

Fresnel lens trial research

Summary report, August 2022

Contents

1	Key findings	3
1.1	Methods	3
1.2	Did heavy vehicle drivers find the Fresnel lens effective?.....	3
1.3	Was the Fresnel lens acceptable to heavy vehicle drivers?.....	3
1.4	Was the Fresnel lens acceptable to fleet managers?	4
1.5	Summary of key recommendations	4
2	About the trial.....	5
2.1	Background.....	5
2.2	The Fresnel lens	5
2.3	Trial objectives.....	6
3	Methods	7
3.1	Research participation	8
3.2	Limitations.....	8
4	Results	9
4.1	Did the Fresnel lens help avoid any crashes and near misses?	9
4.2	Did the Fresnel lens increase visibility for heavy vehicle drivers?	9
4.3	Did drivers find the Fresnel lens helped make driving safer?	10
4.4	Was the Fresnel lens acceptable to heavy vehicle drivers?.....	12
4.5	Were Fresnel lenses acceptable to fleet managers?	12
5	Recommendations	14
5.1	Communication to fleet managers.....	14
5.2	Communication to drivers	14

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1 Key findings

Heavy vehicles are over-represented in serious injury and fatal crashes with other road users. Crashes involving other road users in the heavy vehicle's passenger side blind spot make a substantial contribution to these crashes. In NSW between 2011 and 2020, 12 per cent of all fatal and serious injury crashes involving a heavy vehicle were due to a lane change/ side swipe manoeuvre¹. Overseas studies have shown that a low-cost device called a Fresnel lens, little known or used in Australia, can be fitted to the passenger window of a heavy vehicle to provide a view of other road users in that blind spot.

This research aimed to examine the effectiveness of Fresnel lenses in enhancing road safety by minimising near-side 'blind spots' on Australian heavy vehicles and assess driver acceptance of using Fresnel Lenses to improve their field of view.

1.1 Methods

Transport for NSW recruited organisations with heavy vehicle fleets to participate in the research. Fleet managers were briefed on the trial and benefits of the Fresnel lens. Drivers provided informed consent to take part in the trial.

Participating drivers completed an online pre-fitment survey. Drivers from six companies completed the minimum eight-week trial period. Following the trial period, 194 participating heavy vehicle drivers completed a post-trial online survey.

Ten drivers participated in telephone interviews about their experience with Fresnel Lens, and six fleet managers also completed telephone interviews.

1.2 Did heavy vehicle drivers find the Fresnel lens effective?

Many heavy vehicle drivers did perceive the Fresnel lens as being effective, with over half the heavy vehicle drivers reporting that having the Fresnel lens improved driving safety (60 per cent). They also tended to report that it improved visibility of road users in the blind spot in four higher risk situations (56 per cent to 67 per cent across the four different situations). Fifteen per cent of drivers reported it had helped them avoid a probable collision or near miss. The objective of improved safety through improved visibility was partly but not fully achieved, as some drivers did not perceive the lens as improving their blind-spot visibility.

1.3 Was the Fresnel lens acceptable to heavy vehicle drivers?

Drivers were more likely to report favourable rather than negative views of the Fresnel lens. Over half found the Fresnel lens easy to use (65 per cent), and easier to use than their existing mirrors (56 per cent), and more were willing to continue (39 per cent) rather than to stop using it (30 per cent) and to be willing to recommend other drivers try it (43 per cent) rather than not (13 per cent). Reporting that the Fresnel lens had helped them avoid a collision or near miss was associated with a large increase in the percentage of drivers who expressed favourable attitudes to and accepted continued use of the lens.

¹ Transport for NSW (2021). Unpublished crash data analysis.

1.4 Was the Fresnel lens acceptable to fleet managers?

Fleet managers were attracted by the low cost of the device compared with other devices for improving visibility of the passenger side blind spot. Four of the six participating managers wished their drivers to continue use, and another indicated that he would like to if problems with the lenses detaching from the window could be overcome.

1.5 Summary of key recommendations

Based on the findings of the study, recommendations included, including:

- Promoting the use of the Fresnel lens in NSW
- Recommending use of the acrylic rather than PVC Fresnel lenses
- Prepare communication materials for fleet managers and heavy vehicle drivers that emphasise manufacturer instructions on how to install the Fresnel lens and how to achieve the most benefits from the lens
- Encourage fleet managers to monitor lens installation and replace any Fresnel lenses that may become detached or damaged.

2 About the trial

2.1 Background

Heavy vehicles are over-represented in serious injury and fatal crashes with other road users. Of all road fatalities in NSW in 2020, 21 per cent involve a heavy vehicle, despite making up only 2.5 per cent of all registered vehicles and covering 8.8 per cent of all kilometres driven. Crashes involving other road users in the heavy vehicle's passenger side blind spot make a substantial contribution to these crashes. In NSW between 2011 and 2020, 12 per cent of all fatal and serious injury crashes involving a heavy vehicle were due to a lane change/ side swipe manoeuvre (both driver and passenger sides of the vehicle)².

Overseas studies have shown that a low-cost device called a Fresnel lens can be fitted to the passenger window of a heavy vehicle to provide a view of other road users in that blind spot. The studies concluded that the device can substantially reduce these crashes. The device is little known and used in Australia.

One study³ tracked "side swipe" incidents reported to police involving heavy vehicles with left hand drives entering the UK as these vehicles accounted for a large proportion of side swipe incidents. Incidents per week were substantially reduced in the eight weeks (55 per cent) after 40,000 left hand drive vehicles were issued Fresnel Lenses before entering the UK compared to the eight weeks before the devices were distributed. Surveys of drivers found most had fitted the Fresnel lens, although some reported the Fresnel lens fell off (mostly due to the passenger window being wound up and down). Driver opinions about use of the Fresnel lens were generally favourable. A later study⁴ testing the device on different types of vehicles found that it eliminated 78 per cent to 90 per cent of near side blind spots on a heavy vehicle.

This summary report provides the key findings of research that trialled the Fresnel lens on heavy vehicles under road conditions in New South Wales.

2.2 The Fresnel lens

The Fresnel lens device is designed to improve driver vision of "blind spots" on the passenger side of heavy vehicles. The enhanced field of view provided by the Fresnel lens is demonstrated in Figure 1.

Having the Fresnel lenses fitted to the passenger side window of heavy vehicles has been found in overseas trials to greatly improve the ability of drivers to see other road users that may be present in these "blind spots", thus reducing the risk of crashes especially when the heavy vehicle driver is changing lanes or turning. Two types of Fresnel lenses were trialled, an acrylic lens and a PVC lens. Most vehicles in this study were fitted with a PVC lens.

² Fitch D (2007) Final Report LHD Vehicles Blind Spot Study. UK Vehicle Operator Safety Agency (VOSA)

³ Dodd M (2009) Follow up study to the heavy goods vehicle blind spot modelling and reconstruction trial.

⁴ Published Project Report PPR403, Transport Research Laboratory.



Figure 1 Fresnel lens field of view compared to traditional mirrors



Figure 2 Cyclist seen through Fresnel lens

2.3 Trial objectives

The research project aimed to:

- Understand the effectiveness of Fresnel lenses in enhancing road safety by minimising near-side 'blind spots' on Australian heavy vehicles
- Assess driver acceptance of using Fresnel lenses to improve their field of view and understand factors that may affect driver acceptance.

3 Methods



•Transport for NSW recruited organisations with heavy vehicle fleets to participate in the research through industry contacts.



•Brief fleet managers, drivers and gain informed consent for driver participation in the trial.



•Participating drivers completed an online pre-fitment questionnaire. 251 drivers from six companies completed the questionnaire.



•Fresnel lenses were installed onto passenger side windows of participating heavy vehicles.



•Drivers completed a minimum eight week trial period of driving with the Fresnel lens attached to their vehicle.



•194 participating drivers completed an online post-trial questionnaire to understand their experiences during the trial period.



•In-depth phone interviews were conducted with ten participating drivers and six fleet managers. Fleet managers provided additional data about the vehicles involved in the trial (including cab design, age, safety features).

3.1 Research participation

Nine companies with heavy vehicle fleets were recruited to install the Fresnel lenses on as many of their vehicles as possible. Two of these companies dropped out of the trial and one only installed the Fresnel lens on two vehicles. Given the limited data available from that company, it was excluded from analysis.

In total, 251 drivers completed the pre-fitment survey, and 194 drivers completed the post-trial survey. Due to the design of the research and the need for anonymity, driver responses to each survey could not be matched. The design meant that the total number of drivers who were asked to complete the pre or post survey could not be determined.

3.2 Limitations

The sample size of N=194 drivers completing the post-trial questionnaire combined with the short follow up period of eight weeks limits the power of the study to detect any change in actual crashes and near misses with under 10 per cent of drivers reporting any crashes or near misses in the eight weeks before the Fresnel lens was fitted.

The heavy vehicles included in this trial were not considered representative of the significantly diverse population of heavy vehicles. In particular:

- The majority were manufactured in 2015 or after (71 per cent) and the average age of the N=208 vehicles for which year of manufacture was obtained was 5.1 years; the oldest of these vehicles was 19 years old
- The average age of the Australian heavy vehicle fleet is 14.9 years
- This means the trial vehicles were much more recent than the total fleet of vehicles
- The types of heavy vehicle included also may not represent the overall mix of diverse heavy vehicles in use on NSW roads
- A large percentage were skip bin vehicles (54 per cent, N=105 of the final N=194 with complete questionnaire data) which might differ from other vehicle types in the effectiveness and acceptability of the Fresnel lens.

The sample was, however, sufficiently diverse to provide a basis for drawing initial conclusions about:

- The potential effectiveness of the Fresnel lens under Australian conditions
- The potential level of acceptance of the Fresnel lens by Australian heavy vehicle drivers
- Differences between heavy vehicles and drivers that might impact on the effectiveness and driver acceptance.

4 Results

The results of the Fresnel lens trial study indicate that the device goes some way to achieving the stated objective of minimising near-side 'blind-spots' on Australian heavy vehicles. The drivers completing the post-trial questionnaire were more likely to report the Fresnel lens was beneficial, rather than not, but some drivers reported that they did not find it effective.

4.1 Did the Fresnel lens help avoid any crashes and near misses?

Fifteen per cent of the drivers indicated that the Fresnel lens had helped them to avoid a probable collision or near miss one or more times during the trial and 13 per cent that it had helped them avoid a collision one or more times. The number of such occasions reported ranged from once to more than ten times. Most drivers (83 per cent) who reported avoiding either a near miss or collision had avoided at least one collision.

The level of actual crashes and near misses during the trial period and in a similar period pre-fitment were all so low (under 5% and under 7%) that, as expected, there was no statistically significant difference in the prevalence of these events.

4.2 Did the Fresnel lens increase visibility for heavy vehicle drivers?

Over half the drivers reported that the Fresnel lens made the passenger side blind spot more visible when changing lanes (67 per cent; Figure 3), at junctions or intersections (64 per cent), in tight yards, parking areas or delivery docks (57 per cent) and when exiting roundabouts (56 per cent).

Drivers reported that the Fresnel lens was less likely to make other road users more visible if driving at night (34 per cent) and if driving in wet conditions (34 per cent).

Some drivers thought the lens was most useful while stopped or driving at low speeds, however some drivers reported finding it useful when changing lanes.

If I was going to change lanes and I wasn't sure if there was something next to me, I found the normal mirrors don't pick it up but that the lens picked that up and enhanced [visibility] – Heavy vehicle driver.

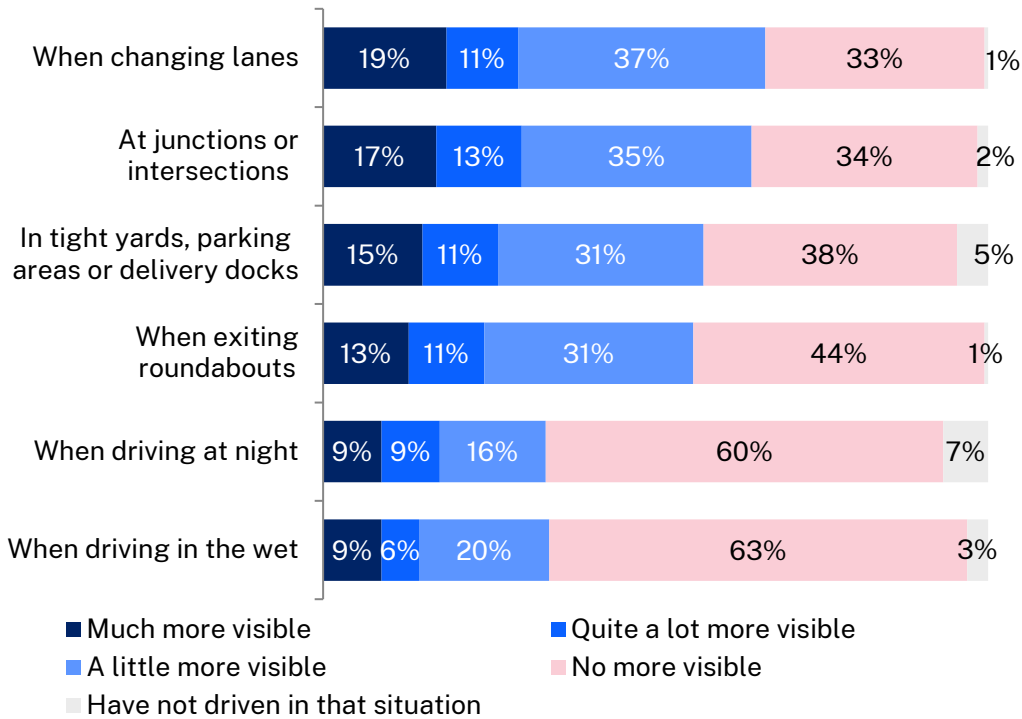


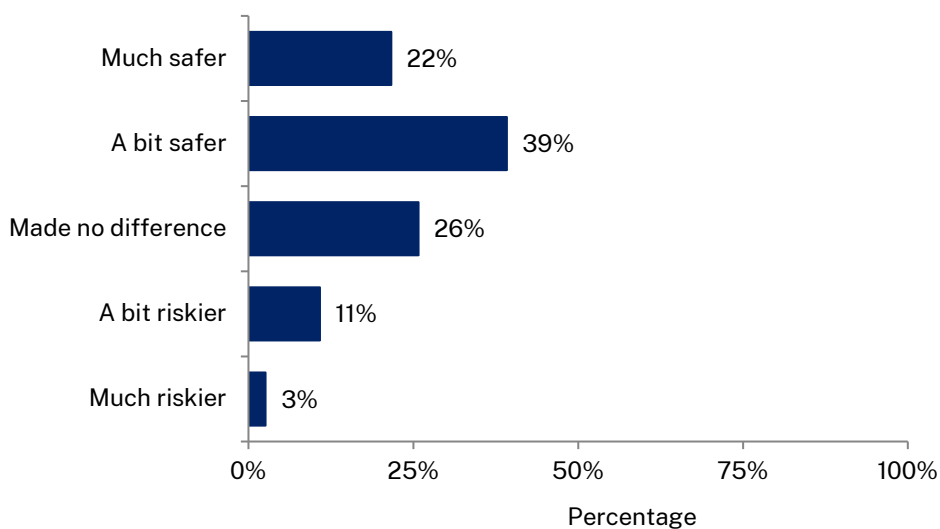
Figure 3. Reported visibility changes when using the Fresnel lens in various conditions (N = 194)

Source: Fresnel lens Trial Research 2020-2021

4.3 Did drivers find the Fresnel lens helped make driving safer?

More than half of the drivers responding to the post-trial survey (61 per cent) reported that having the Fresnel lens made driving at least a bit safer compared with 14 per cent of drivers who reported it made driving ‘much riskier’ or ‘a bit riskier’ (Figure 4).

Figure 4. Drivers reported that having the Fresnel lens fitted made driving... (N=194)



Source: Fresnel lens Trial Research 2020-2021

4.3.1 When did heavy vehicle drivers find Fresnel lens most helpful in avoiding a crash or near miss?

Drivers were more likely to report that the Fresnel lens helped to avoid a collision or near miss during the trial period if:

- The vehicle was manufactured before 2015
- the vehicle had a conventional bonnet
- The vehicle was of US or European makes
- The vehicle was fitted with an acrylic rather than PVC Lens
- They also reported that the Fresnel lens made the blind spot quite or a lot or much more visible in at least one of the six situations (described in Figure 3)
- They also reported that using the Fresnel lens made driving much safer or a bit safer (Figure 4)
- Drivers reported that using the Fresnel lens was easier than using existing truck mirrors to see into their passenger side blind spot
- Drivers considered the Fresnel lens very easy to use.

4.4 Was the Fresnel lens acceptable to heavy vehicle drivers?

On various measures of driver acceptance of the Fresnel lens, drivers were more likely to have positive rather than negative views of the lens and a preference to continue using the lens.

Specifically:

- 56 per cent found the Fresnel lens easier to use than existing truck mirrors while 11 per cent found it harder and 32 per cent found there was no difference
- 65 per cent found the Fresnel lens easy to use while 31 per cent found it difficult
- 39 per cent wanted to continue using the Fresnel lens while 30 per cent wanted to stop and 30 per cent did not mind either way

4.4.1 Was the Fresnel lens easy to use?

Drivers were more likely to say that the Fresnel lens had been easier to use than existing truck mirrors rather than saying it was harder, and nearly two-thirds of drivers reported that the Fresnel lens was easy to use, including 20 per cent who stated it was 'very easy to use'.

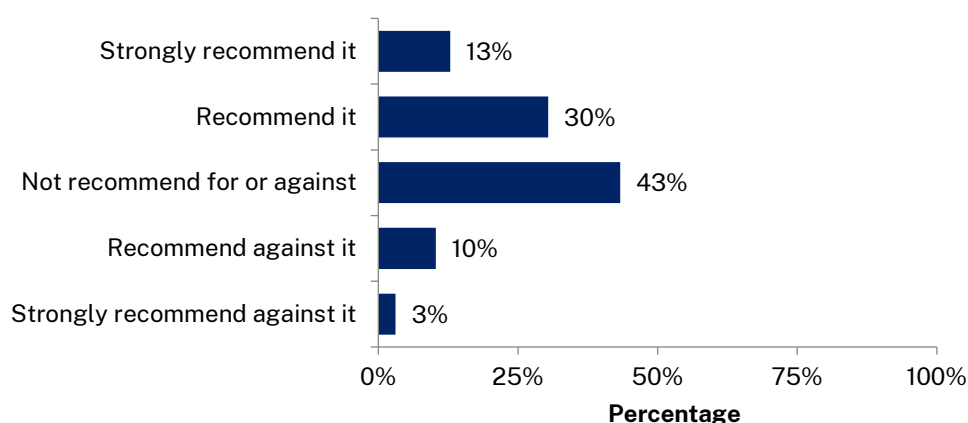
Being easier to use than the existing mirrors, general ease of use, the impact of Fresnel lens use on perceived safety and on visibility of vehicles in the blind spot were very important for acceptability of the Fresnel lens

Overall, finding the Fresnel lens distracting at the end of the eight-week trial period (18% of drivers) and reporting experiencing distortion of the image (21%) was a problem both reduced favourable attitudes towards the lens and how easy it was to use.

4.4.2 Would heavy vehicle drivers recommend the Fresnel lens to other drivers

More drivers would recommend other drivers try using the Fresnel lens (43%, including 13% strongly; Figure 5) than would recommend against trying it (13%, including 3% strongly), with 43% saying they would not make a recommendation either way. Some who had rejected continued use were willing to recommend other drivers try it or to not give a recommendation one way or the other.

Figure 5. Driver recommendation of the Fresnel lens



4.5 Were Fresnel lenses acceptable to fleet managers?

Fleet manager responses to the Fresnel lens trial were mixed but were more likely to be favourable than unfavourable.

One feature of the Fresnel lens that aroused great interest was the low cost compared to all the other devices and systems (mirrors, monitoring systems, and cameras) in the market designed to improve visibility of road users in the heavy vehicle passenger side blind spot.

The existing instructions for installation of the Fresnel lenses were found to be unclear by some managers and could be improved. The delay between installation and when the vehicle's passenger window can be wound up and down – approximately one day – without damaging the Fresnel lens needs to be clarified.

The position of door handles on the passenger door of vehicles also needs to be considered as one manager found it was not possible to install the Fresnel lens in the recommended position due to the placement of the door handle on his company's vehicles.

5 Recommendations

The results of the trial support continued work to promote awareness and adoption of the Fresnel lens in Australia

The Recommendations focus on communications to companies and drivers, and priorities for future research and monitoring of Fresnel lens use. Recommendations on future research and monitoring were also provided but are not included in this report.

5.1 Communication to fleet managers

Any presentation or other communication aimed at fleet managers should:

- focus on adoption of the acrylic Lenses in preference to the PVC lens.
- be targeted at owners of older vehicles manufactured before 2015.
- Emphasise the relatively low cost of the Fresnel lens compared with other safety devices should be emphasised, along with the relative ease of use, and improved view of the passenger side blind spot.
- Include a well-designed audio-visual presentation to promote the benefits of the Fresnel lens and how it is best used to aid companies to introduce the device to their drivers.
- Include a package of advice to managers be developed on ways to assist drivers to adapt to and learn how best to use the device.
- Include installation instructions for use by company management and drivers, including audio-visual demonstrations.
- Advise fleet managers of the need to closely monitor early experience among drivers (the first few weeks of use), including whether the Fresnel lens on their vehicle had been detached or damaged.
- Advise managers to involve drivers who have successfully adapted to using the Fresnel lens to give support and encouragement to drivers who are having more difficulty.

5.2 Communication to drivers

Any presentation or other communication aimed at drivers inform them of:

- The major benefits
- The sorts of difficulties they might experience
- That these difficulties can be overcome with a week or two of practical experience with the device
- Provide specific guidance on how best to adapt to use and how best to make use of the device

Such instructions should include dealing with distraction from the device, when to pay more attention to the image shown by the Fresnel lens, how to cope with distraction from the images in the lens, and how to cope with any distortion of the image provided by the device.

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