
Safe Systems approach for mining road safety

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Abstract

Historically, road safety efforts around the world have focused on educating and influencing road users to adopt appropriate behaviour while using a road network. Past gains have been significant, but securing further improvements has become increasingly harder to achieve. This has led to a fundamental change in thinking, and the development of a multi-disciplinary, systematic approach to road safety.

The Safe Systems approach acknowledges that road users make mistakes but should not pay with their life for an innocent mistake. This in turn necessitates an in-depth understanding of the system's four key components: users, vehicles, speeds and road environments. Improvements must be well targeted and be complementary.

The system is gradually being rolled out on public road networks throughout Australia. The mining industry, however, is an example where Safe Systems has been in place for some time now as mining organisations have direct control of all the four system's cornerstones.

Resulting from experience obtained during numerous road safety projects on mining operations across Australia, this paper will synthesise the industry's adherence to Safe Systems and will provide directions for developing an action plan, on either an industry-wide or organisational level, with the ultimate aim of minimising traffic related hazards on mines.

Introduction

A historical context of road safety on public roads

From the 1920s, the ongoing increase in the number of vehicles on Australian roads resulted in a comparable increase in the number of road crash deaths and serious injuries. The level of road crash deaths peaked in the 1970s with an average of more than 3 600 fatalities (Figure 1), or 30 fatalities per 100 000 population per year [1]. Similar trends have been recorded in the Organisation for Economic Cooperation and Development (OECD) countries [2].

The 1970s saw the commencement of a focused government approach aimed at stopping and reversing the trends in road trauma. Road safety legislation, intensive public education coupled with enhanced enforcement activities as well as practical improvement to roads and vehicles, resulted in a decline in the levels of road trauma with the negative trends continuing to this day [1].

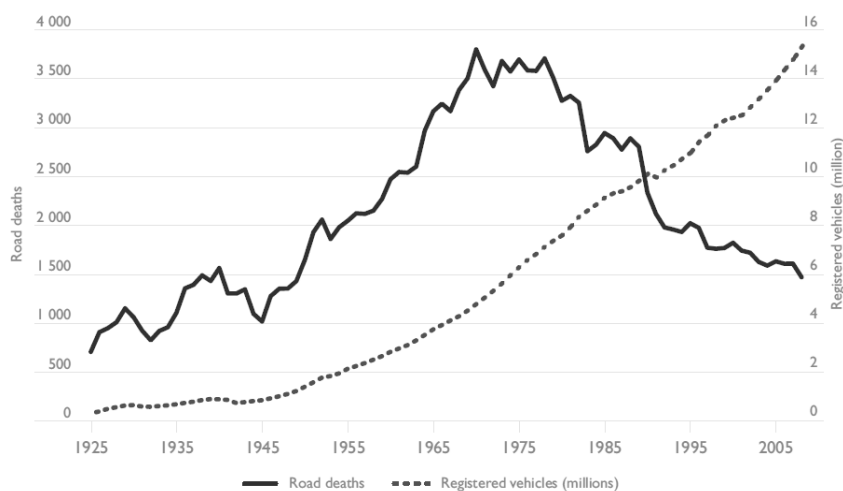


Figure 1: Number of road deaths and registered vehicles in Australia, 1925-2008 [1]

Practical interventions such as compulsory seat belt fitting and wearing, introduction of radar guns, random breath test operations, mobile and covert speed cameras, media campaigns, reduced speed limits in high pedestrian activity areas have all resulted in step reductions in road trauma rates.

These reductions continued despite increases in population levels, numbers of registered vehicles or the total kilometres travelled each year. As such, the existing approach in improving road safety could be considered to be adequate.

However, in the last 15 years there has been a steady decline in the rate of reduction in the number of fatalities in Australia [3] as well as on the roads of most of the OECD countries [4]. Under the existing approach it became harder to secure further significant improvements.

Introduction of Safe Systems on public roads

The decline in the road trauma reduction rates amongst OECD member countries led to a fundamental change in thinking, and the development of a multi-disciplinary, systematic approach to road safety based on a long term vision named Safe Systems.

The basic premise behind Safe Systems is the appreciation of the limitations of the human body to absorb physical forces as well as the acknowledgement that road users make, and will continue to make, mistakes while driving and crashes will continue to occur despite prevention efforts. However, society does not accept that innocent mistakes should result in death or serious trauma. In other words, the road system should be designed to expect and accommodate human error [2].

Safe Systems is a philosophical approach for implementing some new actions and using a lot of existing countermeasures in a different way. It is a systematic approach that requires a thorough understanding of the four key components of road safety: users, vehicles, speeds and road environments, as well as their interaction (Figure 2).

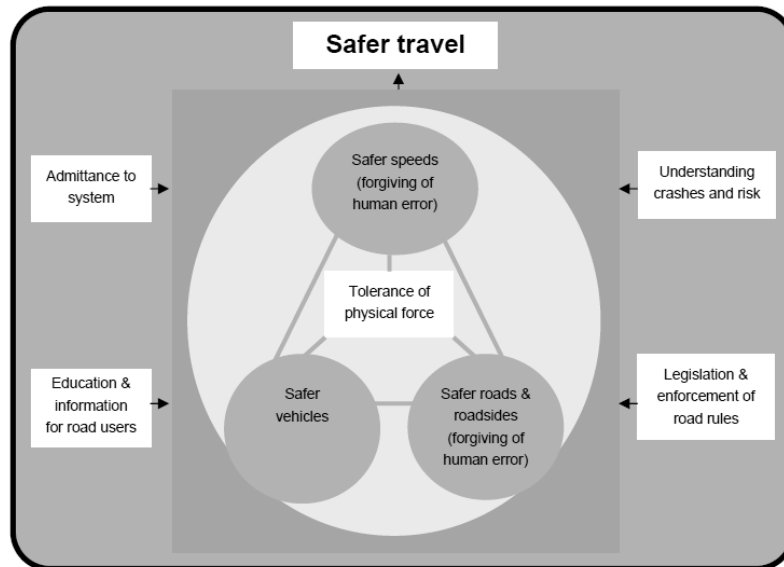


Figure 2: A conceptual overview of the Safe Systems framework [5]

The principles of Safe Systems have now been fully accepted by all road authorities in Australia and are gradually being rolled out on public road networks throughout Australia. In Western Australia, it is known as 'Towards Zero' and in its visionary context is similar to the 'Zero Harm' aspirations commonly adopted by Australian mining organisations.

Safe Systems on mining operations

There are a number of key influencers that manage traffic operations on the public road network, but not necessarily in a coordinated manner or with a full control over the road system:

- road owners and managers (at national, state or local government levels)
- enforcement agencies
- driver education / licensing organisations
- vehicle compliance regulators.

Mining operations, on the other hand, are an example where all the aspects of traffic management listed above are contained within the same closed environment. In other words, as opposed to public road networks, the mining industry has complete control over all Safe Systems elements and as such could aspire to move 'Towards Zero' much quicker than on public roads.

However, the reality is that road crashes with serious consequences still occur on Australian mining operations and, therefore, the industry could benefit from formally implementing a Safe Systems approach on its operations in order to reduce, and ultimately eliminate, crashes.

Background

Road safety on mines

Road safety is recognised as one of the major risk areas on Australian mining operations. Mr Stewart Bell, Queensland's Commissioner for Mine Safety and Health recently stated that:

Over the last 10 years in Australia's mining, exploration and extractive industries, vehicle collision incidents and accidents caused 31 deaths or 28 per cent of all fatalities, and the whole industry wants to reduce that figure.

In Queensland's mining, exploration and extractive industries, six of the 17 fatalities in the past six years involved incidents related to interactions with vehicles. [6]

Despite past improvements in all areas of mining risk management, including road safety, there are currently no indications that the existing trends will result in a complete elimination of road hazards in the near future.

The importance of this area of risk management is evident by the inclusion of a specific action/program on the development and promotion of leading practice principles for the minimisation of vehicle contacts in the Queensland Resource Council's Health and Safety Plan 2009-2012 [7].

Safe Systems on mining and resource processing operations

The mining industry is in an ideal position to fully implement the Safe Systems approach on its operations for a number of reasons:

- Mine sites are predominantly private properties with restricted, or no, access for the general public.
- Mines operate under relevant State Mining Acts and Regulations including general duty of care provisions.
- Mining organisations have complete control over the four elements of Safe Systems.

However, similarly to public road networks, elements of the traffic system on most mines are dealt with by various departments on either operational or corporate levels. This results in traffic risk management frameworks that are disjointed, not complementary, incomplete, irrelevant, outdated, or similar.

Additionally, mining organisations often lack skills and knowledge in this specific area of risk management. The industry relies on teams of individuals highly specialised in core areas of mining business and traffic management is generally not seen as one of these areas.

Some of the issues in addressing Safe Systems on Australian mining operations, as identified by ARRB Group, are presented in the following sections.

Road users

One of the challenges facing the booming mining industry is the lack of experienced personnel to fill a variety of mining roles. Opportunities abound resulting in high turnover rates and the attraction of personnel without prior experience in the mining environment.

Such workforce may not always have the necessary skills to operate vehicles and machinery in a safe manner. Similarly, some of the workforce with mining experience may have a history of risk-taking behaviour which could result in safety breaches during their employment.

Site specific road rules, regulations and information are not always available or are not presented to the workforce in a fashion that is understood by everyone. Some training packages are fairly basic and do not ensure the retention of required knowledge by the workforce or they sometimes allow operators to work independently without being ready to do so.

Driving related rules and regulations are not always implemented or followed in a consistent way sending contradictory messages to the workforce with the detrimental effect of eroding the fundamentals of safety culture on sites.

Alcohol and substance abuse are generally adequately controlled by mining organisations. Fatigue, on the other hand, is an important impairing factor that is still not fully managed and frequently contributes to undesirable outcomes.

An important factor that contributes to the increased exposure to traffic risks is the size and composition of the vehicle fleet used on mines. Without appropriate driving restrictions in place, which can be based either on specific workforce groups or high-risk work areas, opportunities for unsafe events increase.

Vehicles

As opposed to a public road network where there is little control over the condition of the vehicle fleet that uses that network, mine sites can establish purchase and maintenance specifications to ensure that risks associated with vehicles used on mines are minimised.

Vehicles used for work purposes could be considered as extensions of employees' workplaces. As such, employers have an obligation to provide vehicles that are fit for purpose, in safe condition and equipped so to minimise the risk of incidents or levels of injury for occupants. Employees, on the other hand, are obliged to follow the applicable rules established by their employers and never endanger themselves or their fellow workers.

Despite significant improvements in recent years, an unacceptable level of accidents occurs due to poor vehicle maintenance and inspection practices.

Mining roads

Very often, particularly on existing operations, mining roads are seen as 'associated' features without a full appreciation of their importance for safe and efficient movement of mining vehicle fleets.

Mining roads can be broadly categorised as: haul roads, access roads, and service roads. Each of these requires a different set of design criteria to accommodate specific vehicle types, road users and driving requirements. Ideally, these criteria, together with road construction and maintenance requirements, should be incorporated in site road management manuals.

In reality, mining operations often give insufficient consideration to appropriate road design, construction and maintenance methods. The design of haul roads is usually done with production requirements as a primary consideration and safety implications associated with road design are seldom considered.

Roads are usually constructed by relying on the skills of experienced machinery operators with only broad instructions given on the actual requirements for roads. Similarly, road maintenance is usually reactive and unplanned.

Such an approach results in a road network that varies in safety and efficiency levels. The main benefit of such an approach, which makes it very attractive to mining operations, is lower upfront costs. These do not necessarily translate in lower whole-of-life costs and so the selected road management approach on a mine depends on whether decisions are made on operational (with a shorter-term focus on expenditures) or corporate (usually longer-term, life-of-mine costs) levels.

Traffic on mines is not restricted to roads only. Areas such as workshops, car parks, go-lines, ROMs, processing plants, etc., can be heavily trafficked and require adequate consideration to reduce risks for road users.

Mining operations often rely on using public road networks for commuting, transportation of goods and products, and similar purposes. Although the management of the public road network is outside their direct control, it is in mining organisations' best interest to collaborate with road authorities on relevant road safety improvement projects.

Speed

Safe Systems considers speed as the most critical factor in determining the outcomes of car crashes. For example, the chances of survival decrease dramatically for pedestrians hit by vehicles at impact speeds above 30 km/h or for vehicle occupants in head-on crashes at impact speeds above 70 km/h [2].

The crash scenarios that most people associate with mining operations are the dramatic interactions between large and small vehicles. The outcomes of these crashes are predominantly related to the vehicle size incompatibility and impact speeds have only a negligible role.

However, a significant proportion of mining related driving is done on roads where vehicles are compatible in size. In these situations, as well as when vehicles interact with pedestrians, speed plays a critical role in defining the outcomes of crashes.

Although there have been improvements in the area of speed management in recent years, there are still frequent instances where inappropriate speed zones have been established in certain areas within mining operations.

These days, most mining organisations appreciate that productivity gains from shorter cycle times do not justify safety implications associated with higher speeds. This appreciation has led to broad adjustments of speed limits on Australian mine sites. While such initiatives are always applauded from a traffic safety perspective, unless speed management reviews are carried out in a comprehensive and structured fashion, they could have undesirable outcomes.

The undesirable outcomes from an unsystematic approach towards speed management include speed limits that have been set too low, excessive numbers of speed zones, speed zones that are too short in length, inconsistency in the application of speed limits, etc.

As it is the case on the public road network, it is important for mining companies to monitor the compliance with speed limits on their sites. Speed monitoring devices are slowly being used by more and more Australian mining operations.

Frequent cases of disobeying speed limits can be an indication of a site-wide attitude towards safety, i.e. poor site safety culture.

Opportunities for increasing compliance with Safe Systems

As previously suggested, Safe Systems is a systematic approach for improving traffic safety by implementing some new things and doing a lot of existing things in a different way.

An example of a Safe Systems approach on mine sites would be a widespread use of central windrows on mining haul roads, similar to median barriers on public roads. For this, a decision would need to be made at an organisational level (due to potential land take issues and associated costs) and implemented at the operational level (site management ensuring that appropriate design, construction and maintenance methods have been applied) with the aim of preventing a vehicle whose driver has been distracted (innocent mistake that could happen to anyone) from crashing head-on with an oncoming vehicle.

The following section lists a number of suggestions for improving traffic safety on Australian mining operations. The list is not exclusive and not all suggestions will be applicable or relevant to all circumstances.

It is suggested that the relevant improvement opportunities are considered, together with those that are already in place, in a systematic way to ensure that their benefits are maximised.

Alert and compliant road users

- Past work performance records of job applicants should be reviewed on organisational levels.
- Employees that have been deemed as potential risk-takers should be allocated to less hazardous duties (until or unless they are proven to be ready to perform riskier tasks, such as driving).
- Allocation of driving permits should be restricted and based on the requirements of individuals' nominated duties (for example, a truck operator does not necessarily require a permit to drive light vehicles).
- Operations should have a good understanding of the risks and benefits associated with permitting driving to individuals whose driving record or profile may suggest inappropriate driving capabilities or standards (e.g. drivers on learners or probationary licences, drivers who have lost their driving licences, etc.)
- Provide targeted training opportunities for all employees, particularly to those with limited exposure to the mining environment, including defensive driving techniques, driving on gravel roads, four-wheel drive training, etc.
- Develop a program of regular retraining and reassessment for personnel to ensure ongoing competencies and skills to carry out their tasks.
- Continue implementing educational and technological measures aimed at minimising risks associated with impaired drivers, particularly related to fatigue management.
- Understand and address the risks associated with commute driving, both for residential and fly in-fly out operations.
- In-vehicle monitoring systems, if implemented and managed appropriately, can be effective in influencing and improving driver behaviour.
- Site-specific rules, regulations and repercussions need to be clearly understood by everyone in the workforce.
- Breaches of rules should be sanctioned consistently and fairly with no differentiation between clients' and contractors' employees.

Safer vehicles

- Continue with the deployment of the latest advanced safety technologies such as proximity detection systems, GPS navigation and fleet monitoring systems, cameras, electronic stability controls, and similar to the mining vehicle fleet. However, these should be treated as tools only and there should be a clear understanding that over-reliance on safety devices may lead to risk compensation.
- Ensure that the proven safety devices are deployed across the vehicle fleet (e.g. reflective striping and numbering, flag pole LED beacons, etc.)
- Organisations should appreciate that due to different driving requirements on mines a 'one-size fit all' vehicle selection approach may not achieve the

safest outcomes (e.g. for long distance driving requirements, sedan vehicles could prove to be safer than 4WD vehicles).

- The EOM requirements, particularly those associated with safe operating conditions and servicing, should be followed and complemented by regular pre-start inspections.

Safer roads

- Mining organisations should develop road management manuals or guidelines, based on current research, standards and best practices, to ensure that road safety is adequately considered during road design, construction and maintenance stages.
- Research into elements of safe road design should be carried out on an industry level to assist organisations with the development and refinement of their site specific guidelines.
- Consideration should be given to carrying out formal road safety audits, by independent and experienced auditors, at various stages of road project development – from reviewing designs, through construction and maintenance practices to auditing of existing roads.
- Mining organisations should provide training opportunities for relevant staff in the areas of traffic safety, engineering and management to enhance their skills enabling them to resolve safety issues on practical levels.
- It is strongly recommended that dedicated site road maintenance crews be established as this has proven to be a very effective measure for drastically improving road safety.

Safer speeds

- Current speed regimes should be reviewed for their appropriateness.
- Educational, speed monitoring and enforcing activities should be continued.
- Comprehensive and appropriate speed management on mines should be established.

Conclusions

Safe Systems is a new systematic approach for addressing traffic hazards on public roads in Australia and comprises of four key elements: road users, vehicles, speeds and road environments. The system has human tolerance to physical forces at its basis and operates under the premise that road users should not be penalised with death or serious injury for innocent mistakes.

In order to achieve further improvements in road safety on Australian mining operations it is recommended that a similar approach be implemented. Relevant measures recommended in this paper, in addition to those that are already in place on mines need to be considered in a coordinated and systematic way.

This should start with a commitment at highest organisational levels and the establishment of a vision and directions for developing and implementing a comprehensive road safety risk management framework on both corporate and operational levels. On a practical level, this would lead to the development of robust traffic management strategies and plans.

Despite improvements in recent years, further gains can be achieved by:

- ensuring that all road users are trained, capable and informed about their specific tasks and 'mining specific' hazards
- enhancing safety and efficiency of mining road networks through improved design, construction and maintenance practices
- ensuring that the mine vehicle fleet is suitable, appropriately equipped and maintained for specific requirements
- establishing a safe and efficient speed management regime.

It is also important to continue raising awareness about road safety issues amongst the workforce and to provide training opportunities for increasing skills and knowledge in the areas of traffic safety and traffic management.

Such an approach, developed and driven by the highest organisational levels has a potential of achieving the 'Zero Harm' vision in this important area of mining risk management.

References

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