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# BEST TRAINING METHODS FOR TEACHING HAZARD PERCEPTION AND RESPONDING BY MOTORCYCLISTS

by

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**Title and sub-title:**
Best training methods for teaching hazard perception and responding by motorcyclists


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**Abstract:**
This project is the first stage of a larger program of research into hazard perception training for motorcycle riders. Future stages of the project will investigate what type of environment can be used to teach hazard perception and responding, for example a motorcycle simulator or a combination of off-road and simulator training.

The first report (Haworth, Mulvihill & Symmons, 2005) reviews the research that has been conducted into hazard perception and responding, assesses what can be learnt from motorcycle crash data and describes current motorcycle simulators. This report examines training methods for teaching safe motorcycling hazard perception and responding and examines the potential usefulness of simulation in motorcycle rider training.

In this project, the model of incremental transfer learning is used as a framework for learning hazard perception and responding skills. This learning model has been successfully applied to many Australian Defence Force situations and, more recently, to novice car driver training through the TAC product DriveSmart.

While more research is needed regarding hazard perception and responding by motorcycle riders, specific deficiencies in current training methods were identified and potential remedies suggested.

The research suggests that simulators are best used as part of a comprehensive rider education system that includes classroom training and skills practice using real vehicles, with simulators being used to training riders in situations that are too dangerous to practice using a real vehicle. The cost of sufficient access to simulators may prevent this approach from being applied to the general motorcycle rider LEARNER population. However, simulators may be cost-effective for training particular groups, such as individuals with high accident rates or professional riders. In the short-term, simulators may provide a useful tool for conducting research into hazard perception and responding by riders.



**Key Words:**
Motorcycle, rider training, hazard perception


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# Preface

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# Acknowledgments

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# EXECUTIVE SUMMARY


This project is the first stage of a program of research into hazard perception training for motorcycle riders. Future stages of the program will investigate what type of environment can be used to teach hazard perception and responding, for example a simulator environment or a combination of off-road and simulator training.

The first report of Stage 1 (Haworth, Mulvihill & Symmons, 2005) summarised the research that had been conducted into hazard perception and responding, assessed what could be learnt from motorcycle crash data and described current motorcycle simulators. It concluded that hazard perception and responding is more important for riders than car drivers, because riders cannot rely on other road users seeing them and because the severity of the consequences of failures of hazard perception and responding are greater for riders. This report describes training methods for teaching safe motorcycling hazard perception and responding and examines the potential usefulness of simulation in motorcycle rider training.

In this report, the model of incremental transfer learning is used as a framework for learning hazard perception and responding skills. In this model, learners (not just LEARNERS - holders of motorcycle Learner Permits) transfer the skills that they have acquired in relatively simple environments to more complex environments. This learning model was the basis for DriveSmart, the training product developed by MUARC for the Transport Accident Commission (TAC) for novice car drivers.

All methods of training are simulations of the real world. They differ in terms of how much they look and feel like the real-world task (physical fidelity) and in terms of how much they share the same functions and responses as the real-world task (functional fidelity). For example, a PC-based training program has less physical fidelity than a set of on-road training exercises for teaching effective braking.

It is assumed that skills are learned in stages, with improving performance as the learner moves from *knowledgeable*, to *prepared*, to *trained*, to *skilled*, to *expert*. Which method of training is best depends on the stage in skill learning. There is generally less need for physical resemblance (physical fidelity) or functional similarity (functional fidelity) in the early stages of learning than in later stages. However, when the expert stage is reached, the wealth of experience means that the need for physical fidelity is reduced.

Table 1 classifies training methods in terms of their levels of physical and functional fidelity. Those methods listed toward the lower-right corner of the table would typically be employed early in training, while those listed toward the upper-left corner would be employed in later stages of training. Methods in the upper-right corner would typically be used for skills that have strong cognitive (thinking and decision making) aspects, while the lower-left corner would be used for skills that have strong psychomotor (perceiving and responding) aspects.

Each of the key issues identified in the first report were examined in terms of their implications for motorcycle rider training. The issues and their implications are summarised in Table 2.

**Table 1 The levels of fidelity of motorcycle rider training methods.**

| | | Physical Fidelity | | |
|---|---|---|---|---|
| | | High | Moderate | Low |
| Functional Fidelity | High | On Road | High-End Motorcycle Training Simulator | High-End Desktop PC Simulator |
| | Moderate | Training Range | Low-End Motorcycle Training Simulator | Low-End Desktop PC Simulator |
| | Low | Static Motorcycle | Arcade Motorcycle Simulator | Written Materials, Multimedia, Classroom |

**Table 2 Key Issues and their Implications.**

| Key Issue from the First Stage 1 Report | Implication for Motorcycle Rider Training |
|---|---|
| Motorcycle riders must deal with the same hazards as car drivers, as well as the additional hazards of failure by car drivers to give way and road surface hazards. | Approaches to hazard perception training that are known to be effective for car drivers may also be effective for motorcycle riders.<br><br>Emphasis should be placed on anticipation of threats posed by car drivers. |
| The potential that the other road user may not have seen the motorcycle means that hazard perception and responding is more crucial for motorcyclists than car drivers, who are more likely to rely on the other road user to avoid them. | As above. |
| The potential severity of crashes, regardless of the type of hazard is greater for motorcyclists. | The risk of serious injury may make the approach of ‘Moderating Illusory Beliefs’ more effective. |
| The vehicle control skills involved in riding a motorcycle are more complex than driving a car and failure to correctly implement a response to a hazard may in itself be dangerous. | Vehicle control skills may be a more important aspect of hazard response for motorcycle riders than for car drivers. |
| It may be that attention sharing between the vehicle control skills and hazard perception and responding may be problematic for novice riders. | Attentional control training may be an important aspect of hazard perception and responding training for novice motorcycle riders. |

A set of high-risk motorcycle riding contexts was developed from the crash data analyses and broken down into scenarios to be incorporated in training.

The following general categories of training methods were assessed in terms of the extent to which they could provide the required outcomes in a cost-effective manner:

- Training Range Rider Training,
- On Road Rider Training,
- Training Range Licence Testing,
- On Road Licence Testing,
- Motorcycle Simulators,
- PC-Based Part-Task Training,
- PC-Based Interactive Recorded Media,
- Recorded Video, and
- Written Materials.

While more research is needed regarding hazard perception and responding by motorcycle riders, specific deficiencies in current training methods were identified and potential remedies suggested. In particular, there is potential to improve existing Training Range rider training through provision of written materials. PC-based part-task training appears to offer a cost-effective means of addressing hazard perception and responding training in the near term. PC-based part-task training could also be used to develop hazard perception tests for the Learner and Licence Tests. This would encourage voluntary use of PC-based part-task training.

Motorcycle simulators allow a rider to experience a wide range of hazards in a safe, and instructor-supervised environment. In addition to the circumstances that can be presented, simulators provide instructors with detailed information about student performance that can assist with the diagnosis of rider errors.

Only in Japan have simulators been used widely in motorcycle rider training. In the Japanese licensing system, learning to drive or learning to ride must occur off-road and training sessions with simulators are a compulsory part of training for a motorcycle licence. However, very little description of these programs and evaluations is available in English.

Riding simulators have been developed by the Honda Motor Company, by Kawasaki (a head mounted display unit) and some European companies. In Britain, TRL Limited may possibly develop a motorcycle simulator in the future. The Honda simulator appears to be the most relevant to hazard perception and responding, although little information was available regarding the Kawasaki simulator. A description and assessment of the first generation Honda driving simulator located in Melbourne is provided as an appendix to the report.

The research suggests that simulators should be used as part of a comprehensive rider education system that includes classroom training and skills practice using real vehicles, with simulators being used to train riders in situations that are too dangerous to practice using a real vehicle.

Currently and in the near future, simulator technology does not allow perfect replication of the motions and other stimuli present in real-world riding. Consequently, simulation must be viewed as no more than an activity leading in to, and augmenting, instruction on an actual motorcycle. Furthermore, the cost of sufficient access to simulators may prevent this approach from being applied to the general motorcycle rider LEARNER population. However, simulators may be cost-effective for training particular groups, such as individuals with high accident rates or professional riders. In the short-term, simulators may provide a useful tool for conducting research into hazard perception and responding by riders.

**RECOMMENDATIONS**

The following recommendations are made:

1. Research should be undertaken to investigate whether experienced riders are faster at perceiving hazards than novice riders and whether this depends on the type of hazard (vehicle-based or road-based) and the level of car driving experience of the rider.

2. The results of the research outlined in 1. should be used to determine the relative emphasis given in training to the two types of hazards and who the training should target (novice car and motorcycle operators, novice motorcycle riders who are experienced car drivers etc.).

3. Hazard perception training products (or a hazard perception test) for motorcycle riders should not be developed until more is known about what affects hazard perception, how this varies among the different classes of hazards, and the extent to which hazard perception can be trained.

4. Research should be undertaken to resolve whether training should focus on addressing hazard perception or responding or the modifying factors. It may be that addressing the modifying factors could be more useful than improving hazard perception or responding.

5. Any hazard perception training that is developed should fit the needs of the Victorian riders. Different approaches may be needed for younger and older novices. There is a need to assess for which categories of motorcycle riders – younger, older, novice, experienced, returning – hazard perception and responding needs to be improved and how this could be done.

6. The current initiative to develop the publication 'Bike Right' is strongly supported. The approach of providing strategies to support long-term skill development is sound and should be a cornerstone of any future program.

7. PC-based part-task training is considered to be a cost-effect method to provide structured experience of a comprehensive range of hazardous contexts. This type of training is likely to be useful for LEARNERS.

8. PC-based part-task training could also be used to develop hazard perception tests for the Learner and Licence Tests. This would encourage voluntary use of PC-based part-task training.

9. A detailed description of the concept for Victorian motorcycle rider training should be documented. This concept should explain the training process and underpinning theories of learning and instruction. The concept should extend beyond acquisition of a licence and consider how ongoing learning can be facilitated.

## GLOSSARY

Terms in *italics* are explained elsewhere in the glossary.

| | |
|---|---|
| **Automaticity** | the state of being able to respond without allocation of conscious attention |
| **Behavioural objectives** | aims in terms of changes in the behaviours involved in performing the task. |
| **Behaviourist** | related to the study of observable and quantifiable aspects of behaviour, excluding subjective concepts, such as emotions or motives. |
| **Behaviourist theories** | theories of learning that aim to develop cue-response chains through repeated practice of well-defined skills and contexts. |
| **Cognitivist** | theories of learning that aim to develop effective responses to well-defined situations, focussing on the cognitive aspects of learning such as progression from *declarative knowledge* about a skill to *procedural knowledge* of skill performance. |
| **Commentary driving** | a training method used during actual driving to help teach hazard perception skills to drivers whereby the driver continuously verbalizes his/her hazard perception and responding abilities to the instructor who offers feedback about his/her performance both during and after the drive |
| **Conservative approaches** | approaches to *instructional design* using content-based learning where learners are taught how to perform a skill and then undertake mediated practice. |
| **Constructivist** | constructivist theories of learning, such as *experiential learning*, are consistent with the *Liberal* approach. Specific contexts for skill performance are not targeted, but rather generalizable abilities to allow a skill to be applied in novel contexts are promoted. |
| **Definition for Classifying Accidents (DCA) codes** | a classification system used in Victoria to report and describe crashes based on their configurations. Similar systems are used in other Australian jurisdictions. |
| **Declarative knowledge** | verbal statements of what to do to perform a task. |
| **Experienced rider** | someone who has ridden regularly for many years and continues to do so. Not all people who have held motorcycle licences for a long time are experienced. |

**Experiential learning** learning through experience

**Expert** the final stage in the *skill learning model*. Experts can cope with unusual and unanticipated contexts of skill performance.

**Far transfer of learning** transfer of a skill from an instructional environment to one where the conditions have not been anticipated during instruction.

**Functional fidelity** the extent to which the training environment requires the same functions and responses as what is being trained.

**Hazard** any permanent or transitory, stationary or moving object in the road environment that has the potential to increase the risk of a crash. Hazards exclude characteristics of the rider or the vehicle, which are classed as *modifying factors*.

**Hazard perception** the process whereby a road user notices the presence of a *hazard*. Other steps between the existence of a hazard and the outcome include *modifying factors* (which modify the risk associated with the hazard), decision making and responding.

**High-end motorcycle training simulator** a *simulator* with moderate *physical fidelity*. Likely to involve the trainee sitting on a motorcycle body with similar controls and responses required to a normal motorcycle and a realistic visual presentation.

**Incremental Transfer Learning** a model of learning in which learners transfer the skills that they have acquired in a relatively simple environment to a more complex environment.

**Insight training** training that focuses not on physical, vehicle-handling skills, but rather on raising the awareness or insight of drivers into factors that increase crash risk. These include attitudinal-motivational factors, such as inflated confidence, and cognitive-perceptual skills, such as *hazard perception*.

**Instructional design** design of learning systems. Approaches to instructional design may be viewed as being 'conservative' or 'liberal' (Bowen & Hobson, 1974). Instructional design typically makes extensive use of digitised video and high quality graphics to convey the intended message, and may extend to some level of *simulation*.

**Kinaesthetic** relating to the sense of body movement and position

**Knowledgeable** — the first stage of skill learning. Becoming knowledgeable about a skill requires past learning to be transferred to the domain of the new skill. During this first stage of learning, the terms used within the skill domain gain meaning, procedures are learnt verbally or symbolically and underpinning principles are apprehended. An example instructional event in this first stage is a classroom lesson on motorcycle rider protective clothing.

**Learner** — a person who is acquiring a knowledge or *skill*. The person does not have to be the holder of a Learner Permit, and may have a full licence.

**LEARNER** — a person who holds a Learner Permit

**Learner-based learning** — a *liberal approach* to learning in which learners explore means of performing a skill and develop proficiency with experience.

**Liberal approaches** — approaches to *instructional design* such as *learner-based learning*.

**Low-end motorcycle training simulator** — A *simulator* with little *physical fidelity*. May not include a motorcycle body and may not have controls and responses similar to a normal motorcycle. The visual presentation may not be realistic or interactive.

**Near transfer of training** — transfer of a skill from an instructional environment to one where the conditions have been anticipated during instruction.

**Novice rider** — a rider who either holds a learner permit or has recently graduated to a probationary/provisional licence. Not all novice riders are young.

**On-road licence testing** — assessing the skills and knowledge of licence applicants while driving or riding on public roads

**On-road rider training** — teaching skills and knowledge to riders on public roads

**Part-task training** — training which requires performance of only one component of the overall task, for example, training in perception of a hazard, without the need to exercise control of a vehicle at the same time. The Transport Accident Commission (TAC) DriveSmart CDROM is an example of PC-based part-task training.

**Physical fidelity** — the extent to which the training environment physically resembles what is being trained. For example, a PC-based training program has less physical fidelity than a set of on-road training exercises.

| | |
|---|---|
| **Prepared** | a stage of skill learning. During the stage of becoming 'prepared' students transfer their newly acquired knowledge to a simplified environment in which components of the skill may be experienced, i.e., part-task training. Experience at this stage may be vicarious since the intended outcome is a primitive mental model of skill performance and not 'hands on' performance. Learning environments for this stage provide demonstrations of the skill and promote mental rehearsal to strengthen and stabilise the forming model of skill performance. An example activity during this stage is observation of gear changing techniques and subsequent practice. |
| **Procedural knowledge** | sub-conscious knowledge of how to perform the task and not verbal statements of what to do. |
| **Psychomotor** | relating to movement or muscular activity associated with mental processes. |
| **Range licence testing** | assessing the skills and knowledge of licence applicants in an off-road area that has been designed and marked out specifically for licence testing (or training). |
| **Range rider training** | teaching skills and knowledge to riders in an off-road area that has been designed and marked out specifically for training. |
| **Risk** | chance or possibility of danger, loss, injury or other adverse consequences |
| **Road hazards** | permanent characteristics of the road surface (roughness, being an unsealed or gravel road, low skid resistance, tramlines, railway lines, painted lines on roads) or temporary characteristics of the road surface (potholes, surface irregularities, pit lid covers, oil or gravel on road, debris) or visual obstructions or characteristics of the road alignment (horizontal and vertical curves) that increase the risk of a crash. |
| **Simulation** | a process of using an artificial situation that has some characteristics in common with the real situation, rather than the real situation itself. Simulation is an instructional process that may be employed in a broad range of learning environments. For example riding a motorcycle on the open road while performing tasks set by an instructor and under instructor supervision is a way of gaining experience for real-world task performance; it is a simulation of eventual real-world performance. Specific simulation training methods may be defined by combining the process of instructional simulation with a specific environment. |

**Simulator** a mechanical and electronic device that attempts to simulate a vehicle. Simulators can range from *low-end simulators* which have little *functional* and *physical fidelity* to high-end simulators which have high *functional* and *physical fidelity*, including sophisticated motion feedback.

**Situational awareness training** training that seeks to improve an individual's understanding of a dynamic environment, perceiving events, developing a holistic understanding of the situation and predicting future actions of the various elements within the situation – essentially predicting how things will change.

**SKAPS** an acronym for **S**can, **K**eep **A**head, **P**lay it **S**afe. This acronym was coined by TAC, MUARC and Learning Systems Analysis P/L staff during the development of DriveSmart.

**Skill** proficiency, facility, or dexterity that is acquired or developed through training or experience.

**Skill learning model** the skill learning model in this report comprises five distinct stages. Learning of skills is assumed to take place in stages, with improving performance as the learner moves from *knowledgeable*, to *prepared*, to *trained*, to *skilled*, to *expert*.

**Skilled** a stage in the *skill learning model* where learners can transfer their ability to contexts which provide exposure to the full range of skill variables. Techniques for dealing with common problems have been developed and reliable performance may be expected under normal conditions.

**Trained** a stage in the *skill learning model* where learners can attempt the skill within a controllable context. The learner transfers his/her mental model to this controllable context and has the opportunity to make modifications on the basis of experience. An example activity during this stage might be turning corners in a strictly supervised test-track.

**Vehicle control skills** the physical skills required for driving including steering, braking, using the pedals, buttons and other controls. These skills are generally learned quickly in learner drivers.

# 1.0 INTRODUCTION

This is the second report in Stage 1 of a study of motorcyclist hazard perception and responding commissioned by VicRoads. The first report of Stage 1 (Haworth, Mulvihill & Symmons, 2005) summarised the research that had been conducted into hazard perception and responding, assessed what could be learnt from motorcycle crash data and described current motorcycle simulators. It concluded that hazard perception and responding is more important for riders than car drivers, because riders cannot rely on other road users seeing them and because the severity of the consequences of failures of hazard perception and responding are greater for riders. This report describes training methods for teaching safe motorcycling hazard perception and responding.

While training environments are expected to be the subject of later studies, the analysis of training methods cannot be totally divorced from considerations of training media and it is these media that define the eventual training environments. Consequently, this report addresses issues of training environments where inextricably linked to training methods.

This report firstly discusses the need for a framework that adequately defines the process of learning hazard perception and responding skills. The results of the first report in this study are then employed to outline principles for hazard perception and responding and define contexts for motorcycle rider training. The defined learning framework and the results from the first report in this study are then combined to establish methods applicable to training hazard perception and responding skills. Cost-benefit issues are considered and, finally, conclusions drawn and recommendations made regarding the most cost-effective approach to training hazard perception and responding skills.

# 2.0 A LEARNING FRAMEWORK

In order to evaluate alternative motorcycle rider training methods it is necessary to have a sound framework for the associated skill learning process. Instructional design for safe and effective operation of dynamic real-world systems has been a major focus of research in recent years and the present study has much to benefit from what has been learnt. In particular, behaviourist, cognitivist and constructivist approaches to learning have all shown benefits and should be considered.

This report discusses approaches to instructional design in terms of what they aim to achieve. Transfer of learning is then proposed as an organising concept by which instructional design approaches can be eclectically applied. A skill learning model is then proposed which aims to exploit the best features of instructional design approaches with transfer of learning to real-world situations as the eventual outcome.

## 2.1 CONSERVATIVE AND LIBERAL APPROACHES TO INSTRUCTIONAL DESIGN

Approaches to instructional design may be viewed as being 'conservative' or 'liberal' (Bowen & Hobson, 1974). The conservative approach refers to content-based learning, i.e., learners are taught how to perform a skill and then undertake mediated practice. The liberal approach refers to learner-based learning, i.e., learners explore means of performing a skill and develop proficiency with experience.

The Conservative approach assumes that the skill to be acquired may be dissected into discrete elements, instruction conducted to cumulatively teach these elements and, consequently, skilled performance be demonstrated by the learner. This process can only proceed if the skill can be precisely defined, that is in terms of anticipated conditions and standards (such statements of intended instructional outcomes are generally referred to as behavioural objectives). Without conditions and standards, accurate description of the skill elements would not be possible. In relative terms, transfer of a skill from an instructional environment to one where the conditions have been anticipated during instruction has been defined as 'near transfer of training' (Royer cited in Clark & Voogel, 1985, p. 114).

Behaviourist theories of learning aim to develop cue-response chains through repeated practice of well-defined skills and contexts. While at times derided as not sufficiently accounting for the cognitive mediation of skill performance that a learner applies to real-world tasks, these theories are prominent in activities that have strong psychomotor components. Cognitivist theories of learning also aim to develop effective responses to well-defined situations, but focus on the cognitive aspects of learning such as progression from declarative knowledge about a skill to procedural knowledge of skill performance. The first Stage 1 report noted an approach to hazard perception and experience, drawing on work by Fitzgerald and Harrison (1999), that could be either behaviourist or cognitivist dependent upon how learning is mediated. The first Stage 1 report commented:

> "With sufficient practice, the skills involved in driving a car become automatic, requiring little cognitive attention for each of the component skills. However, by their nature hazards that require some change in behaviour of the driver may not occur often enough for their processing to become automated." (p. 19)

Provision of opportunities to safely experience a broad range of hazardous situations may be used to develop automatic responses. The defining characteristic of both behaviourist and cognitivist learning theory is that the eventual context for skill application can be well-defined and the goals of learning detailed.

The transfer of a skill from an instructional environment to one where the conditions have not been anticipated during instruction may, on the other hand, be considered 'far transfer of training' (Royer cited in Clark & Voogel, 1985, p. 114). This second case is the antithesis of the first; since the operational context has not been anticipated the skill elements are unknown and, therefore, undefinable. In such circumstances, instruction must prepare the learner to adapt previously acquired procedures and create appropriate solutions in situ; this focus on the learner is the philosophical basis of the Liberal approach.

Constructivist theories of learning, such as experiential learning, are consistent with the Liberal approach described here. Specific contexts for skill performance are not targeted, but rather generalizable abilities to apply a skill in novel contexts are promoted. A study of instructional design theory for simulation design in the Australian Defence Force noted:

> "Constructivist theories stem from the view that learners view skills from a different perspective to experts and that an important learning process is the shift in perspective that must occur; the mechanics of the shift cannot be prescribed, it depends upon how individuals use imagery and insight to their own benefit." (p. 4-10, Wallace, 1992)

Consequently, situations requiring application of a skill in anticipated circumstances would seem to warrant a Conservative approach to instructional design. Conversely, situations requiring application of a skill in unanticipated situations would seem to warrant a Liberal approach to instructional design.

## 2.2 NEAR AND FAR TRANSFER OF LEARNING

Both near and far transfer of learning is required for effective motorcycle rider training. Research into the types of accidents most prevalent amongst motorcycle riders informs us of situations for which specific training is, arguably, warranted. The aim of such specific situation training is, by definition, near transfer and respective approaches to instructional design should be adopted. It may also be argued that motorcycle riders should be given more generalizable performance strategies so as to safely cope with any situation faced. The application of generalizable performance strategies is, by definition, far transfer and applicable approaches to instructional design should be adopted.

The first Stage 1 report has provided an insight into specific behaviours and general strategies that should be applied by motorcycle riders. This earlier report has also identified specific contexts for skill performance which motorcyclists must be able to deal with in a safe manner. Consequently, we have a set of content that is very much suited to notions of near and far transfer and associated approaches to instructional design.

The final aspect of instructional design required before examining this set of motorcycle riding content is a skill learning model that coherently applies conservative and liberal approaches under the organising concept of transfer of learning.

## 2.3 INCREMENTAL TRANSFER LEARNING

Incremental Transfer Learning is a model of skill development that has been developed in Australian Defence contexts over the past 15 years[1] and which has recently been successfully applied to novice driver training through the development by MUARC and the Transport Accident Commission (TAC) of the DriveSmart CD ROM product (Regan, Triggs and Godley, 2000; Regan et al., 2000; Triggs and Regan, 1998; Wallace and Regan, 1998). This skill learning model embedded in DriveSmart employs transfer of learning as an organising concept to effectively apply the benefits of both conservative and liberal approaches to instructional design.

The acquisition of a skill may be viewed as an evolutionary process extending over definable stages. During this process, learners transfer their skills between increasingly complex environments; this is referred to as incremental transfer. Figure 1.1 illustrates an incremental transfer skill learning model that comprises five distinct stages. 'Knowledgeable' is not normally sufficient for task performance, but exists within the illustrated model as a necessary stage of skill learning.

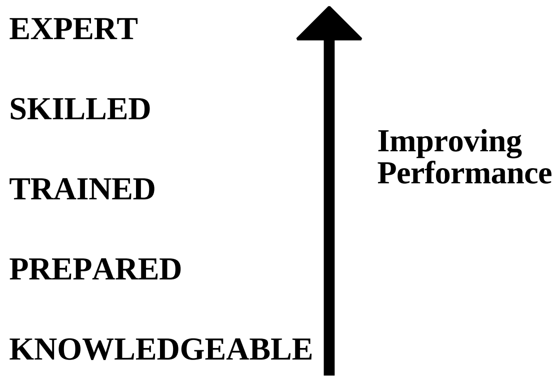


*Figure 1.1 Stages in Skill Learning.*

Attainment of competence in each of the five stages may be viewed in terms of transferring skill between increasingly complex contexts of performance. The extent to which a context of performance used for training replicates the eventual real-world context is referred to as fidelity. In a seminal work on simulation fidelity in training system design, Hays and Singer argued that simulation fidelity is "…a two dimensional measurement … in terms of: (1) the physical characteristics, for example, visual, spatial, kinaesthetic, etc.; and (2) the functional characteristics, for example, the informational, and stimulus and response options of the training situation" (1988, p. 50). Physical and functional fidelity can be used to define requirements of learning environments at each stage of transfer.

Typically in fields such as aircrew training, the requirement for physical and functional fidelity is low in early stages of transfer and increases with progression in learning. For example, instruction generally proceeds from a classroom environment, to part-task

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[1] Originally developed for RAAF undergraduate pilot training, Incremental Transfer Learning has been applied to a wide range of aircrew and groundcrew training needs and has been especially useful as a means for determining required instructional functionality of simulation systems. This model has been applied to the F-111C, F/A18 Hornet, AP-3C Orion, S-70-B Seahawk, SK-50 Sea King, and B-737 Airborne Early Warning and Control (AEW&C) aircraft.

training on systems trainers, to whole-task training on full flight simulators and the aircraft. An exception to this trend is at the expert stage of transfer where the wealth of experience available reduces the need for high physical fidelity; for example, highly experienced aircrew tend to focus on discussion during the debrief to instructional events rather than physical actions during the execution of the events.

Consider the first stage of skill learning: Knowledgeable. Becoming knowledgeable about a skill requires past learning to be transferred to the domain of the new skill. During this first stage of learning, the terms used within the skill domain gain meaning, procedures are learnt verbally or symbolically and underpinning principles are apprehended. The requirement for both physical and functional fidelity is low. An example instructional event in this first stage is a classroom lesson on motorcycle rider protective clothing.

During the stage of becoming 'prepared' students transfer their newly acquired knowledge to a simplified environment in which components of the skill may be experienced, i.e., part-task training. Experience at this stage may be vicarious since the intended outcome is a primitive mental model of skill performance and not 'hands on' performance. Learning environments for this stage provide demonstrations of the skill and promote mental rehearsal to strengthen and stabilise the forming model of skill performance. The requirement for physical fidelity is still low, but with a moderate requirement for functional fidelity. An example activity during this stage is observation of gear changing techniques and subsequent rehearsal.

Once prepared, learners may attempt the skill within a controllable context. The learner transfers his/her mental model to this controllable context and has the opportunity to make modifications on the basis of experience. Although the skill has now been performed in an actual or simulated environment and learners may be classified as 'trained', little confidence can be placed in their ability to cope with variables in skill performance. The requirement for both physical and functional fidelity is moderate. An example activity during this stage might be turning corners in a strictly supervised test-track.

In advancing from 'trained' to 'skilled', learners transfer their limited ability to contexts which provide exposure to the full range of skill variables. Techniques for dealing with common problems are developed and reliable performance may be expected under normal conditions. The learner's mental model of skill performance has now stabilised and new contexts may be introduced in a structured manner. Nevertheless, learners could not be expected to cope with novel and difficult problems for which they have had no preparation. The requirement for both physical and functional fidelity is high. An example activity during this stage might be repeated practice of riding curves under a range of environmental (road, weather, etc) conditions.

In advancing from 'trained' to 'skilled', learners also increase automaticity in their responses to previously experienced situations. Typically, repeated practice is employed to proceduralize task performance and reduce the cognitive workload associated with analysis of options. This is analogous to recognition-primed decision-making and the development of situational awareness skills as discussed in the first Stage 1 report.

The final stage of 'expert' qualifies learners to cope with unusual and unanticipated contexts of skill performance. While learners have applied pre-defined procedures to problems in the past, generalizable strategies are now required which will ensure competent performance regardless of the circumstances. The requirement for physical fidelity is low, but the requirement for functional fidelity is high. An example activity during this stage might be discussion of performance strategies, and possible alternatives, during thedebrief to a complex riding task or during experimentation with a PC-based simulation of a riding activity.

The process defined by incremental transfer learning is systematic and similar processes underpin other approaches to skill development. Indeed the four stage process described in the VicRoads publication 'Bike Right' (Roads Corporation, 2002) is consistent with incremental transfer learning. In 'Bike Right', Stage 1 corresponds to the transfer stages of Knowledgeable and Prepared; Stage 2 corresponds with the transfer stage of Trained; Stage 3 corresponds with the transfer stage of Skilled; and Stage 4 corresponds with the transfer stage of Expert.

The main difference between incremental transfer learning and the four stage process described in 'Bike Right' is that the former is a generalizable process for developing and evaluating training methods, whereas the latter is a specific training method.

A major benefit of the incremental transfer skills learning model is the availability of general instructional strategies for each of the five stages of transfer. Application of the model to a specific phase of motorcycle rider skill development would involve adapting these general strategies to define a coherent and comprehensive set of training methods. Table 2.1 lists instructional strategies for the five stages of transfer.

**Table 2.1. Transfer Stages and Instructional Strategies.**

| Transfer Stage | Instructional Strategy | Typical Student Activities |
|---|---|---|
| Knowledgeable | Expository Examples | Recall information required for skill performance. Interpret principles and processes important for cue discrimination and response formulation. |
| Prepared | Inquisitory Examples | Interpret cues and determine appropriate responses. Build cue-response chains. |
| Trained | Guided Convergent Practice | Perform skill in a specific instructional context. |
| Skilled | Independent Convergent Practice | Perform skill in familiar contexts. |
| Expert | Independent Divergent Practice | Apply skill to novel contexts. |

The Incremental Transfer skill learning model is very general in nature and would need to be carefully tailored to varying types of motorcycle riders. Initial skill level, past experience and motivation to learn are all key issues and it would be misleading to suggest that a single program could cater for all learners. Furthermore, the skill learning model should be applied in a manner that is consistent with the VicRoads scheme of motorcycle rider licensing. For example, the minimum three month period between obtaining a

Learner Permit and a Licence may present opportunities for guided experience of a range of riding conditions.

## 2.4 MOTORCYCLE TRAINING METHODS

The first Stage 1 report identified several hazard perception training programs for car drivers. The programs and their underpinning training methods comprised:

1. RoadSense. A UK program employing video and written materials. The video presents key principles and provides a basis for student/trainer discussion. A workbook is provided for the student and a guide for the trainer. Handouts are also provided to aid the trainer in testing key concepts.

2. DriveSmart. A training product developed by MUARC for the TAC employing a PC-based CD ROM interactive program. This program is designed around the concept of incremental transfer learning described earlier in this report. Two types of instructional activity are employed, video-based tasks and a simulated driving task that addresses attentional control skills. The content of DriveSmart video-based tasks was based on the following principles and aspects of driver training:

- Insight Training (Gregersen, 1996, De joy 1992)
- Optimism Training (Job 1992)
- Unknowns Training (Trankle et al, 1990)
- Variable Priority Training (MUARC IC)[2]
- Road Hazards (MUARC RA)
- DCA Focussed Training (MUARC RC, SB)
- Construct Focussed (MUARC ID)
- Embedded Cue (MUARC SE)
- Resource Allocation Training (MUARC AA)
- Manipulated Workload (MUARC TA)
- SKAPS (MUARC/ NSW Driver Ed Framework)[3]
- Commentary Driving (Mayhew & Simpson, 1996)
- Prediction Training (McKenna & Crick, 1997)
- Situational Awareness Training (Gugerty & Tirre, 2000)

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[2] MUARC IC refers to Experiment IC conducted by MUARC as part of the TAC-funded driving simulator research program conducted to develop the content for DriveSmart. Similarly, RA, RC, SB, ID, SE, AA and TA refer to related experiments conducted at MUARC in its advanced driving simulator. The principles and aspects of driver training were drawn from these experiments. The Reference section at the end of this report contains full bibliographic details of these experiments.

[3] SKAPS is an acronym for Scan, Keep Ahead, Play it Safe. This acronym was coined by TAC, MUARC and Learning Systems Analysis P/L staff during the development of DriveSmart. The elements of SKAPS were drawn from literature in the field, including the NSW Driver Education Framework.

3. Driver Zed. A US program employing a PC-based interactive program. This program preceded DriveSmart and has a very similar approach to video based driving tasks.

4. TRAINER. A European Union program under development, but expected to employ a combination of PC-based interactive multimedia and simulators (Falkmer & Gregersen, 2001). This program is expected to use multimedia to present basic driving principles and low and medium cost simulators to train hazard perception and responding.

5. Moderating Illusory Beliefs. This is an approach to training rather than a specific program. The underpinning concept is that more cautious driving behaviour can be encouraged by having learners contemplate their involvement in a serious crash for which they were to blame (McKenna & Myers, 1997). This approach is very similar to Insight Training and Optimism training as employed in DriveSmart.

6. Hazard Information. The provision of information about specific hazards (eg 'Blackspots') may best be considered an alternative or complementary strategy to training rather than a sub-component.

In addition to the specific training methods considered in the first Stage 1 report (Haworth et al., 2005), general instructional techniques of motorcycle rider training that accord with the stages of incremental transfer learning are proposed in Table 2.2. The initial attempt to define candidate media, in Table 2.2, is based on matching required levels of physical and functional fidelity with the transfer stage being addressed.

**Table 2.2 Transfer Stages and Instructional Strategies.**

| Transfer Stage | Instructional Strategy | Potential Instructional Techniques |
|---|---|---|
| Knowledgeable | Expository Examples | Self-directed learning, eg written materials and multimedia materials. (Cognitivist methods)<br><br>Instructor-led theory instruction. (Cognitivist methods)<br><br>Candidate Media: Static Motorcycle, Written Materials, PC-based Multimedia, Classroom Materials. |
| Prepared | Inquisitory Examples | Instructor-led demonstrations and discussion of both cognitive and psychomotor aspects. (Cognitivist and behaviourist methods) Candidate Media: Motorcycle on Road, Motorcycle on Training Range.<br><br>Student-experienced simulations of cognitive skill aspects. (Cognitivist methods) Candidate Media for Cognitive Components: PC-based Multimedia, PC-based Simulator. |
| Trained | Guided Convergent Practice | Instructor-guided practice. (Behaviourist methods) Candidate Media: Motorcycle on Road, Motorcycle on Training Range.<br><br>Instructor-guided motorcycle simulation practice. (Cognitivist and behaviourist methods) Candidate Media: Motorcycle Simulator, PC-Based Simulator. |
| Skilled | Independent Convergent Practice | Independent practice with feedback from experienced rider. (Cognitivist and constructivist methods) Candidate Media: Motorcycle on Road.<br><br>Independent motorcycle simulation practice with performance appraisal. (Cognitivist and constructivist methods) Candidate Media: Motorcycle Simulator, PC-Based Simulator. |
| Expert | Independent Divergent Practice | Independent practice in on-road and contrived environments with critical self-review and objective feedback from an expert rider. (Cognitivist and constructivist methods) Candidate Media: Motorcycle on Road, Motorcycle Simulator. |

## 2.5 SIMULATION AS A TRAINING METHODOLOGY

The first Stage 1 report (Haworth et al., 2005) noted that little information is available on the application of simulation to motorcycle rider training. Apart from reports of the use of simulation for motorcycle rider training in Japan, there does not appear to be any detailed information on this field. This places reliance on the underpinning theories of learning and instruction already discussed in this report.

In Australia, the only serious attempt to provide a motorcycle rider training simulation capability appears to be at the Honda Australia Rider Training Centre (HART). An on-site assessment of the HART simulation capability was conducted during this study and is provided at Appendix A.

From the perspective of theories of learning and instruction, task performance is essential to any form of skill development. The eminent behavioural psychologist Edwin R. Guthrie described this as "…we learn only what we do…" (Guthrie cited in Sahakian, 1970, p. 38) and since that time this statement has been repeated in many forms; for example 'learning by doing', and the popular comparison of learning by hearing, seeing and doing. Simulation is the alternative to real-world task performance and must, therefore, be considered as a training methodology.

Simulation is a methodology as distinct from a method because it provides a general instructional process that must be applied to specific training situations. Riding a motorcycle on the open road while performing tasks set by an instructor and under instructional supervision is a way of gaining experience for real-world task performance; it is a simulation of eventual real-world performance. Additionally, observing emerging hazards on a video and selecting safe responses is also a way of gaining experience for real-world performance. Consequently, simulation should be viewed as an instructional process that may be employed in a broad range of learning environments.

Specific simulation training methods may be defined by combining the process of instructional simulation with a specific environment. Table 2.3 employs the concepts of physical and functional fidelity, as discussed earlier in relation to incremental transfer learning, to present an ordering of simulation methods for motorcycle rider training.

In general, the simulation methods listed toward the lower-right corner of the table would typically be employed early in training, while those listed toward the upper-left corner would be employed in later stages of training. Moreover, the upper-right corner would typically be used for skills that have a strong cognitive aspect, while the lower-left corner would be used for skills that have a strong psychomotor aspect. While this ordering of simulation methods is intended to provide a useful overview of the potential application of simulation to rider training, the concept is very general and application to any specific training activity would require detailed analysis.

**Table 2.3 Ordering of Simulation Motorcycle Rider Training Methods by Fidelity.**

| | | Physical Fidelity | | |
|---|---|---|---|---|
| | | High | Moderate | Low |
| Functional Fidelity | High | On Road | High-End Motorcycle Training Simulator | High-End Desktop PC Simulator |
| | Moderate | Training Range | Low-End Motorcycle Training Simulator | Low-End Desktop PC Simulator |
| | Low | Static Motorcycle | Arcade Motorcycle Simulator | Written Materials, Multimedia, Classroom |

# 3.0 GUIDING PRINCIPLES FOR HAZARD PERCEPTION AND RESPONSE

The first Stage 1 report (Haworth et al., 2005) provided a detailed discussion of behaviours for hazard perception and responding. This earlier discussion is used here as a basis for identifying principles that may usefully guide the development of motorcycle rider training methods.

The first Stage 1 report discussed a model for perception and responding to hazards (refer to Figure 3.1). Importantly, this model includes a mechanism for learning through feedback. The key aspects of this model with regard to training are:

1. for hazard perception, students need to learn to discriminate between cues for hazardous situations and non-hazardous situations;

2. threat appraisal is more important for less experienced motorcycle riders;

3. threat appraisal may be influenced by levels of self-confidence;

4. action selection is influenced by allocation of attention;

5. action selection may be less effective if a large number of equally practised actions are known;

6. threat appraisal and action selection is improved through feedback from the process of implementation; and

7. action selection may be further aided by supervised practice of implementation.

The first Stage 1 report discussed causes of motorcycle rider failures in implementing responses to hazards. These causes may be important to address in training and are summarised as:

1. errors in braking,

2. failure to accelerate, and

3. failure to counter-steer and swerve.

The first Stage 1 report reported the importance of situational awareness in hazard perception and response. This aspect of skill performance has been briefly discussed above in the description of incremental transfer learning, but the related issue of learner stress is worthy of separate consideration. Stress is well accepted as an instructional device for focussing and increasing learner effort. However, too much stress can have adverse, and even negative, effects. Consequently, training methods should provide for the management of student stress to promote efficient learning while avoiding undesirable effects. The management of stress is a key aspect of 'manipulated workload' as researched at MUARC in Experiment TA for the development of DriveSmart (see review of DriveSmart in Section 2.4).

The first Stage 1 report also identified several generally applicable key issues from which implications for motorcycle rider training may be drawn. The key issues and respective conclusions are summarised in Table 3.1.

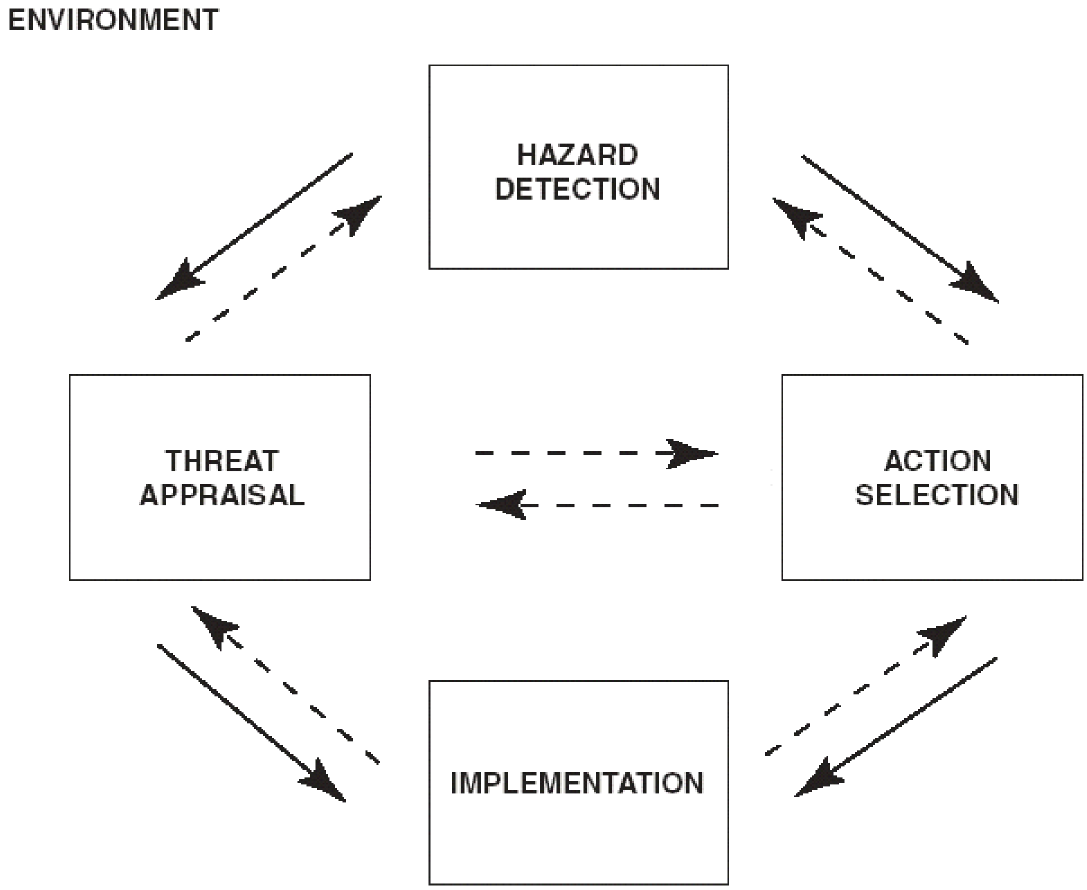


*Figure 3.1 Processes involved in responding to risk (from Grayson et al., 2003). The bold arrows represent hypothetical forward links. The dashed arrows represent hypothetical feedback links.*

**Table 3.1 Key Issues and their Implications.**

| Key Issue from the First Stage 1 Report | Implication for Motorcycle Rider Training |
|---|---|
| Motorcycle riders must deal with the same hazards as car drivers, as well as the additional hazards of failure by car drivers to give way and road surface hazards. | Approaches to hazard perception training that are known to be effective for car drivers may also be effective for motorcycle riders.<br><br>Emphasis should be placed on anticipation of threats posed by car drivers. |
| The potential that the other road user may not have seen the motorcycle means that hazard perception and responding is more crucial for motorcyclists than car drivers, who are more likely to be able to rely on the other road user to avoid them. | As above. |
| The potential severity of crashes, regardless of the type of hazard, is greater for motorcyclists. | The risk of serious injury may make the approach of 'Moderating Illusory Beliefs' more effective. |
| The vehicle control skills involved in riding a motorcycle are more complex than driving a car and failure to correctly implement a response to a hazard may in itself be dangerous. | Vehicle control skills may be a more important aspect of hazard response for motorcycle riders than for car drivers. |
| It may be that attention sharing between the vehicle control skills and hazard perception and responding may be problematic for novice riders. | Attentional control training may be an important aspect of hazard perception and responding training for novice motorcycle riders. |

# 4.0 CONTEXTS FOR MOTORCYCLE RIDER LEARNING

Detailed consideration of contexts for motorcycle rider training should take account of the traits and needs of different types of learners. For example, someone who has little to no experience in driving a car would, presumably, benefit from different training contexts than someone who has extensive experience in driving a car. While this is intuitively sensible, a rigorous examination of the issue is required. However, the first Stage 1 report has revealed that detailed information regarding the hazard perception and responding abilities of different types of motorcycle riders is not available. Consequently, the following discussion of training context is general and any interpretation for a specific subset of learners should be done with care.

In general terms, the first Stage 1 report identified the following types of hazards for motorcyclists:

- road-based hazards:
    - permanent characteristics of the road surface,
    - temporary characteristics of the road surface,
    - visual obstructions,
    - characteristics of the road alignment:
        - the extent to which it obscures the presence of the motorcyclists and other road users, and
        - the extent to which it affects the dynamics of the motorcycle and hence its travel path;
- roadside hazards such as street furniture; and
- hazards arising from other road users:
    - failure to give way, and
    - pedestrians.

A review of motorcycle riding contexts that present high levels of risk (Allardice, 2002) has led to those contexts in Table 4.1 being identified as candidates for instruction. The information in Table 4.1 is organised into a hierarchy of:

1. major process in skill performance,
2. contextual segments within the skill process, and
3. motorcycle riding tasks performed within the segment.

The benefit of the organisation of information in Table 4.1, is that detailed analysis of environmental cues may be undertaken to determine what aspects should be presented in learning environments. Furthermore, the more frequent types of accident (as reported in the first Stage 1 report in relation to DCAs) may be used as a basis for determining which Process-Segment-Task combinations should receive more attention during training.

**Table 4.1 High-Risk Motorcycle Riding Contexts.**

| Process | Segment | Task |
|---|---|---|
| Riding in low speed zones | Un-signalised intersections | Approach |
| | | Cross |
| | | Turn |
| | Roundabouts | Approach |
| | | Cross |
| | | Turn |
| | Residential streets | Transit |
| | | Join |
| | Pedestrians | Approach |
| City riding in high speed zones | Signalised intersections | Approach |
| | | Cross |
| | | Turn |
| | Un-signalised intersections | Approach |
| | | Cross |
| | | Turn |
| | Arterial roads | Overtaking |
| Country riding in high speed zones | Un-signalised intersections | Approach |
| | | Cross |
| | | Turn |
| | Single lane roads | Transit |
| | | Overtaking |
| | Multi-lane roads | Transit |
| | | Join |
| | Animals | Approach |
| | | Pass |
| | Curves | Approach |
| | | Transit |
| | | Exit |

# 5.0 FEATURES OF EFFECTIVE TRAINING METHODS

From the discussion in earlier sections, we can surmise that a training method, or combination of methods, needs to provide a structured learning framework, implement principles of hazard perception and responding, and present suitable riding contexts during instruction. These requirements may be summarised as a set of features of effective training methods (refer to Table 5.1).

**Table 5.1 Required Features of Effective Training Methods.**

| Incremental Transfer Learning Stages | Instructional Techniques | Guiding Principles | Contexts |
|---|---|---|---|
| Knowledgeable (Transfer of prior learning to the skill domain) | Self-directed learning, eg written materials and multimedia materials. (Cognitivist methods)<br>Instructor-led theory instruction. (Cognitivist methods)<br>Candidate Media: Static Motorcycle, Written Materials, PC-based Multimedia, Classroom Materials. | Treat over-confidence and its effects on threat appraisal. Emphasise risk of serious injury.<br>Specific issues:<br>1. Insight Training<br>2. Optimism Training<br>3. Unknowns Training<br>4. SKAPS | All relevant contexts. |
| Prepared (Mental Model Formation) | Instructor-led demonstrations and discussion of both cognitive and psychomotor aspects. (Cognitivist and behaviourist methods) Candidate Media: Motorcycle on Road, Motorcycle on Training Range.<br>Student-experienced simulations of cognitive skill aspects. (Cognitivist methods) Candidate Media for Cognitive Components: PC-based Multimedia, PC-based Simulator. | Students need to learn to discriminate between cues for hazardous situations and non-hazardous situations.<br>Emphasise threats posed by car drivers.<br>Improve action selection through attentional control skills.<br>Specific issues:<br>1. Unknowns Training<br>2. Road Hazards<br>3. Embedded Cue<br>4. SKAPS<br>5. Prediction Training<br>6. Variable Priority Training<br>7. Road Hazards | Representative selection of contexts to demonstrate the range of skill variables. |

| | | | |
|---|---|---|---|
| Trained (Initial Skill Practice) | Instructor-guided practice. (Behaviourist methods) Candidate Media: Motorcycle on Road, Motorcycle on Training Range.<br><br>Instructor-guided motorcycle simulation practice. (Cognitivist and behaviourist methods) Candidate Media: Motorcycle Simulator PC-Based Simulator.<br><br>On completion of this stage, learners have the basic skill set required to perform safely under benign conditions. This point equates to the certification of basic skills provided through the Motorcycle Learner Test. | Emphasise threat appraisal for less experienced motorcycle riders.<br><br>Provide skills in braking, accelerating, counter-steering and swerving.<br><br>Ensure adequate vehicle control skills.<br><br>Specific issues:<br>1. Unknowns Training<br>2. Road Hazards<br>3. Embedded Cue<br>4. SKAPS<br>5. Prediction Training<br>6. Variable Priority Training<br>7. Road Hazards | Minimal number of contexts to present key situations. |
| Skilled (Near Transfer) | Independent practice with feedback from experienced rider. (Cognitivist and constructivist methods) Candidate Media: Motorcycle on Road.<br><br>Independent motorcycle simulation practice with performance appraisal. (Cognitivist and constructivist methods) Candidate Media: Motorcycle Simulator, PC-Based Simulator.<br><br>On completion of this stage, learners have the skill set required to perform safely within the normal range of skill variables. This point equates to the certification of skills provided by the Motorcycle Licence Test. | Speed action selection by focussing practice on a small number of actions.<br><br>Provide feedback on the effectiveness of action implementation.<br><br>Supervise practice of implementation.<br><br>Ensure adequate vehicle control skills.<br><br>Build automaticity in hazard response.<br><br>Develop situational awareness skills<br><br>Specific issues:<br>1. Insight Training<br>2. Optimism Training<br>3. Unknowns Training<br>4. Variable Priority<br>5. Road Hazards<br>6. DCA Focussed Training<br>7. Construct Focussed<br>8. Embedded Cue<br>9. Resource Allocation | Comprehensive treatment of contexts identified through research. |

| | | | |
|---|---|---|---|
| | | Training<br>10. Manipulated Workload<br>11. SKAPS<br>12. Commentary Driving<br>13. Prediction Training<br>14. Situational Awareness Training | |
| Expert (Far Transfer) | Independent practice in on-road and contrived environments with critical self-review and objective feedback from an expert rider. (Cognitivist and constructivist methods) Candidate Media: Motorcycle on Road, Motorcycle Simulator. | Provide feedback on the effectiveness of action implementation. | Contexts presenting novel and unanticipated circumstances. |

# 6.0 COST-BENEFIT CONSIDERATIONS

Table 5.1 presents features that should be present in training methods, but does not present a training method per se. In essence, Table 5.1 summarises the requirement without stipulating a solution. Nonetheless, general categories of training methods may be examined in terms of capability to cost-effectively provide those features listed in Table 5.1.

A comprehensive set of training methods has been devised by considering 'on-bike' rider training, 'on-bike' licence testing, the use of special-purpose simulators and PC-based part-task training, and recorded media. The resultant set of training methods comprises:

- Training Range Rider Training,
- On Road Rider Training,
- Training Range Licence Testing,
- On Road Licence Testing,
- Motorcycle Simulators,
- PC-Based Part-Task Training,
- PC-Based Interactive Recorded Media,
- Recorded Video, and
- Written Materials.

## 6.1 TRAINING RANGE RIDER TRAINING

Training Range rider training is conducted by VicRoads accredited training organisations. These courses are not mandatory, but are completed by most LEARNER motorcycle riders as reported in the first Stage 1 report. A summary assessment of Training Range Rider Training against the proposed features of effective training methods is provided in Table 6.1.

Training Range rider training offers expert instruction in a controlled and safe environment. This method of training satisfied most features proposed as being required in this report, but is inherently constrained to riding circumstances and conditions available at Training Ranges.

The very limited extent to which hazardous conditions can be presented to students implies that much learning through experience will occur after training and in real-world conditions. Consequently, a significant component of skill development will not occur in a harm-free environment. A corollary to this observation is that there will be hidden costs associated with accidents that occur during the period of on-road skill development. It is worth noting that all training methods will have some component of skill development and consolidation after formal training has been completed, but the issue here is the extent to which this can be supported by initial exposure to hazard perception and responding in a harm-free environment.

**Table 6.1 Assessment of Training Range Rider Training.**

| ITL Stage | Strengths | Weaknesses | Costs |
|---|---|---|---|
| Knowledgeable (Transfer of prior learning to the skill domain) | Instructors can address individual learner needs. | Limited time available for instruction of required knowledge. | Reasonably low cost borne by individual riders for both small niche groups and the larger population of riders. |
| Prepared (Mental Model Formation) | Expert demonstrations. | Limited scope for introducing the types of hazards that will be encountered on the road, especially actions of car drivers. | |
| Trained (Initial Skill Practice) | Training Ranges provide controllable environments for early skill practice.<br>Supervised learning with feedback. | Speeds are restricted to range conditions.<br>Limited scope for developing skills in threat appraisal and action selection. | |
| Skilled (Near Transfer) | Supervised learning with feedback. | Speeds are restricted to range conditions.<br>Limited opportunity for extensive practice of contexts and associated instructional feedback on action implementation.<br>Limited contexts available for certifying skill level achieved.<br>Relatively short period of training does not permit managed development of attentional control skills and automaticity in hazard response. | |
| Expert (Far Transfer) | Special on and off road programs are available. | Lack of ongoing advice regarding performance improvement. | |

## 6.2 ON ROAD RIDER TRAINING

Training on the road is largely restricted in Victoria to informal training and skill extension courses offered after a motorcycle licence has been obtained. Nevertheless, the 'on road' environment offers a greater range of conditions than that of a Training Range and is worthy of consideration. For the purpose of this assessment, an assumption is made that peers acting as instructors are appropriately skilled to perform this role. A summary assessment of On Road Rider Training against the proposed features of effective training methods is provided in Table 6.2.

On Road rider training places the student in a rich learning environment, but one over which an instructor may have little to no control. Though it may be possible to select stretches of road that are appropriate for training, there is a clear danger posed by, and to, other road users.

On Road rider training that is not formal and approved by regulating bodies also risks the learning of incorrect riding techniques and strategies.

The use of the real-world environment for gaining experience in hazard perception and responding indicates that learning will not occur in a harm-free environment. Furthermore, there will be hidden costs associated with accidents that occur during skill development.

**Table 6.2 Assessment of On Road Rider Training.**

| ITL Stage | Strengths | Weaknesses | Costs |
|---|---|---|---|
| Knowledgeable (Transfer of prior learning to the skill domain) | Instructors can address individual learner needs. | Limited time available for instruction of required knowledge. | Reasonably low cost borne by individual riders for both small niche groups and the larger population of riders, although possibly higher than on training ranges because of smaller groups, need for an additional bike for the trainer and possible insurance issues. |
| Prepared (Mental Model Formation) | Expert demonstrations. | | |
| Trained (Initial Skill Practice) | Supervised learning with feedback. | Initial skill performance would be in environments over which there is little to no control of conditions and behaviours of other road users. | |
| Skilled (Near Transfer) | Supervised learning with feedback.<br><br>Extensive range of contexts available for instruction. | Hazards are real and an instructor may have little control over evolving situations. | |
| Expert (Far Transfer) | Special on road programs are available through riding schools. | Lack of ongoing advice regarding performance improvement. | |

## 6.3 TRAINING RANGE LICENCE TESTING

Licence testing is, arguably, a critical aspect of motorcycle rider training and worthy of assessment against the proposed features of effective training methods. In terms of incremental transfer learning, Learner Permit Testing occurs during the Trained stage, while Licence Testing occurs during the Skilled stage. A summary assessment of Training

Range Licence Testing against the proposed features of effective training methods is provided in Table 6.3.

**Table 6.3 Assessment of Training Range Licence Testing.**

| ITL Stage | Strengths | Weaknesses | Costs |
|---|---|---|---|
| Trained (Initial Skill Practice) | Training Ranges provide controllable and measurable environments for skill assessment. | Assessment is based only on observable behaviours, not perceptions or judgements. | Reasonably low cost borne by individual riders. |
| Skilled (Near Transfer) | Training Ranges provide controllable and measurable environments for skill assessment. | Assessment is based only on observable behaviours, not perceptions or judgements.<br><br>Limited contexts available for certifying skill level achieved. | |

Training Range licence testing offers expert assessment in a controlled and safe environment. This method of testing satisfies some features proposed as being required in this report, but is inherently constrained to riding circumstances and conditions available at Training Ranges.

A limitation of Training Range licence testing is that only the observable manifestations of rider performance can be used as the basis for skill assessment. The need to test important skills such as hazard perception is acknowledged within Victoria by the existence of the VicRoads Hazard Perception Test, but an equivalent mechanism is not available in Training Range licence testing.

## 6.4 ON ROAD LICENCE TESTING

On Road licence testing offers an increased range of circumstances for assessing skill levels. These include vehicle control at higher speeds than possible on a training range, road surface hazards and interaction with traffic. For this reason, it is worthy of consideration. A summary assessment of On Road Licence Testing against the proposed features of effective training methods is provided in Table 6.4.

On Road licence testing offers expert assessment, but not in a controlled and safe environment. While a greater diversity of hazards may be available for testing purposes, there is a clear risk of injury if incorrect responses are made.

As with Training Range licence testing, only the observable manifestations of rider performance can be used as the basis for skill assessment.

**Table 6.4 Assessment of On Road Licence Testing.**

<table>
<tr><th>ITL Stage</th><th>Strengths</th><th>Weaknesses</th><th>Costs</th></tr>
<tr><td>Trained (Initial Skill Practice)</td><td>Performance must be demonstrated in real-world conditions as will be faced in subsequent riding.</td><td>Assessment is based only on observable behaviours, not perceptions or judgements.<br><br>There is little to no control over the environment.</td><td rowspan="2">Reasonably low cost borne by individual riders, although possibly higher than for off-road testing because of the need to test one rider at a time, instead of a group, possibly longer test time, need for an additional bike for the tester and possible insurance issues.</td></tr>
<tr><td>Skilled (Near Transfer)</td><td>Performance must be demonstrated in real-world conditions as will be faced in subsequent riding.</td><td>Assessment is based only on observable behaviours, not perceptions or judgements.<br><br>There is little to no control over the environment.<br><br>Limited contexts available for certifying skill level achieved.</td></tr>
</table>

## 6.5 MOTORCYCLE SIMULATORS

Motorcycle simulators are not used formally within Victoria, but do provide an important component of training in Japan and, as discussed elsewhere in this report, are worthy of consideration. Simulators are a device that may be used in training rather than a training method in their own right, nevertheless, the extent to which they could support other forms of training, such as Training Range rider training, can be assessed. A summary assessment of motorcycle simulators against the proposed features of effective training methods is provided in Table 6.5.

Motorcycle simulators allow riders to experience an extensive range of hazards in a safe and instructionally supervised environment. In addition to the circumstances that can be presented, simulation provides instructors with access to detailed student performance information that can assist with the diagnosis of errors in technique.

Despite the capability available through simulation, technology at present, and in the foreseeable future, will not permit adequate replication of motion and other stimuli present in real-world riding. Consequently, simulation must be viewed as no more than an activity leading in to, and augmenting, instruction on an actual motorcycle. Furthermore, the cost of sufficient access to simulation devices may prevent this approach from being applied to the general motorcycle rider LEARNER population. However, application to small niche groups, such as individuals with high accident rates, may be considered cost-effective in terms of reducing hidden costs due to injury.

**Table 6.5 Assessment of motorcycle simulators.**

| ITL Stage | Strengths | Weaknesses | Costs |
|---|---|---|---|
| Knowledgeable (Transfer of prior learning to the skill domain) | N/A | N/A | Practice of an extensive range of contexts requires a lengthy period of training for each individual. Making sufficient simulation resources available at reasonable cost may be possible for small niche groups, but is unlikely to be so for the larger rider population. |
| Prepared (Mental Model Formation) | Expert demonstrations. | Limited capability for students to observe demonstrations because of the stationary nature of simulators | |
| Trained (Initial Skill Practice) | Supervised learning with feedback.<br><br>A wide range of performance parameters, eg front brake pressure, may be monitored to assess and remedy techniques. | Any deficiencies in the modelling of vehicle control skills will limit early skill development. | |
| Skilled (Near Transfer) | Supervised learning with feedback.<br><br>Extensive range of contexts for skill practice.<br><br>A wide range of performance parameters, eg front brake pressure, may be monitored to assess and remedy techniques. | Deficiencies in the modelling of vehicle control skills may cause negative transfer of learning.<br><br>Visual and motion cues that may be required for some riding contexts will not be available. | |
| Expert (Far Transfer) | Suitable contexts can be devised and implemented.<br><br>Range of skill performance measures available to aid self-critiques. | | |

## 6.6 PC-BASED PART-TASK TRAINING

PC-based part-task training can be used to improve performance on a wide range of perceptual and cognitive skills needed to ride or drive safely. The TAC product DriveSmart offers PC-based part-task training in hazard perception and responding and attentional control for car drivers. The training offered by DriveSmart is optional, but undertaken by a substantial number of Victorian LEARNER drivers. Given this level of acceptance by LEARNER drivers, a similar product for motorcycle riders is worthy of consideration. The TAC is developing such a product.

While the term 'PC-based' is used here, the same type of training could be provided through the Internet. Also, the term 'part-task training' is assumed here to imply that learning aims to develop procedural knowledge of the task and not simply declarative knowledge, i.e., sub-conscious knowledge of how to perform the task and not verbal statements of what to do. A summary assessment of PC-Based Part-Task Training against the proposed features of effective training methods is provided in Table 6.6.

**Table 6.6 Assessment of PC-Based Part-Task Training.**

| ITL Stage | Strengths | Weaknesses | Costs |
|---|---|---|---|
| Knowledgeable (Transfer of prior learning to the skill domain) | Being PC-based, interactive recorded media can be used to support this stage of learning (refer to discussion below of PC-Based Interactive Recorded Media). | | The ubiquitous nature of PCs permits up-front development costs to be spread over a potentially large numbers of learners and avoids the need to provide resources for the delivery of training; DriveSmart is a good example of this. However, the development of tailored training for small niche groups will clearly be more costly per learner. |
| Prepared (Mental Model Formation) | Skills such as hazard perception and responding can be broken down to key elements for individuals to practice.<br>Performance problems can be monitored and remedial feedback provided.<br>Performance at part-tasks can be accurately assessed. | Stimuli for task performance are limited to those available through a PC, ie limited field-of-view and image resolution, no motion, PC interface. | |
| Trained (Initial Skill Practice) | Learning contexts that are suitable for initial skill practice may be contrived.<br>Performance at part-tasks in key contexts can be accurately assessed. | As above. | |

| | | | |
|---|---|---|---|
| Skilled (Near Transfer) | A comprehensive range of learning contexts can be devised to enable variations in skill variables to be experienced.<br><br>Performance at part-tasks in a broad range of contexts can be accurately assessed. | As above. | |
| Expert (Far Transfer) | Novel and unanticipated circumstances can be presented to challenge the development of effective coping strategies. | Self-analysis of performance is an important aspect of this stage that may be constrained without a human mentor/coach present. | |

PC-based part-task training offers a potentially cost-effective means of providing training focussed on hazard perception and responding to the broad population of riders. A comprehensive range of hazard types can be addressed, although limitations of the PC interface will impose some constraints. The availability of a comprehensive range of hazard types also permits minimum levels of safe performance in the part-task to be assessed. Perhaps most importantly, PC-based part-task training enables almost all principles for hazard perception and responding, as discussed earlier in this report and in the first Stage 1 report, to be addressed in a reliable manner.

The need to follow part-task training with whole-task training is important to note. PC-based part-task training, by definition, can only provide a partial solution to training and must be carefully positioned within an overarching training strategy.

## 6.7 PC-BASED INTERACTIVE RECORDED MEDIA

The PC provides an environment for learning declarative knowledge, such as road rules and concepts of roadcraft, that is in widespread use in modern society. Furthermore, procedures for the effective design of this type of instruction have progressed considerably since the introduction of the first IBM PC in 1981 and there is little risk in achieving an effective product. Instructional design typically makes extensive use of digitised video and high quality graphics to convey the intended message, and may extend to some level of simulation although the issue of part-task training is specifically addressed above.

As an example of this approach, in the United Kingdom, UK CD-ROMS that are available to licence applicants which include all the road rules and the road rule questions to allow applicants to practice (see http://www.imagitech.co.uk/driving_prods/dts.htm).

While the term 'PC-based' is used here, the same type of training could be provided through the Internet. A summary assessment of PC-Based Interactive Recorded Media against the proposed features of effective training methods is provided in Table 6.7.

**Table 6.7 Assessment of PC-Based Interactive Recorded Media.**

| ITL Stage | Strengths | Weaknesses | Costs |
|---|---|---|---|
| Knowledgeable (Transfer of prior learning to the skill domain) | Reliable and well-tested instructional processes are available to ensure effective treatment of required content.<br>Student knowledge of road rules, roadcraft and their application can be tested. | Limited opportunity to respond to learner questions or special needs. | As for PC-based part-task training, although development costs are typically lower than for the simulations that underpin part-task training. |
| Prepared (Mental Model Formation) | Detailed information of task performance can be presented in a clear visual manner. | The effectiveness of instructional may be limited by the extent to which free-play is available with recorded media. | |
| Trained (Initial Skill Practice) | As above. | Substantial constraints will be imposed by the lack of free-play due to use of recorded media. | |
| Skilled (Near Transfer) | As above. | As above. | |
| Expert (Far Transfer) | Clear and detailed information may be sufficient to prompt learner analysis of performance strategies. | As above. | |

PC-Based Interactive Recorded Media can provide a useful strategy for early stages of skill development, especially in relation to the acquisition of declarative knowledge. As such it may provide some of the background knowledge upon which hazard perception and responding skills may be built. This type of training may also be useful for advanced stages of learning where students require information-rich environments to analyse performance strategies.

The major constraint imposed by the use of PC-Based Interactive Recorded Media is the lack of opportunity for free-play in task performance. This problem increases as students master the basics of skill performance and effectively prevents procedural knowledge to develop. Consequently, PC-Based Interactive Recorded Media must be used in combination with other training methods and within an overarching training strategy.

## 6.8 RECORDED VIDEO

Modern video techniques allow rich visual information regarding task performance to be made available to learners in a number of formats including video cassette, DVD and video CD-ROM. In relation to hazard perception and responding, this information might be used to aid hazard recognition, understanding of the dynamics of an evolving hazardous situation and demonstrations of effective responses to hazardous situations. The application of recorded video is assumed not to be interactive in the sense that PC-based digitised video can permit interaction, eg of the type employed in DriveSmart. A summary assessment of Recorded Video against the proposed features of effective training methods is provided in Table 6.8.

**Table 6.8 Assessment of Recorded Video.**

| ITL Stage | Strengths | Weaknesses | Costs |
|---|---|---|---|
| Knowledgeable (Transfer of prior learning to the skill domain) | Clear dynamic and still visual and aural presentation of road rules and the principles of roadcraft. | Requires presence of an experienced rider to respond to student questions and special needs. | Video production costs are similar to those for the production of PC-based materials. Consequently, recorded video may be cost-effective if available to a large population of learners, but is unlikely to be so for a small niche group of learners. |
| Prepared (Mental Model Formation) | Clear dynamic and still visual and aural demonstrations of the key aspects of task performance, especially visual identification of hazards. | Learning is vicarious with no opportunity for the student to attempt tasks for themselves. | |
| Trained (Initial Skill Practice) | As above. | Only visual aspects of tasks can be practised. | |
| Skilled (Near Transfer) | A broad range of visual contexts can be presented. | As above. | |
| Expert (Far Transfer) | Clear and detailed visual information may be sufficient to prompt learner analysis of performance strategies. | As above. | |

Recorded video offers detailed visual information that can usefully support skill development. The major benefit of recorded video is the ability to portray a rider encountering a hazard that is otherwise impractical or too risky to train. Such vicarious learning can play an important role in training and is worthy of consideration. However, the potential for the effective application of recorded video without other training methods is very limited.

## 6.9 WRITTEN MATERIALS

Written materials can provide instructional text and images to support the learning of road rules and roadcraft. As well as presenting content, written materials can be used to provide guidance to learners as they progress in skill development; the VicRoads publication 'Bike Right' is a good example of such an application. A summary assessment of Recorded Video against the proposed features of effective training methods is provided in Table 6.9.

**Table 6.9 Assessment of Written Materials.**

| ITL Stage | Strengths | Weaknesses | Costs |
|---|---|---|---|
| Knowledgeable (Transfer of prior learning to the skill domain) | Clear text and imagery to aid learning of road rules and the principles of roadcraft. | May require the presence of an experienced rider to adequately deal with student questions regarding roadcraft and special needs. | Written materials are relatively inexpensive to develop and can be tailored to suit the needs of a small niche group or the larger learner population. Consequently, written materials provide a very cost-effective way for disseminating information. |
| Prepared (Mental Model Formation) | Clear textual, diagrammatic and pictorial presentation of key information related to task performance. | There is no dynamic representation of task performance and no opportunity to practice the task. | |
| Trained (Initial Skill Practice) | Effective strategies for learning can be recommended. | As above. | |
| Skilled (Near Transfer) | As above. | As above. | |
| Expert (Far Transfer) | As above. | As above. | |

Written materials have a direct application to the early stages of learning hazard perception and responding. In later stages, the most effective application of written materials may be to offer advice of effective strategies for continued skill development.

## 6.10 IMPLICATIONS OF MANDATORY AND NON-MANDATORY TRAINING

Participation in Learner Permit and Licence training courses has been reported, in the first Stage 1 report, as being very high in Victoria. Accordingly, there would seem to be little justification for making these courses compulsory; apart from a possible concern regarding the potential safety risk posed by those who pass the tests, but have not had the additional benefits of Training Range rider training. However, the above assessment of Training Range rider training has indicated that hazard perception and responding training is quite limited, and the obvious conclusion is that making current training compulsory may not substantially improve safety on the road.

On the other hand, extending current Learner Permit and Licence training to comprehensively address hazard perception and responding may make formal training less attractive to some participants; for example, due to the increased commitment of time. In this case, the knowledge that hazard perception and responding could be comprehensively trained, combined with the lower participation rates, may warrant a mandatory training scheme.

## 6.11 COMPARISON OF TRAINING METHODS

Motorcycle riding schools are an important resource for hazard perception and responding training and will continue to be so in the future. Consequently, those aspects of hazard perception and responding training that may not currently be adequately, or cost-effectively, addressed at riding schools need to be identified and suitable remedies devised.

The above assessment of Training Range rider training for hazard perception and responding has indicated a number of key problem areas that are summarised in Table 6.10.

**Table 6.10 Assessment of training range rider training for hazard perception and responding.**

| ITL Stage | Training Range Rider Training Weaknesses | Potential Remedies |
|---|---|---|
| Knowledgeable (Transfer of prior learning to the skill domain) | Limited time available for instruction of required knowledge. | Written materials appear to offer the most cost-effective training method to augment this aspect of hazard perception and responding training. |
| Prepared (Mental Model Formation) | Limited scope for introducing the types of hazards that will be encountered on the road, especially actions of car drivers. | Written materials would provide some benefits, although dynamic representation of hazards through video and/or PC-based interactive recorded media is also required. |
| Trained (Initial Skill Practice) | Speeds are restricted to range conditions.<br>Limited scope for developing skills in threat appraisal and action selection. | A safe environment for initial skill development is required. This is only conceivably available through PC-based part-task training and/or motorcycle simulators. In terms of cost-effectiveness, PC-based part-task training is likely to offer the best solution.<br>PC-based part-task training could also be used to more thoroughly assess the skill level of candidates for the Motorcycle Learner permit, in addition to the current test requirements. |
| Skilled (Near Transfer) | Speeds are restricted to range conditions.<br>Limited opportunity for extensive practice of contexts and associated instructional feedback on action implementation.<br>Limited contexts available for certifying skill level achieved.<br>Relatively short period of training does not permit managed development of attentional control skills and automaticity in hazard response. | A safe environment for experience of a comprehensive range of contexts is required. PC-based part-task training could usefully prompt consideration of the full range of skill variables, but whole-task training is important for the consolidation of skills at this stage. Motorcycle simulators appears to be the most capable training method, but the high cost is likely to make this impractical, especially over the extended period required for skill consolidation. A combination of PC-based part-task training and written materials, to guide self-directed skill consolidation, may offer the optimum approach for this stage.<br>PC-based part-task training could also be used to more thoroughly assess the skill level of candidates for the Full Motorcycle Licence, in addition to the current test requirements. |

| | | |
|---|---|---|
| Expert (Far Transfer) | Lack of ongoing advice regarding performance improvement. | Written materials may be the best means of promoting ongoing development of hazard perception and responding skills. The skill extension courses offered by riding schools provide short intense periods of skill development and should also be encouraged. |

# 7.0 CONCLUSIONS

This report has proposed a framework for the learning of hazard perception and responding based on the model of incremental transfer learning. In this model, learners (not just LEARNERS - holders of motorcycle Learner Permits) transfer the skills that they have acquired in relatively simple environments to more complex environments. This learning model has been successfully applied to many Australian Defence Force situations and, more recently, to novice car driver training through the TAC product DriveSmart.

It is assumed that skills are learned in stages, with improving performance as the learner moves from *knowledgeable*, to *prepared*, to *trained*, to *skilled*, to *expert*. Which method of training is best depends on the stage in skill learning. There is generally less need for physical resemblance (physical fidelity) or functional similarity (functional fidelity) in the early stages of learning than in later stages. However, when the expert stage is reached, the wealth of experience means that the need for physical fidelity is reduced.

The following general categories of training methods were assessed in terms of the extent to which they could provide the required outcomes in a cost-effective manner:

- Training Range Rider Training,
- On Road Rider Training,
- Training Range Licence Testing,
- On Road Licence Testing,
- Motorcycle Simulators,
- PC-Based Part-Task Training,
- PC-Based Interactive Recorded Media,
- Recorded Video, and
- Written Materials.

While more research is needed regarding hazard perception and responding by motorcycle riders, specific deficiencies in current training methods were identified and potential remedies suggested. In particular, there is potential to improve existing Training Range rider training through provision of written materials. PC-based part-task training appears to offer a cost-effective means of addressing hazard perception and responding training in the near term. PC-based part-task training could also be used to develop hazard perception tests for the Learner and Licence Tests. This would encourage voluntary use of PC-based part-task training.

Motorcycle simulators allow a rider to experience a wide range of hazards in a safe, and instructor-supervised environment. In addition to the circumstances that can be presented, simulators provides instructors with access to detailed information about student performance that can assist with the diagnosis of rider errors.

The research suggests that simulators should be used as part of a comprehensive rider education system that includes classroom training and skills practice using real vehicles, with simulators being used to training riders in situations that are too dangerous to practice using a real vehicle.

Currently and in the near future, simulator technology does not allow perfect replication of the motions and other stimuli present in real-world riding. Consequently, simulation must be viewed as no more than an activity leading in to, and augmenting, instruction on an actual motorcycle. Furthermore, the cost of sufficient access to simulators may prevent this approach from being applied to the general motorcycle rider LEARNER population. However, simulators may be cost-effective for training particular groups, such as individuals with high accident rates or professional riders. In the short-term, simulators may provide a useful tool for conducting research into hazard perception and responding by riders.

# 8.0 RECOMMENDATIONS

The following recommendations are made:

1. Research should be undertaken to investigate whether experienced riders are faster at perceiving hazards than novice riders and whether this depends on the type of hazard (vehicle-based or road-based) and the level of car driving experience of the rider.

2. The results of the research outlined in 1. should be used to determine the relative emphasis given in training to the two types of hazards and who the training should target (novice car and motorcycle operators, novice motorcycle riders who are experienced car drivers etc.).

3. Hazard perception training products (or a hazard perception test) for motorcycle riders should not be developed until more is known about what affects hazard perception, how this varies among the different classes of hazards, and the extent to which hazard perception can be trained.

4. Research should be undertaken to resolve whether training should focus on addressing hazard perception or responding or the modifying factors. It may be that addressing the modifying factors could be more useful than improving hazard perception or responding.

5. Any hazard perception training that is developed should fit the needs of the Victorian riders. Different approaches may be needed for younger and older novices. There is a need to assess for which categories of motorcycle riders – younger, older, novice, experienced, returning – hazard perception and responding needs to be improved and how this could be done.

6. The current initiative to develop the publication 'Bike Right' is strongly supported. The approach of providing strategies to support long-term skill development is sound and should be a cornerstone of any future program.

7. PC-based part-task training is considered to be a cost-effect method to provide structured experience of a comprehensive range of hazardous contexts. This type of training is likely to be useful for LEARNERS.

8. PC-based part-task training could also be used to develop hazard perception tests for the Learner and Licence Tests. This would encourage voluntary use of PC-based part-task training.

9. A detailed description of the concept for Victorian motorcycle rider training should be documented. This concept should explain the training process and underpinning theories of learning and instruction. The concept should extend beyond acquisition of a licence and consider how ongoing learning can be facilitated.

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# APPENDIX A - HART MOTORCYCLE SIMULATOR

## BACKGROUND

The Honda Australia Rider Training (HART) Centre, located in Tullamarine Melbourne, owns and operates the only motorcycle simulator known to exist in the Southern Hemisphere. It was built in 1996 by Honda in Japan and has been designed as a training simulator rather than as a research simulator. The same simulators (and more advanced versions) are currently used in Japan and it is mandatory for all motorcycle licence applicants there to undergo three hours of simulator training. Apparently, the simulator is used in Thailand for training police motorcyclists. The simulator cost approximately $250,000 to purchase in 1996.

The HART motorcycle simulator is not being used for training purposes at present, although it is understood that Australia Post is interested in using the facility as a tool for assessing the riding skills of employee riders who have recently returned to work following a crash and employee riders who are over-involved at work in crashes and near misses. In the longer term, it is hoped to be used to train advanced riding skills.

## COMPONENTS

The facility consists of the following key components:

- a motorcycle (without wheels) mounted on a partial motion platform;
- a high-end personal computer;
- Ethernet board;
- image generator;
- rectangular projection screen (about 4 by 3 feet);
- projector;
- sound board;
- speakers; and
- operator station with PC and mouse for running, recording and replaying simulation scenarios.

## FIDELITY

Generally, the simulator has medium to high fidelity. The motorcycle itself has a standard "1 up and 4 down" manual gearbox and leans left and right as the handlebars are turned left and right.

Other key features include a variable speed fan which blows on the rider's face when the motorcycle is in motion, and an audio system which can simulate a range of sounds (eg other vehicle noises, horn honking, foot pedals scraping the ground, etc).

The computer graphics are projected from behind onto a rectangular display screen. The view is as seen from the rider's seat. Left and right rear-vision mirrors appear superimposed on the left and right bottom corners of the display screen, respectively. The quality of the graphic display is, understandably, not as high as that of more modern PC-based systems which run at higher refresh rates. For example, road signs cannot be seen as clearly at long distances as they can in the real world. The quality of the display is, however, very good and is suitable for training purposes.

Through the graphical user interface, the operator can program the facility to function as a 50cc, 400cc (most popular) or 750cc motorcycle. The vehicle dynamic model driving the simulation is different for each of these (e.g., the 50cc motorcycle does not accelerate as rapidly as larger capacity motorcycles).

Simulator perceptual discomfort is a commonly reported occurrence. This attests to the medium to high level of fidelity built into the facility.

The system does have some limitations. Unlike a real machine, the simulator vehicle does not fall over to the left or right if allowed to balance freely. The motion platform is quite capable, but cannot simulate acceleration forces such as the g-force felt when cornering. The field of view is limited laterally – hence, judgement distances are more limited than those in the real world (eg the rider cannot look left far into the distance to detect an approaching vehicle). Finally, counter-steering cannot be used to manoeuvre the motorcycle.

## SCENARIOS

All scenarios are scripted: that is, they run in the same sequence every time and it is not possible to change, through software, the entities (eg pedestrians, vehicles) within a scenario and the order in which they come and go. This may be technically possible, but it is understood that HART does not currently have the capability to do so.

A wide range of training scenarios can be played, recorded on videotape, and re-played. In replay mode, front, side and birds-eye views of the rider's situation can be seen.

The following training modules exist: motorcycle characteristics; riding and traffic rules; hazard perception and prevention; high speed operation; racing circuit; and small motorcycles (presumably 50 cc and 400cc). These include operation of the motorcycle through curves, in windy conditions, and when emergency braking.

A wide range of atmospheric and road characteristics can be superimposed over the existing scenarios. These include: bitumen, ice, gravel, day, night, and fog. Six different road types can be simulated (eg freeway, urban, etc). An impressive range of entities are simulated, including: pedestrians, cyclists, trucks, cars, motorcycles, traffic signals, signs and buildings.

A very impressive range of DCA-type scenarios (e.g., turning right against oncoming traffic; pedestrians appearing from behind parked cars; etc) are available in the hazard perception and avoidance scenarios. These are well scripted and appear to be based on an analysis of motorcycle crash types and near misses in Japan. These appear to be representative of crash types experienced by Australian riders.

## PERFORMANCE MEASUREMENT

Several performance measures are captured automatically and displayed to the operator whilst a scenario is running: current vehicle speed; front and rear brake pressure; gear choice; use of clutch; braking distance; and reaction time to unexpected hazards. The latter two measures can be compared to desirable reaction times and braking distances set by HART.

As the facility is a training simulator rather than a research simulator, no other performance measures (e.g., standard deviation of lane deviation; average speed) can be derived from the replay files. Instructors can, however, review each scenario and provide feedback to the student on observed riding behaviours.

## INSTRUCTIONAL DESIGN OF TRAINING MODULES

Guidance for instructors is provided in a very detailed set of documentation. This guidance includes scenario descriptions and teaching points. The recommended progression of instruction appears to be sound starting with simple hazard situations and building up to a reasonably comprehensive set of potentially hazardous situations.

There is considerable similarity between the types of situations presented in the simulated environment and those used for the development of the TAC DriveSmart training product. Furthermore, the similarity between these two training products in terms of the way potential hazards emerged was surprisingly high. For example, indirect cues to the presence of a potential hazard were provided rather than the hazard suddenly appearing, eg the presence of a stationary pedestrian on the sidewalk and a taxi slightly ahead of own motorcycle gives an advance cue that the taxi may brake suddenly (to pick up the pedestrian). This type of advance cue is used throughout DriveSmart to develop hazard prediction skills.

While this type of motorcycle simulation and the associated courseware is excellent, it requires personal experience by each learner and, therefore, is resource intensive. Cost-effective employment for the broad population of motorcycle riders is unlikely to be possible. Perhaps the most cost-effective use of such a device would be for evaluation of skill deficits in riders who have a history of accidents. This application of the device is understood to be under consideration by HART as mentioned above. The performance monitoring and recording capability of the device would be a useful tool for diagnosing and remedying the causes of poor riding performance.

## SUMMARY

The HART motorcycle simulator provides a reasonable level of fidelity along with well-developed instructional materials. While this type of device appears to have a considerable capacity to develop skills for the perception of, and response to, hazards, cost-effective implementation in the broad motorcycle population is problematic. A more likely cost-effective application of this form of simulation appears to be evaluation and remediation of motorcyclists who have a history of accidents.

The underlying strategy employed in the HART simulator for hazard perception and avoidance training is very similar to the video-based activities used in DriveSmart. This suggests that DriveSmart-style strategies of video-based scenarios may be usefully applied to motorcycle training.