Submission to Safe Work Australia in response to the *Public Discussion Paper: Review Of Design and Engineering Controls For Improving Quad Bike Safety*

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INTRODUCTION

The Federal Chamber of Automotive Industries (FCAI) is Australia's peak organisation for the automotive industry and represents importers of ATVs and motorcycles as well as car manufacturers and importers.

The FCAI and the industry it represents will continue to refer to All Terrain Vehicles by that (correct) name. The slang term "quad bike" has become popular in some quarters in recent years, but only because of an unfortunate confusion between "terrain", on the one hand, and "topography", on the other.

The ATV industry in Australia is concerned about the number of deaths and injuries associated with ATV use and has always been a willing and collaborative contributor to forums aimed at developing strategies and actions to improve safety.

Our involvement has included participation in a lengthy Coroner's inquiry in Victoria and Tasmania and, over the past few years, in numerous workshops which culminated in the development by the Heads of Workplace Safety Authorities of an ATV safety strategy that was released in 2011. The industry will also be involved in recently announced research into ATV safety which will commence later this year in New South Wales.

Throughout this time, the industry has supported proven safety measures including mandatory wearing of helmets, comprehensive training and appropriate use of ATVs and particularly the banning of children under the age of 16 from using adult-sized ATVs.

The industry has investigated potential engineering safety enhancements ever since ATVs were first put into the market place. Any proposed engineering change must take into account the inherent design of the ATV as a vehicle that is actively ridden like a motorcycle and hence the rider is not restrained. The industry will continue to seek engineering improvements where they can be proven to be safe and effective.

To that end, the industry cannot support the fitment of ROPS (including so-called "crush protective devices", or CPDs) to ATVs based on current international research evidence. Put simply, these devices do not meet world standards as a safety intervention. ROPS on ATVs have an unacceptably high injury risk and can cause more injuries than they prevent. As mentioned above, the industry supports further scientific research – including into ROPS. But, as matters currently stand, the industry is of the view there is no credible research which indicates a ROPS is beneficial to ATV rider safety.

The ATV industry believes more needs to be done to promote proven safety interventions. No attempt has been made to mandate helmets; training offered by the industry is largely ignored; and there has been inadequate publicising of the responsibility adults must show for the safety of children, by ensuring they do not ride an adult-sized ATV.

DISCUSSION PAPER PROPOSALS

The FCAI would like to make the following specific comments in relation to the Discussion Paper:

Foreword

Australia is a very small part of the world market for ATVs so introducing design elements just for Australia is generally unwarranted. When design elements are tested and proven to have a safety (or other) benefit they are quickly integrated into new models and rolled out across all major markets.

In the automotive sector, international standardisation and regulation has become the norm and the days of unique design rules for Australia are over, as what is proven safe and effective for one market generally applies to all. In the same way, the ATV industry aims to provide the best product for all consumers regardless of geography.

Some 29 ATV engineering design, performance and safety features are already required by mandatory regulations in North America, the region where the vast majority of ATVs are manufactured and sold. It is also, without doubt, the region who's legislators and regulatory bodies have scrutinised ATV design and use more thoroughly than any other over the past three decades. From this they have developed a "world's best" design standard (ANSI/SVIA-1) which was updated less than two years ago. Australia should leverage that vast and unparalleled experience and adopt for itself those ATV engineering standards, which the majority of the industry already comply with voluntarily, rather than attempting to reinvent ATV standards.

ATV sales continue to grow in Australia and around the world, providing the industry with every incentive to pursue continual improvement in ATV design. There ought be no doubt that the industry will introduce additional engineering solutions if and as they believe them to be both safe and effective, as safety is the industry's highest priority.

What design solutions and/or engineering controls could improve quad bike stability and safety?

As part of any discussion on “improving” ATV stability and safety, it is necessary to consider where the class of vehicles called ATVs sits in the continuum of vehicles used in agriculture and recreation.

Motorcycles, side-by-side vehicles, 4x4 vehicles, utility vehicles, tractors and trucks are all used in agriculture, with the latter three to a lesser extent in recreation.

From a design perspective, motorcycles and ATV’s are considered as “rider active” vehicles, for which appropriate movement of the rider’s body position is critical to, and intrinsically linked with, the relative stability, mobility, utility and safe and effective use of the vehicle. This is largely due to the relatively large percentage which the rider’s weight contributes to the gross vehicle mass. Design elements which normally characterise these rider active vehicles are:

- “Sit astride” seats with footpegs/ footrests [as per ANSI/SVIA-1] where the rider’s legs are either side of the engine and/or gearbox and their feet are placed on individual footpegs or footrests. This allows the rider to place appropriate weight on either foot (often by standing) and to move their body weight both fore and aft and side to side on the seat in order to control the vehicle, particularly when ascending, descending or traversing slopes. This combination of sit astride seat and footpegs /footrests also enables the rider to separate from the vehicle due to natural forces in the event of overturn, and allows the rider the option of separating from the vehicle in a controlled manner if the riding situation requires it (e.g., stalling whilst ascending a steep slope or potential instability whilst traversing a slope).
- Handlebars (as opposed to a steering-wheel) which are used both to turn the front wheel(s) and to provide two hand grip points (similar to what the footpegs /footrests provide for the feet) to assist the rider in moving their body weight to control the vehicle. They also allow the rider to move their body weight forward “above” the handlebars, particularly when ascending slopes. In addition, the handlebars assist in allowing the rider to shift their body weight to the “uphill” side of the vehicle when traversing slopes.
- A smooth seat. This normally continues both forward and behind the rider’s “neutral” seating position, allowing them to “slide” their weight forward and backward (and to a lesser extent side to side) to enable appropriate body position to be achieved when ascending and descending slopes.
- A relatively narrow track and short wheelbase (compared to a side-by-side vehicle or 4x4) to allow high manoeuvrability and mobility in restricted space or changing environments (such as when mustering livestock).
- Hand operated accelerator.
- Hand operated brake(s) and clutch, if fitted. In addition, one or more brakes (and gears if fitted) may be operated by the foot.

By contrast, vehicles such as side-by-side vehicles, 4x4s, utilities, trucks and tractors are not rider active (or driver-active). That is, occupant weight is small in comparison to the vehicle, and they do not require the driver to shift their body weight to effectively control the vehicle. Consequently, they have fixed seating positions for the driver and any passengers. Design elements which normally characterise these types of "non-rider active" vehicles are:

- A fixed seat (normally of "bucket" design) which provides a single fixed position for each vehicle occupant within a protective space engineered by creating protective structures around vehicle occupants. These structures often include, but are not limited to, a rigid body shell or chassis or frame with roof pillars, a roof, floors, sometimes doors, limb restraint nets (i.e., netting "doors"), ROPS, etc. The one exception to this are tractors under 560kg, for which there is no requirement for any protective structure.
- A restraint system ("seat belt") to restrain each vehicle occupant in their fixed seating position, and within the protective space of the vehicle, when driving on rough terrain or in a crash or rollover situation.
- A steering wheel, fixed at a point relative to the driver's seating position, designed to steer the vehicle.
- A relatively wide track and long wheelbase, providing a high degree of stability (i.e., reduced manoeuvrability and mobility) to allow for increased passenger and payload carrying capacity.
- Foot-operated accelerator, brake and clutch. (If fitted.)

As can be seen by this comparison, and as the "quad bike" description suggests, ATVs have much more in common with motorcycles than with side-by-side vehicles, 4x4's or tractors.

Hence, in considering any proposed design solutions and/or engineering controls, it is important to consider how the ATV design has evolved to its current point in the continuum of available vehicles, and how changing the design will necessarily affect its utility and operating characteristics.

Given its single track, a motorcycle is the most manoeuvrable of the vehicles commonly used in agriculture. It has the narrowest track and requires significant rider intervention by way of body weight shift and control input to follow a desired path. In agriculture or off road recreational use they are primarily a single user vehicle with high mobility but very limited load carrying capacity.

An ATV has a track that is wider than a motorcycle. By its nature, it therefore has greater lateral stability. However, there is no evidence to suggest that greater lateral stability is a valid measure of ATV safety. Whilst still primarily a single person vehicle, ATVs have greater load carrying capacity than motorcycles but, as they are also "rider active", this capacity is still significantly less than the longer, wider and more stable "non-rider active" vehicles such as side-by-sides and 4x4s.

As the track width and wheelbase length of vehicles increase, they become more stable, heavier and consequently less manoeuvrable and less mobile. The fundamental utility of the vehicle thus changes and the nature of the manner in which they are controlled must also change. A (comparatively) wide track, long wheelbase vehicle can no longer be rider active and thus requires a steering wheel, fixed seating and consequential protective structures to surround, as well as restrain within it, all parts of the driver and passengers. By widening and/or elongating an ATV, the engineering adaptations which need to be added (i.e., bucket seat/s, an occupant restraint device, ROPS, a steering wheel, change in control positions, etc.) essentially change the vehicle from an ATV into a side-by-side vehicle (two or more seats) or a single seat buggy.

These wider and longer types of side-by-side vehicles with ROPS have already been designed and are freely available for sale in Australia, primarily originating from the same manufacturers who build ATVs. Choosing the correct vehicle for the application is of prime importance as, whilst they do have points of usage crossover, they are not identical in usage profile.

With regard to lowering the centre of gravity of ATVs to make them less likely to rollover, there are already ATVs available, with shorter suspension and lower profile tyres, which have a lower centre of gravity than the more utility focused ATVs. But this naturally affects available ground clearance and thus the mobility and utility for which the vehicle was likely employed in the first place. Whilst a rider on a sand dune or MotoX track may value a low centre of gravity ATV and not require much ground clearance, a dairy farmer in rutted tracks in a muddy paddock requires exactly the opposite, and would often "high-centre" and become stuck if riding such a low sprung vehicle.

With regard to *"active stability controls that can automatically take control of vehicle systems to minimise roll over risk"*, there are presently no such systems available (i.e., it is beyond the state of technology). On-road vehicles that have electronic stability control (ESC), for example, implement them via antilock brake systems (which off-road vehicles do not have for safety reasons). Moreover, on-road and off-road tyre force characteristics are very different (essentially opposite in terms of their force/slip characteristics). So, while on-road ESC systems rely on applying brakes to increase roll stability, in an off-road situation this would increase tyre forces and decrease roll stability. While it is conceivable that such systems may be developed in future years for off –road vehicles such as ATVs, they are presently beyond the scope of current technology.

With regards to "passive stability control systems like operator warnings that sound when slopes that increase roll over risk are encountered", an observant rider should be able to easily observe that they are approaching a slope, how steep the slope is and to position their body accordingly, if they are trained to do so. For any passive system to recognise a slope (say with an inclinometer) the vehicle would already have to have been on the slope for a period of time. Thus, if relying on the warning device, it may be too late for the rider to make the decision not to ride on to the slope in the first place, unless of course the system is measuring slope well ahead of the vehicle.

However, the slope of the terrain is just one (albeit major) determinant of tipping point. Many other inputs to the system would also be necessary to make the tipping point warning valid, given the significant rider active nature of ATVs. Such systems would need to monitor the weight and body position of the rider as well as any load being carried, as well as transient bumps being encountered and incorporate that information to calculate the point at which turnover may occur on that particular slope and situation. This of course assumes constant speed, direction, slope and body position, none of which *can* be assumed in such a dynamic riding environment. Key well-known limitations of such systems – which may work on heavy, slow-moving earthmoving equipment operating on gradually changing, more uniform slopes - include the inherent time delays of the sensing system; the inherent time delay for the operator to react (which is important if a vehicle such as an ATV is moving across complex, varying terrain) and the nature of the warning (i.e., visual, audio, etc.).

Obviously a visual display is inappropriate for a vehicle such as an ATV as it would require the rider to look downward, away from the forward terrain at a moment when it is critical that their visual attention be directed toward the terrain. An aural warning, in the presence of engine sounds, can conflict with use of an appropriate helmet and, like other warnings, has the inherent issues of delay and occurrence of nuisance warnings when, for example, the vehicle traverses rough (bumpy) terrain, even when there is no risk of overturn. Riders would have to learn how to interpret and when and whether to react to such nuisance warnings. As an example, a rider traversing a slope with correct body position – i.e., leaning up the hill – could traverse a much steeper slope without tipping than could the same rider with incorrect body position. Without such inputs as rider weight and body position, an operator warning system would give a rider with incorrect body position a false sense of how far the vehicle could lean (i.e., it would overestimate the tipping point) while, conversely, it would underestimate the tipping point for a rider with correct body position. If speed, slope, direction or riding position change, then of course so does the tipping point.

They key to avoiding tip over on slopes is for riders to identify potentially hazardous slopes BEFORE they attempt to ride on them. In addition, on any slope (or in any turn) ATV riders should use a correct combination of body position and speed to ensure they have the maximum margin in which to react, and the maximum margin for error should conditions change. As a last resort, having the correct riding position will in most cases allow a safe separation away from the path of the vehicle if a tip over eventually does occur.

The only way that riders can appropriately identify and deal with hazards is if they are significantly experienced or trained to do so. As with a motorcycle, the rider's weight and body position has a significant effect on the behaviour of the ATV. Regardless of engineering modifications to the ATV, the rider and their ATV are intrinsically linked and the safe operation of the vehicle is dependent on the rider knowing how to make the correct inputs to the machine and then making those inputs.

What engineering controls could improve operator protection in the event of a roll over?

In the event of a rollover, correct riding position and a lack of obstructions are key to the rider separating from the vehicle in a controlled manner.

ATVs are designed with flat, smooth surfaces, free of obstructions, to facilitate the movement of the rider away from the path of the ATV. They are now also required to be designed (under ANSI/SVIA 1- 2010, with which all FCAI members comply) with a standardised protective "foot environment" to minimise the chances of lower extremities being inadvertently placed between footpegs and the wheels or body of the vehicle.

However, given the intrinsic relationship between rider and safe control of the vehicle, it is critical that riders place themselves in the correct riding position prior to any tip over risk occurring ("uphill" of the vehicle on slopes and to the "inside" of the corner in turns.) In the vast majority of cases these simple but essential techniques will prevent the tip over from occurring in the first place. If, despite these precautions, tip over does occur the rider will be in the safest position to move away from the path of the vehicle.

Given that head injuries are significantly overrepresented in roll over events, and one of the major causes of death, the obvious engineering control to improve operator protection in a roll over would be to mandate that all riders wear a properly engineered motorcycle helmet.

With regard to the fitting of ROPS or so-called "crush protection devices" (CPDs), the FCAI is unaware of any reputable research, worldwide, which shows any evidence that their use would provide a net benefit to users. In fact the opposite is the case. Physical and simulation research conducted by Dynamic Research Incorporated has found that, for helmeted riders, the least harmful of the CPD's tested caused approximately as many injuries as it prevented and thus was of no net benefit.

Not only are the CPD's themselves unproven but no ATV in current use has been designed to accept fitment of any of the CPD's on the market.

It is inconceivable that anywhere else in the automotive industry, an unproven device (with no supporting research to demonstrate that it has any safety benefit, but with research indicating the contrary[1]) would be allowed to be fitted to a vehicle which was never designed to accept it, or that this would somehow be considered to be a "safety" measure.

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[1] Zellner, J.W., Kebschull, S.A., Van Auken, R.M. UPDATED INJURY RISK/BENEFIT ANALYSIS OF QUADBAR CRUSH PROTECTION DEVICE (CPD) FOR ALL-TERRAIN VEHICLES (ATVS) DRI-TR-06. 3 August 2012.

With regard to “*automated emergency alarms that are initiated in the event of roll over” f*or those working alone or in isolated places, there may be value in the fitment of an aftermarket EPIRB (or EPIRB-like) alarm device which triggers upon inversion and is linked to a notification service. This would conceivably be of value to all vehicle types used by those working alone and/or in isolated areas, not just ATVs.

What engineering options could minimise the capacity of children to start and/or operate quad bikes?

Unless the vehicle has been tampered with, removal of the key from the ignition of the vehicle will prevent the vehicle being operated by any unauthorised person, not just a child.

Furthermore, isolating the key in a place where it is not accessible to children (e.g., key safe, gun safe, responsible adult’s pocket, etc.) will ensure that children do not have the ability to start the vehicle and therefore will be unable to ride it. There seems little need to look for a highly complex engineering solution when such a simple solution is already available.

With regard to the inclusion of *“seat weight sensors”,* it has been rightly observed that children are resourceful and would soon work out that the weight of two children would also trigger a simple pressure switch in the same way as would a single adult. Potentially encouraging one child to take a sibling or mate in order to trigger the seat sensor, rather than riding the ATV alone, would likely be a counter-productive step.

Futuristic infrared or other sensing systems that detect the physical size of the rider are under development in cars (for airbag sensing systems) but despite major efforts are still beyond the state of technology. How or whether such systems, if ever developed, might be adaptable to the dusty and exposed outdoor environment of an ATV is unknown. In addition, they would discriminate against small adults who are capable of safely operating an ATV.

With regard to the operator controls, much effort, over many years, has been invested in refining their functionality to enhance the rider’s control of these vehicles. To arbitrarily make them difficult for children, who have no place being on the adult sized ATV’s, to us seems ill advised, and likely to be circumvented by children.

What engineering controls could minimise the capacity of a quad bike to carry passengers.

As they are rider active vehicles, the smooth seat normally fitted to an ATV is designed quite specifically to make it possible for the rider to shift their body weight in order to control the vehicle effectively. The seat normally continues smoothly both fore and aft of the rider's "neutral" seating position allowing them to "slide" their weight forward and backward (and, to a lesser extent, side to side) to enable appropriate body position to be achieved when ascending and descending slopes.

As most ATV (and off-road motorcycle) seats are non-adjustable, the seat is also designed to allow the accommodation of riders of different heights and sizes.

Therefore *"modifying the seats to limit space to a single operator"* would necessarily compromise the ability of the rider to operate the vehicle effectively and safely.

Regarding *"redesigning carrying racks to restrict the ability to carry passengers and/or make it uncomfortable to use carrying racks as seats.",* it should be understood that the individual design of the carry racks on any particular vehicle is based around the effective carrying of small loads, whilst ensuring that there are smooth surfaces and minimal obstructions for the rider, particularly in the event of a crash or at the time they choose to separate from the vehicle.

Making the racks uncomfortable to sit on may have unplanned negative consequences. As long ago as the 1970's, research by a Dr. Peter Bothwell found a "strong indication that general smoothing of the outer contour all over the motorcycle is a desirable feature." and that "handlebars and motorcycle profile should be free of trauma producing projections." These findings have influenced motorcycle and ATV design ever since and may provide a counterpoint to the argument of making elements of the ATV deliberately rough or uncomfortable.

CONCLUSION

Given that there is a highly integrated and synergistic relationship between the ATV and its rider, it is unfortunate that this discussion paper deliberately excludes proven safety interventions.

Whilst some additional engineering solutions (in addition to the 29 ANSI/SVIA-1 engineering requirements which are already mandated) may conceivably offer some marginal improvement in safety outcomes, evidence from other countries show that it is not until all stakeholders get serious about rider behaviour and, more importantly, misbehaviour that improved safety outcomes can be expected.

Design changes, even if they could be shown to have effective safety outcomes (which is currently not the case,) will take years to implement throughout the entire ATV fleet. Changes in behaviour and compliance with proven safety measures can be implemented widely and relatively quickly through a combination of education, legislation and ultimately enforcement.

We know the major issues implicated in injuries and fatalities are a lack of helmet use, children under 16 years riding full sized adult ATVs, passengers and overloading of single operator vehicles and a lack of training/certification of users. They can be addressed by:

- Making helmet use mandatory for all ATV riders.
- Not allowing children to access full sized ATVs.
- Ensuring all users are trained in the safe operation of ATVs through provision of training and awareness and enforcement of existing workplace health and safety legislation.

The industry remains committed to ATV safety and continues to be willing to be involved in discussion on this issue.