NZTA position on the use of driving simulator technology for learner/novice driver training

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More information

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Background

There is an increasing desire to introduce simulator technology into the driver training landscape in New Zealand. NZ Transport Agency Waka Kotahi is often asked for guidance and/or funding to implement driving simulators into driver training programmes. Whilst the technology is attractive due to lower risk of physical injury while the simulator is in use, it is important to understand the potential for other forms of harm and safety risks when translated to on-road driving performance and safety outcomes.

The current evidence

The evidence for driving simulators for learner/novice driver training is varied and continues to develop. Several studies have evaluated simulator training for those learning to drive. However, these evaluations differ substantially in nature and scope. More generally (ie for research purposes where simulators are frequently used), there is relatively little evidence confirming their validity (the ability of a simulator to accurately represent real-world driving; Wynne, Beanland & Salmon 2019). It is important to understand the appropriateness and effectiveness of driving simulators for the training of different skills and in relation to clear learning objectives and outcome measures. This requires a particular focus on the underlying constructs of validity and fidelity and the extent to which this can be achieved through simulation.

When considering the range of driving skills that novice drivers must learn, the teaching of procedural skills in a driving simulator is problematic. Owing to the difficulty in emulating on-road driving (fidelity), simulator training could lead to incorrect learning of procedural skills such as reduced mirror scanning (due to learning on a simulator with a single screen and narrow field of view) or poor vehicle control (due to limitations in steering, braking or motion functionality). There is also a lack of realistic vibrotactile feedback (ie feeling of the road surface) that even with a full motion base would not be the same as real world driving. Driving simulators are more commonly used to train higher-order cognitive skills such as hazard perception. Whilst there is some evidence to show that hazard perception can be trained and assessed using PC-based tests, most evaluations are experimental and have similar strengths and limitations to those relating to procedural skills, including not assessing real world-driving behaviour. There is some research to indicate that simulators could be used to train skills covered in more resilience-based programmes. However, this is limited and would need to be further explored to understand the potential on-road safety benefits.

In sum, there is no substitute for on-road training and experience, and it is unclear whether any benefits of training would translate to meaningful improvements in on-road safety. A simulated environment does not emulate real on-road driving and learners do not acquire the same level of skill and competence. Importantly, there is potential for over-confidence which leads to learner/novice drivers being introduced to the licencing system at heightened risk, which may translate to more crashes and road trauma. In addition to the lack of valid evidence, and contrary to the proposed objectives of many simulator programmes, there are also cost, access and equity issues that may make them impractical. Alternatives and wider system solutions with known safety benefits would be more appropriate.

NZTA position on the use of simulators for learner/novice driver training

There is no substitute for on-road training and experience. The degree to which simulator-recorded behaviour corresponds to real-world driving remains unclear and there are known risks associated with over-confidence and heightened risk of on-road performance and crashes. The evidence is not only problematic from a valid safety perspective and is therefore unable to be endorsed on that basis, but there may be additional cost, access and equity issues that make simulator training unviable, where education and wider system solutions should be considered instead.

NZTA **does not** support:

- The use of simulators to increase appetite among learner/novice drivers for driver licensing or familiarity with the driving task.

- The use of simulators to train procedural or vehicle handing skills among learner/novice drivers.

- The use of simulators to train higher-order cognitive skills as a replacement for on-road training and experience.

- NZTA **will continue to monitor the research evidence** in this space such as comparing the validity of different types of simulators. Due to the potential risk of harm, NZTA is not currently in a position to sponsor simulator trials for novice driver training and strongly recommends that any industry-led trials are designed with extreme caution, noting the potential for harm and adverse outcomes, with rigorous requirements around study findings.

- NZTA **acknowledges** that there may be other specific areas for the use of simulation to support training (such as in the heavy vehicle space where trainees can be prepared in manual gear changes in relation to roadranger gear boxes prior to on-road experience) or assessment (such as hazard perception and assisting in determining whether a patient can be taken on the road for a practical driving assessment or whether their physical or cognitive symptoms prevent them from being able to hold a driver licence). There may also be opportunities to explore and further develop the application of virtual reality technology for specific educative purposes and target audiences.

Introduction

The issue

There is an increasing desire to introduce simulator technology for driver training in New Zealand. NZTA and other public and private organisations are often asked for guidance and/or funding to use driving simulators in driver training programmes. Whilst this technology is used for a variety of purposes and audiences in this area, the predominant customer audience for much of the emerging simulator technology are learner/novice drivers. There are numerous organisations throughout New Zealand incorporating different types of simulator technology into novice driver training programmes or curriculum. The emerging technology ranges in fidelity (the degree to which they emulate driving in the real world), with varying objectives and outcome measures, as standalone modules or as part of more structured programmes. It has been observed that the objectives for the use of these simulators include providing a training tool in locations where driving instructors are less available, increasing familiarity or appetite for gaining a driver's license, or to train specific procedural or higher-order skills.

The evidence for simulators for learner/novice driver training is varied and continues to develop. Even when used for other purposes (ie research) recent evidence demonstrates there is relatively little evidence confirming their validity (the extent to which they accurately represent real-world driving) (Wynne, Beanland & Salmon, 2019) and they are not a substitute for on-road training and experience. The evidence surrounding simulators must be assessed objectively to inform decision making and ultimately support safety outcomes for novice drivers. Whilst the reduction of direct physical risk of injury in a simulated environment makes the technology an attractive option for driver training purposes, it is important to understand the limitations and potential risks associated with the technology and ensure it is adopted in line with evidence and international best practice and in the context of the overall driver licensing system. This is critical to understanding and having the necessary degree of confidence in the validity of a simulator programme or module and the potential implications for real-world driving performance and crash risk in a non-training environment. This requires careful consideration of the objectives and overall structure in which the learning is taking place, and the extent to which those objectives align with clear evidence-based outcome measures. Unclear or poorly defined training objectives or those with outcome measures that do not align with the evidence cannot be adequately assessed in this manner and therefore cannot be endorsed by NZTA. NZTA does, however, acknowledge the need and support further research in this field, and that there are other potential specific uses for simulator and/or virtual reality technology. Taking an evidence-based approach is a fundamental principle of road safety (OECD/ITF, 2008) and our strategic approach as a system leader in this space.

Purpose of the position paper

The purpose of this position paper is to outline the NZTA position on the use of simulator technology for learner/novice driver training. This is intended to inform and help guide simulator developers, funders and users to where the technology could be used appropriately, and where alternatives should be considered.

This paper draws upon the following NZTA research report that contains a section on simulator training for learner drivers and another on hazard perception that includes simulator and PC-based technologies:

Beanland, V and I Huemmer. (2021). *The effectiveness of advanced driver training.* Waka Kotahi New Zealand Transport Agency Research Report 677.
https://www.nzta.govt.nz/resources/research/reports/677

Scope of the paper

Driving simulators are used for a range of different purposes (eg research, assessment, training), target audiences (eg inducting visitors by rental car companies, those who are mentally and physically impaired) and sectors (eg aviation, rail, heavy vehicles, medicine). However, much of the emerging technology by industry is targeting learner/novice drivers for training-related purposes. This represents a specific and extremely vulnerable cohort of the driving population and for a purpose that has not been endorsed by the global road safety community. In a driver licensing context, simulators have been used for some years by some hospital occupational therapists for medical referrals to assist in determining whether they are able to be taken on the road for a practical driving assessment or whether their physical or cognitive symptoms prevent them from being able to hold a driver licence. Simulator-based driving test pre-screening can also be used to complement driver testing (Thorslund, Thellman, Nyberg, & Selander, 2024). The scope of this paper is limited to the use of simulators for the purpose of **learner/novice driver training.**

Definition of a driving simulator

There is no set definition of a driving simulator. For the purpose of this position paper, a driving simulator is defined as a dynamic interactive form of technology that is intended to teach or assess driving skills in learner or novice drivers relating to any aspect(s) of the driving task (Bates et al 2013). Video clip-based multi-media tools such as e-Drive and virtual reality technology are considered out of scope.

It is important for the purpose of this position paper to be clear on the relevant constructs that sit behind the assessment of the evidence. The construct of validity, or the extent to which a simulator can accurately represent real-world driving, is the first to consider. There are different forms of validity, with most studies typically assessing two types: absolute validity and relative validity. As defined by Wynne et al (2019):

Absolute validity occurs when the measurements obtained in a simulator (eg speed or lateral position) match those obtained in a real vehicle in absolute terms. Establishing absolute validity requires direct comparison of simulated and real-world driving, with statistical tests showing no significant difference between the values for the two types of driving. Even though absolute validity is always desirable it is not always achieved, and in some contexts relative validity may be acceptable.

Relative validity occurs when simulator results show the same patterns or effects as real-world driving. Empirical tests of relative validity could take different forms, depending on the study design. Relative validity could be demonstrated if simulated and real-world driving measures were positively correlated, but differed in magnitude (ie drivers who exceeded the speed limit in the real world also drove faster in the simulator, but at different absolute speeds).

It is important to note that most simulators would not achieve absolute validity. Relative validity is adequate for a lot of research questions, so lack of absolute validity is less problematic when using simulators for research purposes. If a simulator cannot achieve absolute validity, then that precludes a lot of training scenarios, particularly those relating to speed and distance judgement.

The second construct is the fidelity of a simulator, or the extent to which they emulate driving in the real world. The validity of simulators is heavily contingent on the fidelity of the simulator. However, the relationship is not straightforward, with some low fidelity simulators demonstrating acceptable validity on some measures, and some high-fidelity simulators demonstrating a lack of validity on other measures (Wynne et al 2019). The dimensions of simulator fidelity are presented in the following table. This shows the considerations of each dimension ranging from low to high fidelity and shows the range and variation of the technology.

Table 1. Rating system used for simulator fidelity (Wynne et al 2019).

	Score				
Fidelity measure	1	2	3	4	5
Visual	Single PC screen	Single projector or PC screen >25 inches	<180° FOV with multiple screens	180-270° FOV; multiple PC screens	> 270° FOV; projector screens
Motion	No motion base		Lower degrees of motion (<6 or partial plate)		Motion-base on Full motion plate
Physical	Computer based-simulation using keyboard or joystick	Computer-based simulation with steering wheel	“Arcade” vehicle – car seat with steering wheel and pedals	Vehicular controls; no or incomplete cab	Full vehicular cab and controls

What we know

Advantages

Simulator technology has grown in popularity in recent decades and is used to support training in other industries such as healthcare, aviation and for specific purposes in other modes of transport including rail, watercraft and heavy vehicles (Dannenhoffer & Green, 2017; Large, Golightly, & Taylor, 2017; LopesFerreira, Bué, & Lopes, 2017). This includes exposure to a diverse range of situations that they would typically not encounter including critical situations that could result in a crash or emergency situation

(Beanland & Heummer, 2021). Despite their use in these industries, they are not used as a substitute for practical training in a real-world environment where minimum “on-road” requirements are still in place. They also represent radically different learning environments and training contexts, involving different types and levels of risk. The driving environment is less controlled and the risk of a near miss much higher than in other transport settings, such as rail or aviation. Learner/novice drivers are also often young and thereby subject to cognitive and adolescent developmental factors that deem them to be particularly vulnerable and at higher risk in a learning environment (Turner, B., Job, S., & Mitra, S., 2021).

A particular benefit of simulator training is the ability to strike an optimal balance between standardisation and customisation of training. This is where scenarios can be standardised, responses/outcomes can be recorded exactly, and individuals can be given tailored feedback and follow-up exercises. Simulators also allow exposure to varied scenarios (eg high risk scenarios and exposing city dwellers to rural driving, and vice-versa). This however raises questions around validity and fidelity and the associated cost of developing scenarios relevant to the New Zealand context. More research evidence is needed to demonstrate the benefits of simulator training – both from a safety and a cost/benefit trade-off perspective. For example, there is some research that suggests that for hazard perception tasks, simulators should have a wider field of view (FOV) (ie three screens or a wider display if using a projector; Shahar et al 2010). A potential alternative is computer-based hazard perception training, which has the potential to be much cheaper and more accessible to a larger population. It would be relevant therefore to compare simulator versus computer-based programmes in a research-based setting. A longitudinal evaluation with 554 teenagers compared three types of simulators (a low fidelity single monitor desktop with gaming controls representing a 45-degree FOV, a three-monitor desktop with gaming controls representing a 135-degree FOV, and a high-fidelity simulator incorporating a full vehicle with an instrumented cab and road images projected on a screen representing a 135-degree FOV). Results suggested that participants drove differently when using the single-monitor simulators compared with other types of simulators (eg treating it more like a computer game).

Disadvantages

It is important to note that whilst a driver cannot be directly physically injured by a simulator, there are other types of potential harm. Some drivers experience simulator sickness, a form of motion sickness, with research suggesting that females are more susceptible (Almallah et al., 2021). Relevant to the use of simulators for training, risk of simulator sickness increases with longer drive duration, and varies depending on simulator characteristics and scenario characteristics. This has implications for who can complete training, and the types of scenarios they can complete. When used for research purposes, simulator sickness can be minimised by carefully constructing the scenario (ie shorter drives, fewer/no turns, shallower curves etc) but in a training context this would effectively undermine the purpose of using simulators for training. There is also the potential for psychological harm or discomfort, especially if it reminds drivers of a previous crash.

It is important to understand the limitations and potential risks associated with the technology and ensure it is adopted in line with evidence and international best practice when considering the driver training context. To understand the effectiveness and appropriateness of driving simulators for novice driver training it is important to consider the evidence in relation to clear objectives and outcome measures. This includes the extent to which the training is transferred to on-road driving performance and safety outcomes, relating to the validity and fidelity of a driving simulator and the way in which a programme or individual module supports structured learning.

Several studies have evaluated simulator training for learner drivers; however, these evaluations differ substantially in nature and scope (Beanland & Huemmer, 2021). Despite being frequently used for research purposes, there is relatively little evidence confirming their validity. There is also inconsistency in both the types of simulators used, and the operationalisation of "real-world" driving in validations (Wynne, Beanland & Salmon, 2019). The most common outcome measure reported in the novice driver simulator training literature is skill acquisition. Whilst this may serve as an informative measure to quantify the degree to which the training has achieved its purpose, that skill acquisition may not be reflected in on-road driving, may not be retained over time, and may pose a risk when transferring that training to a non-training environment. More rigorous outcome measures are crash risk and traffic offending. Whilst there are various methodological issues to consider when drawing the link between driver training and crash risk (ie, the rarity of crashes, the under-reporting of crashes, and the range of factors that influence novice driver crashes), it is important to clearly identify the objective of a programme/module and what outcome measure is being used to determine the validity of the training to real-world driving.

A meta-analysis undertaken by Martin-delos-Reyes et al (2019) did not provide evidence to support or refute the efficacy of training programmes using simulators for young learner or novice drivers in improving the safety of their driving. The ambivalence of that overall finding related not only to the low quality of the studies due to various methodological drawbacks, but also to inconsistent results across studies in relation to the outcome measures that were used. Of particular relevance to training studies is whether the way an individual performs in a simulated training environment reflects their real-world driving. This within-subject validity has not been demonstrated, meaning the extent to which individuals respond to simulators remains unclear.

The strength of the evidence to date

The range of necessary skills for driving is demonstrated by the results of an extensive EU project, where four levels of Goals for Driver Education were defined (Hatakka et al., 2002). These skills were identifiedthrough a combined approach including literature and theory evaluation. The GDE offers a comprehensive model against which to assess driver training and education programmes and has been used to frame this section of the paper. Four levels are defined:

Level 1 focuses on vehicle manoeuvring and control skills: This looks at the ability to control the vehicle, even in difficult situations, as well as the functioning, use and benefits of injury prevention systems such as seatbelts.

Level 2 focuses on the mastery of traffic situations: This is the ability to adjust their driving to constant changes in traffic as well as the ability to identify potential hazards and act correctly to avoid them.

Level 3 focuses on the goals behind driving and the context in which driving is performed such as the type of car you choose to drive, the trips you make and if you choose to drive under the influence of alcohol.

Level 4 focuses on the personal motives and tendencies that may influence attitudes, decision-making and behaviour in driving that may lead to crash involvement.

Most simulator-based training for novice drivers focuses on either procedural skill (relating to Level 1 of the GDE) or higher-order skills such as hazard perception (relating to Level 2 of the GDE). The remainder of this section will present the available evidence relating to each level of the GDE matrix.

A comprehensive literature review of the evidence can be found in Sections 3.4 and 3.5 of the NZTA research report on the effectiveness of advanced driver training (Beanland & Huemmer, 2021). The relevant sections are linked in the respective sections below.

Procedural skills training

This relates to Level 1 of the GDE. The training of procedural skills involves teaching novice drivers how to undertake a sequence of actions that may become automatic after practice (Filtness et al., 2013). This could include manoeuvring or operating the vehicle (Beanland et al., 2013). Evidence on the use of simulators for procedural skill training is limited. This is because simulators are not widely used for this purpose due to validity-related concerns about how well the training would transfer to on-road performance, and numerous other methodological limitations.

Teaching procedural skills in a driving simulator is problematic due to the difficulty in emulating on-road driving. It is argued that this could lead to incorrect learning of procedural skills such as reduced mirror scanning due to learning on a simulator with a single screen and narrow field of view (FOV), or poor vehicle control due to limitations in steering, braking or motion functionality (Greenberg & Blommer, 2011). There is a risk that this could lead to novice drivers failing to scan the environment sufficiently and experience difficultly in developing the necessary vehicle control skills (Filtness et al., 2013).

More generally, evidence shows that post-licence training of certain procedural skills is problematic, generally, due to the risk of over-confidence and increase in risk-taking behaviour (Turner et al., 2021). More recent reviews have demonstrated increases in crash rates from vehicle handling skills-based training such as skid training – with the simplest way to understand this being that any benefits that might arise through training are greatly out-weighed by the overconfidence imparted in those involved in these courses (Turner et al., 2021). Driver skills training is shown to increase confidence (making existing general over-confidence worse) and increased confidence is associated with increased risk taking (p. 38). Evidence shows that the playing of racing games (a) increases the accessibility of thoughts that are positively related to risk taking, (b) leads to enhanced arousal and excitement, and (c) increases risk-taking behaviour in critical road traffic situations.

A review of the relevant literature is provided in Beanland & Huemmer, 2021, Sections 3.4.1 and 3.6.2.

<u>Finding: The evidence does not support the use of simulators to train procedural or vehicle handing skills at any stage</u>

Higher order cognitive skill training

This relates to Level 2 of the GDE. Driving simulators are more commonly used to train higher-order cognitive skills such as hazard perception among novice drivers. Hazard perception refers to a driver's ability to anticipate potentially dangerous conditions on the road ahead (Horswill, 2016), with poor hazard anticipation associated with higher crash rates for young drivers (McDonald et al., 2015, UnVerricht et al., 2018, Pressley et al., 2017). Most hazard perception training programmes aim to improve hazard perception overall or focus on a broad category of hazards such as intersections or latent hazards. However, some programmes target highly specific aspects of hazard perception, such as hazards involving pedestrians, motorcycles, or rural roads (Beanland & Huemmer, 2021).

There is some evidence to show that hazard perception can be trained and assessed using PC-based tests. However, most hazard perception training evaluations are experimental and have similar strengths and limitations including not assessing real world-driving behaviour (instead using simulator driving or hazard perception test score as the outcome measure) and other methodological limitations. As such it is unclear whether any benefits of training would translate to meaningful improvements in on-road safety (Beanland & Huemmer, 2021). There is also a risk that training with or without improving hazard perception skills could increase driver over-confidence/optimism and thus risk taking and crashes. This is a known effect of training in other skill areas (Turner et al., 2021), and it remains unproven as to whether this would also occur with hazard perception.

There are also several programmes adapted from the risk awareness and perception training based on theory and extensive research (McDonald et al 2015, Pressley et al., 2017), although the direct relationship between training and crash rates requires further study (Pressley et al., 2017; Beanland & Huemmer, 2021). A study of a revised RAPT programme developed by the University of Massachusetts has shown improved hazard anticipation skills as measured by the computer assessment test completed before and after training, although it was suggested that advanced skills such as hazard anticipation might benefit from booster training or reminders aimed at keeping performance levels high until drivers have developed ingrained habit patterns (Thomas et al., 2016).

There are fewer examples of hazard perception training being taught in higher fidelity simulators that replicate the visual and physical aspects of driving. In 2019, Singapore Police Force (SPF) introduced a higher fidelity simulator training programme that learner drivers are required to pass before being able to attempt their practical test (SPF, 2019). The aim of the programme is to raise learner drivers' awareness of various road conditions and risks and encourage good driving and riding behaviour. To our knowledge this programme has not been evaluated and there is no evidence to demonstrate its effectiveness.

A comprehensive review of the literature is presented in Beanland & Huemmer, 2021, Section 3.5.

<u>Finding: The use of simulators to train higher order cognitive skills is not a replacement for on-road training and experience. Further, the validity of the available evidence is insufficient, and it is unclear whether any benefits of training would translate to meaningful improvements in on-road safety.</u>

Higher levels of the GDE

Skills located at the higher levels of the GDE focus on the goals behind driving and the context in which driving is performed, and the personal motives and tendencies that may influence attitudes, decision-making and behaviour in driving that may lead to crash involvement. This type of learning is covered in resilience training programmes that are recognised as a useful training type for young people; however, there is limited research on the inclusion and effectiveness of driving simulators for this purpose and more research would be needed to confirm the potential safety benefits of these programmes (Beanland & Huemmer, 2021).

Other programmes that have used simulators have been designed to improve speed management behaviour among novice drivers through feedback training (Krasnova et al., 2015, 2016; Molesworth 2012; Molloy et al 2019) and team-based training for peer passengers (Lenné et al., 2011). These studies have limitations and have achieved mixed results. However, they suggest that feedback as part of training showed the greatest improvement in speed management behaviour and that for at least some drivers, passengers can be trained to facilitate safer driving behaviour. It is unclear though how long these training effects would last, and whether they would work for all drivers or only a subset (Beanland & Huemmer, 2021).

Recent Australian research also shows that higher order cognitive-based training, including driving on the road and in a simulator, could be used to improve speed management among novice drivers. The training intervention provided novice drivers with specific feedback about their driving, the safety implications of speeding, and the potential financial penalties they could face, and resulted in reduced speeding in between 85-100% of participants. The follow up drive was also conducted in a simulator and thus the same limitations apply regarding the transfer of skills to on-road performance and safety outcomes (Williams, 2023).

Further development of simulator tasks and scenarios that focus on skills and abilities located at higher GDE levels is needed and more research needed to understand the potential benefits of driving simulator training of this type (Rodwell et al., 2020).

More detail on these studies can be found in Beanland and Huemmer, 2021, Section 3.6.

<u>Finding: Further research is needed to validate the effectiveness of higher order cognitive training, including the inclusion of a simulator component.</u>

Conclusion

The validity-related concerns raised in this paper call into question the fundamental purpose of why simulators should be used, considering the overall benefits, costs, equity issues and alternatives. In the context of the GDE matrix:

- Using simulators to improve vehicle handling skills (Level 1) before allowing learners to practice in a real vehicle raises many issues around the simulator used (see de Winter 2007 regarding their use in the Netherlands). First and foremost, is it valid for this purpose, would it be cost-effective to develop a valid simulator with scenarios relevant to the New Zealand context, and realistically who would be able to access this resource (financially and geographically)? Would this be cheaper and more equitable than having lessons in a dual-controlled or standard car?

- Using simulators to improve mastery/hazard perception skills (Level 2) would similarly require a specific simulator and valid, relevant scenarios to the New Zealand context. Comparing simulator and computer-based programs for hazard perception in a research environment would be relevant here in order to better understand the field of view that is required.

- Targeting GDE Level 3 or 4 would be technically possible but in most cases impractical. Most of this would be better addressed through alternative programmes (eg resilience, driver education). There could be scope for using simulators to demonstrate the negative effects of impaired driving, but this would need to be carefully designed and evaluated to ensure there were no negative safety impacts, especially given the past research showing negative effects of improperly designed training.

In relation to providing additional training to learners who have difficultly accessing a vehicle/supervisor:

- Due to cost/equity issues, in practice the effectiveness of simulators for this purpose is questionable. It is likely that the same individuals would have difficulty accessing a simulator training facility (either due to cost or geographic location). In large population centres it may prove more worthwhile; however, this would still assume that the training is effective, which needs more research.

Lastly, using simulators for other reasons such as reducing fuel consumption and/or reducing wear and tear and roads/vehicles would need further research, and could be better addressed through wider system settings such as increasing EVs and public/active transport.

NZTA position on the use of driving simulators for learner/novice driver training

As an evidence-based system leader in road safety, it is important to consider the evidence to inform decision making and not undermine safety outcomes. The following outlines the position of NZTA in relation to the use of simulators for different aspects of learner/novice driver training:

- NZTA **does not endorse the use of simulator technology for the training of procedural skills.** There is no substitute for on-road training and experience. Learners do not acquire the same level of skill and competence and there are potential risks for increased over-confidence, and corresponding crash risk. Driving simulators should not aim to replace or replicate supervised on-road driving experience obtained through the evidence-based stages and conditions of the GDLS.

- NZTA **does not endorse the use of simulator technology to increase familiarity, access or create appetite for young people to enter the driver licensing system.** The need and ability for young people to apply for a driver's licence and progress through the GDLS is influenced by numerous system-wide factors. NZTA supports a whole-of system view to understanding those system wide factors to achieve equity and safety outcomes. It is important to note, however, that the use of simulators to increase familiarity and appetite for attaining a licence is associated with the same limitations and validity-related risks noted above for the training of procedural skills.

- **NZTA does not support the use of simulators to train higher order cognitive skills as a replacement for on-road training and experience -** thus making training of this nature an additional tool that may not necessarily add to safety benefits.

- Due to the unknown safety risks and potential for harm when exposing novice drivers to simulated driving conditions, **NZTA is not currently in a position to sponsor simulator trials for novice driver training** and strongly recommends that any industry-led trials are designed with extreme caution, noting the potential for harm and adverse outcomes, with rigorous requirements around study findings. We will continue to monitor the research evidence as and when it becomes available, but the focus remains on improving access to the licensing system to ensure novice drivers receive safe training under evidence-based driving conditions.

- NZTA **acknowledges** that there may be other specific areas for the use of simulation to support training (such as in the heavy vehicle space where trainees can be prepared in manual gear changes in relation to roadranger gear boxes prior to on-road experience) or assessment (such as hazard perception and assisting in determining whether a patient can be taken on the road for a practical driving assessment or whether their physical or cognitive symptoms prevent them from being able to hold a driver licence).

- NZTA will continue to review **research evidence** as it becomes available and monitor ongoing advances in technology.

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Glossary

Simulator - a dynamic interactive form of technology that is intended to teach or assess driving skills in learner or novice drivers relating to any aspect(s) of the driving task.

Fidelity - the realism of the simulator and includes both physical or functional fidelity (the way the simulators looks and behaves) and psychological fidelity (the way the driver relates to the simulator).

Validity - how well driving behaviours translate into the real-world. A distinction is often made between absolute and relative validity. Absolute validity is achieved if the exact effect created in a simulator is equal to the effect on real roads. Relative validity on the other hand, often referred to as ecological validity, relates to an effect or behaviour which is equivalent in a simulator to on-road driving but is not identical.

Higher order cognitive skill – a level of cognitive skill comprising hazard perception, situation awareness and decision making.

Procedural skill – basic vehicle handling skills typically taught through practical driving lessons.

Resilience – a level of cognitive skill focusing on the goals behind driving and the context in which driving is performed, and the person motives and tendencies that may influence attitudes, decision making and behaviour.

Hazard perception training – the training of higher order hazard perception which refers to a driver's ability to anticipate potentially dangerous cautions on the road ahead.

Novice drivers - Inexperienced drivers, regardless of their age, are most at risk during their first year of unsupervised driving. For the purposes of the Graduated Demerit Point system, a person is a Novice driver until they have held a driver's licence for at least two years.

Structured learning programme – training that is part of an overall structured programme of learning as opposed to a standalone training module or task.

Graduated driver licensing system – a structured learning programme whereby drivers move from a learner to a restricted and then a full licence with evidence-based conditions for safety.