effective countermeasures.

**TEM is a proactive approach that has a focus on self-improvement.**

Traditional safety approaches often do not work in creating enduring high-performance skills on the front line[12]. Operators weigh up the advantages and disadvantages of various types of decision options and then choose the option with the best outcome[13]. Moreover, the individual knows that placing more effort towards this behaviour will increase the chances of attaining a valued outcome. As an example, an operator may be aware of being fatigued or having an unrealistic workload planned for the day, but chooses to push through due to weighing up the advantages of the behaviour. The operator may desire the esteem of colleagues (e.g. to be seen as a team player), or the esteem of the supervisor (e.g. to not hold up the work) and thus, persevere without relevant countermeasures to deal with the threat at hand. Thus, we argue that traditional approaches to safety training need to be enhanced with a high-performance approach which provides tools for the operator regardless of the choices made.

# A Focus on High-Performance over Compliance

Approaches to safety management have changed significantly over the last 50 years with a greater focus placed on "just culture"[14]. A just culture aims to balance the need to learn from failure through the reporting of errors, adverse events and accidents with the need to take disciplinary action[15]. Research shows that an act is very rarely carried out with the intention to inflict damage and if an operator perceives that their reports of minor incidents or near misses are treated unfairly, the willingness to report declines[16]. A just culture addresses this paradox of accountability





and learning by asserting that operators should not be punished for actions, omissions or decisions taken by them that are in-line with their experience and training but for gross negligence, willful violations and destructive acts[17,18]. Operators can differentiate between legitimate and illegitimate behaviour because each operator is aware of their intentions behind actions and consequences (e.g. did not intend to inflict harm) and the reasons behind any violations of safe operational procedures (e.g. imperfect knowledge, time constraints)[19]. Hence, a strong argument can be made that not all violations of safety procedures should be criminalised[14].

**Safety is a by-product of high-performing individuals and teams rather than the result of absolute compliance with rules and regulations.**

No procedure is perfect, and evidence has shown that unintended problems with safety procedures can result in standardised violations[7]. Procedure problems can arise because there is not enough time to perform all the tasks required, checks are seen as unnecessary or operators feel that there is a better method for carrying out a task. Introducing more procedures will not necessarily prevent accidents, nor do additional instructions or emphasis to follow procedures more carefully increase compliance or enhance safety[20]. Dekker[20] highlights the need to redefine safety – it is not the result of rote rule following but the result of individuals' insight into situations that demand certain actions and individuals being skillful at using a variety of resources to accomplish their work goals[21,22]. Hence, safety is a by-product of high-performing individuals and teams rather than the result of absolute compliance with rules and regulations.

» *We propose a focus on providing high-performance countermeasures to the operator allowing them to adapt to unfamiliar situations, rather than procedural compliance*

Operators need to be informed of the opportunity for rules to be adapted in certain situations[20,23]. It is the role of organisations to support operators in becoming skillful at judging when and how to adapt procedures[20, 23].

# A Novel Approach to Safety Training and Human Performance

In most developed countries employers are legally responsible for educating employees on workplace safety standards and the hazards that they may face while on the job through the provision of effective safety training. Trainers need to deliver training in an educational and engaging manner to enhance the retention of information and application of learning to workplaces[24]. Research shows that training is more effective when trainers use language, situations and examples operators will relate to and understand. Training becomes more meaningful and enjoyable to operators when trainers relate the training content to operators' day-to-day work experiences[25]. As a result, operators are more likely to pay attention throughout training and apply what they have learned. Moreover, training activities should be chosen that allow operators to relate their skills and knowledge to work and health safety issues relevant for the industry that they work in. For instance, trainers can achieve better results by incorporating scenarios or real-life situations that link to the concept being learnt whilst being appropriate for the target audience.

» *It is critical that training is directly relatable to on-the-job activties; this can only occur with a detailed understanding of the job demands*

There are considerable benefits for trainers to connect and build rapport with operators[26,27]. One meta-analysis revealed that training utilising conversation or dialogue with trainees was highly engaging and





**The challenge for a practitioner is transitioning from a "spy" to an "okay guy" in the eyes of operators.**

was approximately three times more effective than the least engaging methods in promoting knowledge and skill acquisition[28]. Researchers assert that safety trainers can connect with trainees by going on ride-alongs before delivering training, as a way of not only observing and understanding the role of trainees, but also become accepted as an outsider who understands. For instance, Herbet[29] conducted an ethnographic field study with police officers to gather their opinions on police brutality. He observed that the police officers were initially reluctant to allow him to go on the ride alongs but then developed rapport and became accepted by the police officers as an outsider who understood their perspective. Herbet[29] described this as a transformation from "spy" to "okay guy" (p. 304).

» *Ride-alongs and operational observations are crucial to developing rapport and creating a catalyst to high-performance on the front-line*

Another effective training delivery tool is the use of informal storytelling[30,31]. In an ethnographic field study, incident-reporting schemes were not integrated in railway technicians' practices and did not seem to serve their interests[32]. Hence, the number of reported occupational health and safety incidents was very low, which impeded the usefulness of such schemes. Informal storytelling, however, was found to be the preferred mode for technicians to address risks, with the circulated stories emphasising attention, vigilance and carefulness. Telling stories of accidents and incidents is advantageous, as it allows for knowledge about recent events to be shared and what one might appropriately learn from them[33,22,34]. Storytelling can also extend to moral and emotional dimensions of unfortunate events, which recuperates persons, relationships and communities[35]. Moreover, the use of self-disclosure develops trust and, allows leaders to connect with and influence front-line employees on a deeper level. The most powerful learning rarely come from facts or figures as individuals learn experientially, through oneself and the vivid example of others[36]. Studies show that storytelling is a much more effective way to drive change in attitudes and behaviour than increased rules and bureaucracy. Storytelling, however, should not substitute incident-reporting systems and instead, should

be used in conjunction with incident-reporting to ensure feedback on contributing factors.

Operators require training to develop behaviours that act as countermeasures to common preconditions or conditions leading to human error (decision making and review of plans for example)[1]. The International Civil Aviation Organisation has identified the most common human factors that contribute to human error[37]. The top twelve factors were: 1) poor communication, 2) distraction, 3) lack of resources, 4) stress, 5) complacency, 6) lack of teamwork, 7) time pressures, 8) lack of awareness, 9) lack of knowledge, 10) fatigue, 11) lack of assertiveness, and 12) norms to deviate from safety procedures. We argue that effective countermeasures to these factors for high-reliability and safety-critical industries can be drawn from the tools and techniques that are implemented in other high-performance fields, particularly from sports psychology and the Special Forces. In this section, we describe a number of techniques athletes and military personnel utilise to maintain

» *Elite military training programs, sports psychology and cognitive psychology offer effective countermeasures that resonate for high-reliability operators*

high-performance. There are a number of mental skills that successful athletes utilise for the long-term development of high-performance, immediate preparation for performance and during actual performance behaviour[38,39,40]. These mental skills include, the ability to:

1. Maintain a positive attitude
2. Maintain a high-level of self-motivation
3. Set high and realistic goals
4. Deal effectively with people
5. Use positive self-talk
6. Use positive mental imagery
7. Manage anxiety effectively
8. Manage one's emotions effectively
9. Maintain concentration.

**We argue that to produce enduring high-performance on the front-line, training needs to promote countermeasures that are conveyed in a way that resonates well with trainees.**





These nine mental skills associated with athletic success are the same mental skills associated with performance in a wide variety of non-sport, performance situations[38]. It is possible for relevant activities and information to be incorporated into the training of operators in high-reliability and safety-critical industries to develop these vital mental skills.

The National Research Council[41] declares that soldiers are required to counteract a range of stressors (e.g. pressure, ambiguity, weather conditions) in their operational environment. Their physical performance is maintained during prolonged periods of physiological and mental stress through eliciting certain behavioural and cognitive skills (maintaining alertness, clarity of thought, and decision making ability for example)[42,43]. Soldiers undergo stress inoculation training (SIT) to develop these skills through making information available and pre-exposing them to stressors to reduce the novelty of stressful tasks. This "increases the likelihood of a greater sense of predictability and control, and a consequent reduction in both physiological and emotional reactivity" (p. 258)[44]. In SIT, soldiers are trained to become aware of the stress environment so that when a specific stressor occurs (e.g. exposure to excessive heat) it prompts the individual to prepare (e.g. drink water and dress appropriately). This training method sustains soldier performance before, during and after battle, by combatting stressors that can lead to mental and physiological fatigue[45]. SIT has been adapted for training in organisational contexts (i.e. Stress Exposure Training, SET) and thus, can be used within high-reliability and safety-critical industries[46]. SET involves training operators about the types of stressors that are likely to occur in the operational environment and develop the cognitive and behavioural skills to counteract these threats before a hazardous situation can strike. It is also utilised to increase operators' abilities to maintain high levels of performance under a variety of stressful conditions.

» *Applied research in the fields of cognitive and evolutionary psychology, and neuroscience readily translate to the front-lines of high-reliability industries*

It is important to train operators to use proven countermeasures that are also easy to remember and apply in the field. Cognitive psychol-

**In order to resonate with operators in our workshops, we often employ former special forces personnel and athletes to discuss moments where they had to manage a number of threats with effective countermeasures.**

ogy principles can be applied in training sessions to assist operators to encode and recall safety procedures, such as using mnemonics[47]. To illustrate, the SBAR (Situation, Background, Assessment, Recommendation) tool is an easy-to-remember mnemonic that provides a powerful framework for communication between health care team members about a patient's condition[48]. Also, it is crucial to make operators highly motivated to learn and maintain desired safety behaviours. As previously mentioned, the attractiveness of behaviours and choice of action, depends on the perceived outcome of each behaviour (desirable or undesirable)[13]. Hence, safety training needs to promote countermeasures that are conveyed in a way that resonates well with trainees and thus, produces persistent front-line high-performance. Trainers can incorporate storytelling to deliver TEM in an impactful manner (we often employ special forces personnel or athletes to discuss moments where they had to manage a number of threats with effective countermeasures). It is also essential for trainers to utilise other effective pedagogical methods when carrying out training. Integrating adult learning principles in training programs improves knowledge retention and performance of participants[49,50]. For instance, adult learners need to know how learning will be beneficial prior to undertaking training and are self-directed in that they are capable of making decisions on their own and dislike being directed or imposed by others in the training process[51,52].

# High-Performance that Persists

SO FAR, WE HAVE PROPOSED AN APPROACH FOR CONDUCTING SAFETY TRAINING FOR HIGH-RELIABILITY INDUSTRIES BY UTILISING TEM IN A WAY THAT RESONATES AND CONNECTS WITH TRAINEES WHILST ADVOCATING FOR A HIGH-PERFORMANCE FOCUS.

However, training research shows that the transfer of training is typically low; simply delivering workshops does not ensure its automatic transfer to the workplace[53]. Also, researchers have found that learning comes from a combination of sources - through formal training programs, on the job learning from colleagues and peers, trial and error in one's work and through the coaching and feedback from a manager. Lombardo and Eichinger[54] propose a '70:20:10' model in that individuals learn mostly on-the-job (70 percent), but also from others (20 percent) and through formal learning programs (10 percent). Thus, we propose the use of in-situ field coaching in high-reliability industries as a strategy to optimise the transfer of training. Field coaches, who are skilled at making observations, know what to look for as trainees develop their skills and, use dialogue and questioning skills to provide direction, help trainees to develop their skills out in the field[55]. Coaches are also needed to regularly enforce and support newly learned behaviours whilst encouraging high levels of motivation in trainees for learning to transfer into the workplace. We also propose that TEM training be permanently integrated with the existing training curriculum for training to improve performance over the long-term and to become fully ingrained in the work culture[56]. Otherwise, in the absence of recurrent training and reinforcement of desirable countermeasures, attitudes and practices decay[57].

**We have found that in-situ field coaching by respected practitioners has a significant impact on transfer and longevity of training.**

From mining to power distribution, finance to healthcare; our unique high-performance approach has resonated with over 1,500 safety-critical operators, resulting in significant reductions in near misses, incidents, regulator fines, time off tools, and increases in reporting, and task efficiency.

We also recommend continued observation and monitoring of threats, errors and effective use of countermeasures into the daily behaviour of the workforce. In aviation, observations of crew by suitably trained peers are taken to measure the threats and errors, how they are managed, and any undesired states. This observational methodology, the Line Operations Safety Audit (LOSA), acts as an effective safety analysis tool for the proactive management of threats and errors[58,59]. Over 20,000 domestic and international airline flights have used LOSA with the Federal Aviation Administration and the International Civil Aviation Organisation supporting the use of this methodology in ensuring airline safety.


» *We have developed a method allowing high-reliability industries to monitor and improve their operational performance*

We have adapted LOSA for use in high-reliability and safety-critical industries, adding controlled expert observations alongside peer-to-peer observations, as well as targeted versions of our high-performance skills development interventions (as outlined above) after the analysis of the observational data. Feel free to follow this link to read our in-depth manual on the Argos Protocol: *Argos Protocol Implementation Manual*

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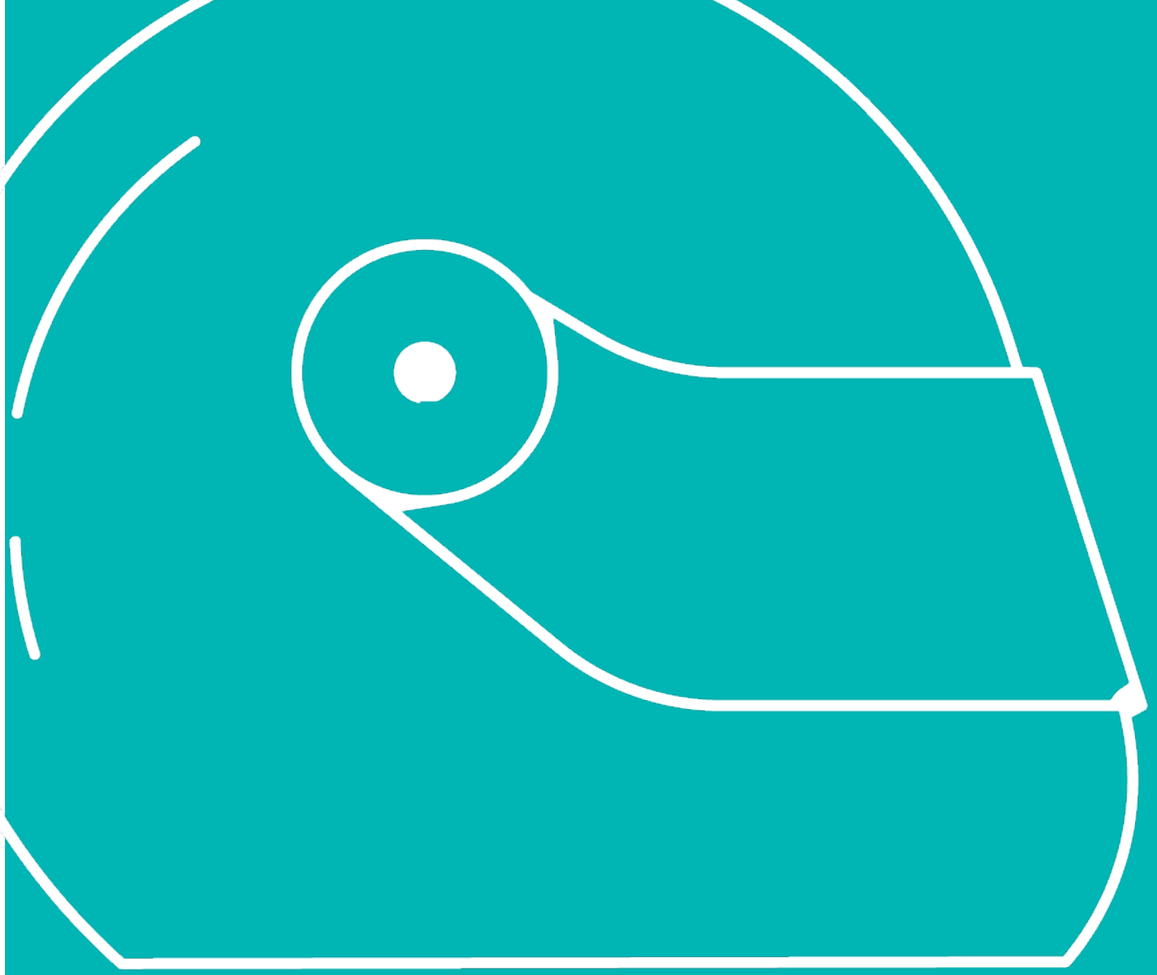

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