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Abstract [Part 1 & 2]

This research paper in two parts, applies information management [IM] system theory to human intelligence [HI], driving. The literature review establishes several reasons why many but not all inexpert drivers have poor driving information management skills.

The study researches how driving experts apply IM, finding statistically significant results confirming use of verbal or non-verbal commentary reasoning to fully apply our working memory. Verbal and non verbal concurrent verbalisation [commentary] is found to contribute significantly in formulating, executing and updating a driving plan that can handle driving conditions. The research finds learning superior driving information management techniques is not without its problems.

Expert IM driving applies observation techniques that accommodate vision saccades and fixations plus additional skills too, thus creating a synergy between man and machine. The study describes how non-expert drivers may learn to apply better IM.

These information management techniques also set up, maintains and improve the communication channels across the open system boundaries and solves the problem of the ‘inattentive autopilot’ driver that is not applying effective information management to driving.

The study finds that a proper learning and application process involving the conscious and unconscious working memory, not just penalty points and fines, is vital to achieve continued driving improvement.
Keywords:

Driving cognitively

Information Management System

Human intelligence

Concurrent verbalisation

Highlights:

• Confirms expert driver agreement on verbal and non-verbal reasoning.
• As a means of achieving effective driving information management
• Applying our working memory to the best effect
Glossary of Terms:

ITS  Intelligent Transport System
IM  Information Management
IS  Information System
ICT  Information Communications Technology
DSS  Decision Support System
ESS  Expert Support System
ABS  Antilock Braking System
TCS  Traction Control System or sometimes identified as
SCS  Stability Control System or
DSC Dynamic stability control system
WM  Working Memory
DAS Driver attention assist system
CCT  Cognitive Computing technology
HI  Human Intelligence
AI  Artificial [neural network] Intelligence
FL  Fuzzy logic
CTL  Conventional temporal logic software
HCI  Human Computer Interface
GP  Generic Programming
CASE tool: Computer Aided Software Engineering [workbench]
1.0 Introduction

Part 1 of this study established the nature of the problems of how and why poor information management techniques are applied by many non-expert drivers. The distribution of driving skills is not normally but asymmetrically distributed across the driving population. Studies have shown that accident statistics are very complex, have a Binomial-Poisson statistical distribution and there is an asymmetric relationship between driving and safety skills, with over-confidence in driving skills leading to risky driving especially if not buffered by safety skills. Enhanced skills on their own cause complacency and increased risk of accidents. (Summer et al., 2006). The study also indentified the important role of human intelligence and coordination reaction times and the increased information processing demands being made on drivers.

Part 2 of this research study now investigates how improved driving information management methods have been identified, how, when and why they can be applied by less skilled and less expert drivers improving their driving standard.

2.0 How do drivers and how should drivers apply Information Management diligently to the driving task and process?

2.1 Literature review


![Fig 1]

*The diagram is adapted from Roadcraft Chapter 2 page 28, (2013).*

Managing information is central to the system. Information processing runs through and feeds into all the phases, making the case that drivers should...

Roadcraft (2007) describes in Chapter 1, how our minds process information. This takes place at both the conscious and sub-conscious level and must be competently applied Roadcraft (2013) Chapter 1, page 4-5.

Roadcraft (2007) page 6 warns that the brain’s information-processing capacity can become overstretched, reducing driving performance and compromising safety. Drivers have to process information from several different sources through different senses at the same time. This affects driving performance because processing complex information can affect perception and slow reaction times.

The Roadcraft (2013) has a very limited explanation of how information is processed, compared with Roadcraft (2007). Arguably this change in emphasis is focusing more on the high-level driving task and less on the low-level processes about how it is achieved. Both are important.

Roadcraft (2007) explains that working memory filters information entering the brain, short-term memory holds limited amounts of information for a very limited time, long term memory can store large amounts of information for a protracted time but under pressure such information can be difficult to recall. In complex and demanding situations, the brain may discard or forget new information before it can be stored in long-term memory. Roadcraft (2013) page 46.

Several related information management attributes are beneficial to a successful drive. Viz:-

- Sustain short –term effective attention and related observational skills to
- apply our working memory to the current driving task to
- handle the required level of ‘multitasking’ in an integrated manner and
- apply the required level of cognitive ability coherently to the whole information management process thereby improving human driving.

2.2 Control of human attention and cognitive ability development

Achieving sustained attention successfully is mainly due to executive control of attention and additionally to a learning process because of extended practice. (Schweizer et al., 2012). Cognitive ability and task performance are related. Research findings show that as expected, high ability individuals demonstrated
a higher accuracy and faster performance than low ability individuals did. The findings show there are some weaknesses in the study and further work is still needed in this area. (Dodonova, et al., 2012)

Arguably less capable people can become higher-level performers and show improved ability by better use of executive control of attention correctly underpinned by ongoing learning/training practice.

How is the executive control of attention being applied when driving? A study established that the more skilled the driver, the more they scan widely. The attentional spotlight is in transit more actively. Interestingly, trained police drivers increased their scanning rate even more. (Underwood, 2007).

What are the more expert drivers ‘scanning for’ and how do they do it?

Roadcraft (2007) page 17, Roadcraft (2013) page 30 & 45, explains that the Roadcraft ‘System of Car Control’ develops full situational awareness by applying two procedures. Firstly, it defines how to use the system to process information efficiently and accurately. Secondly, the system delineates how to formulate, implement and continually adjust as required, a safe and effective plan to the driving process, thus handling any hazard.

These two procedures interact, making the Police system of car control a recursive methodology; in systems theory terms, one that uses or calls itself. In this case it is a system that positively reinforces its own information processing and controlling performance. It thereby increases the quality of the system output, hence competence of its user. The system is systematically applied. It is adaptable, being non-linear by being legitimately re-entered at any appropriate point, if required. By improving driving observation, anticipation and thinking it provides more time to react and for decision making. It crucially addresses the driving IM problems associated with declining intelligence and reaction times discussed earlier in part 1 of this research.

Proper training in the system of car control ensures this control system does not become stochastic. This is when small changes in system output being then re-input, can have catastrophically or chaotically significant changes in output results. Applying system theory, the Police system of car control (Roadcraft, ibid) is the open system’s (Fig 2) [Fig 5, Westlake, (2015)] comparator or external quality control standard. It’s there to ensure the system outputs are consistently satisfactory not stochastically unpredictable or chaotic.
2.3 Our working memory: our concurrent multitasking misnomer and achieving integrated reasoning.

Research work investigated the abilities of circa 300 air traffic control applicants. The research findings showed that intelligence and working memory capacity [WMC] are both related to multitasking, with both storage and processing components of WMC predicting multitasking performance. Intelligence is a weaker predictor than working memory. (Colom, et al., 2010).

There are interrelated means by which our working memory receives ‘data input’ (Fig 2).

i) visual observation.

Specific working memory resources, as opposed to general capacity were felt to be the limiting factor but more work was needed to relate cognitive process to a reasoning task. (Suß et al., 2002). Later work has shown vision observation skills and working memory are both significantly involved in driving information management. Working memory is essential for processing both driving tasks and visually based observation hence anticipation. But crucially both processes cannot be executed simultaneously. Driving task processing competes for working memory use and dual-tasking reduces the execution of each task, not just delaying it. (Lehtonen et al., 2012). Thus working memory is a resource bottleneck. A highly detailed overview research paper about studies of eye movements over the last 25 years concluded the effects of retinal image motion was most important for visual observation but what was optimal for a given task was not known. Planning a movement of the head and eyes and arms to facilitate the use of saccades was starting to be better understood for the higher level decision formation and lower level of movement execution. (Kowler, 2011). In the driving context, more is known about how our vision works and how to apply it effectively.

The function of our eye movements is to keep objects of maximum importance focused within the maximum resolution area of our central vision. Saccadic eye movements are used when objects are moving too fast for pursuit (tracking) eye movements to follow. (Evans, 2001, p 48). Saccades have a vital role to play, otherwise with head or eye movement we would have blurred vision. Studies of eye movements, gazes and optical flow during driving round a curve have shown involuntary movement of the eye. Optokinetic nystagmus consists of a smooth drift and flicking back of successive tracking eye movements and fast resetting saccades in the opposite direction. Between these saccades, slow eye movements occur in order to stabilize the retinal image. (Authie et al., 2011).
During a saccade we cannot see anything. Our brain blocks the image that is received whilst our eyes are moving, processing the image at very short periods of fixations. Our eyes don’t move smoothly across a scene, unless tracking a moving object brought into the centre of vision by head or eye movement. The faster the eye or head movement, the larger are the saccades and smaller the pauses or fixations. The brain fills in these information-gaps with a combination of peripheral vision and a ‘working-memory-pattern-matching assumption’. It works on the premise that what is not being seen in the vision gaps (saccades) is the same as what is being actually seen in the vision pauses (fixations). (Sullivan, 2014).

A driver in a side junction looking in your direction but continuously moving their head and eyes without pausing probably has not seen you approaching them on the main road and will pull out into your path. Thus proper observation skills must be learnt to be applied during driving. A collision could occur if the driver does not observe properly, avoid ‘blind spots’ or misses moving objects altogether or wrongly interprets their velocity vector, with its scale and direction quantity. The expert advice is to look left and right methodically several times pausing momentarily thus properly focusing on three different points on the road; foreground, middle distance and at the far vision ‘limit-point’. (Sullivan, ibid; Gilbert, 2013). Our retinal peripheral vision indicates where to look and our central most detailed fovea vision, what we are looking at. (Evans, 2001, p 49). Our binocular vision is processed by the brain to provide depth perception. (Roadcraft 2013) page 53 describes the need to learn to use a scanning motion in every direction to build up a picture of what is happening all around. But it fails to explain (Roadcraft 2013, page 54) when moving the eyes or head to do this, saccades prevent you from seeing anything at all. The scanning motion must be done correctly in order effectively to see properly, thereby allowing your mind to process the data. This is not just looking; the scanning must support momentary pauses of eye or head movement long enough to facilitate fixations, hence enable reliable information processing.

ii) further forms of open system ‘data input’

The information processing what our brain must do when driving is not just based on visual data. Additional data, in particular the gravitational and centripetal forces that act on our inner ear balance mechanism is processed into information. Ongoing research into exactly how this works already shows this too influences our gaze stabilisation, nystagmus, saccades, fixations and the optical flow of our eyes (Pettorossi et al., 2011; Authie et al., 2011).
Our brain uses data from all our senses including vibration, sound and feedback from our body about the changing position of our limbs and joints [proprioception] in exerting forces when braking or steering etc. When our eyes are in a long or short saccade, our working memory [WM] needs to ‘pattern-match’ with prior experience, to comprehend what is probably happening. Our conscious mind, (working memory), is acting as a comparator and validator applying system theory. This is achieved by working memory temporarily storing and sorting into the correct order the several rapidly taken ‘pictures’ (fixations) as the brain processes our incoming vision data into what we see. Reconciling all this sometimes conflicting or imperfect incoming data includes processing what we really see during a fixation, into meaningful information for decision making. Our working memory will also call on prior knowledge stored in our long term memory to aid this decision making. The movement of the eye gaze etc is being used for further driving research (Xianping et al., 2013) and in driver ‘attention-assist’ systems in Volvo, Ford, BMW and Mercedes vehicles. (Halpert, 2012). [retrieved 3rd July 2014].

The rate of progression or retardation of the visual limit point relative to the motion of a vehicle when approaching, negotiating and leaving a bend is used by experts in order to corner safely. (Gilbert, 2013; Roadcraft, 2013 p 172). This assists in stabilising our eye gaze and our optical flow, thus gathering relevant continuously evolving data for safe progression through the hazard. (Coutton-Jean, et al., 2009).

iii) concurrent verbalisation

A study applied both verbal reports and eye-camera methods of analysis with experienced and inexperienced drivers. The study concluded that verbal reporting by experienced drivers inferred they acquired the type and amount of information necessary for safe travelling. The study also showed that verbal reporting was not without its own problems. (Renge, 1980). A paper supported the hypothesis that ‘Commentary driving’ could decrease the accident risks of car drivers. Spolander, K (1990) cited by Westlake (2015).

A study was made of concurrent verbalisation during driving as a method of measurement. It hypothesised that verbalisation would affect both how and what drivers looked at and the cognitive task of hazard perception. The study concluded that concurrent verbalisation did not interfere with visual strategies or hazard perception. It may affect the type of protocol produced, meaning the commentary style and content must be related to the chosen driving technique to deal with different hazards. (Crundall and Underwood 1997), accessed by British Library document service 29th November 2013).
The IAM Driving Manual provides clear instruction of how and why to conduct effective observation and its contribution to advanced driving. (Sootheran, (2009) page 28-31). It briefly explains why and how to conduct a very simple commentary in slow traffic conditions. (Sootheran, (ibid, page 35). Whilst it is not part of the current IAM entrance driving exam, it says one may be required during preparation for the drive. The IAM Manual (1967) devotes all of chapter 5 to ‘Commentary Driving’ with justification for and detailed example of, a commentary that was then a mandatory requirement in the IAM entrance drive examination. It is unfortunate that a similar detailed example is not available in updated format in the more recent edition (ibid).

Other texts advocated giving a running commentary aloud about where danger lurks, explaining how each risk is identified and counteracted, helping the driver to think more deliberately. Unfortunately, the accompanying detailed example in the text is far too verbose and complex for use as an easy practical training aid. (Topper, 1970 p 16-18). A more recent text (Lyon 2012) describes a long detailed over-elaborate example of a commentary. This gives some useful ideas of what to consider but appears too verbose to apply literally in practice. It applies the methodology of ‘observation-assessment-driving plan’. This is arguably linear in nature and has the defect of this simplicity. It is not recursive or adaptable as the Police System of Car Control. Thus it is too cumbersome to easily implement as suggested it should be by Lyon (2012).

Initial training of young inexperienced trainee drivers in commentary technique in a simulator based detailed study, enabled proper application of a succinct vocabulary to the driving task and process. It improved many but not all types of hazard recognition, having a beneficial effect on driving behaviour. It suggested more specific in-depth training could improve environmental [hidden] hazard detection with improved commentary use. (Crundall et al., 2010). As researched and discussed later in this paper, achieving this is not as easy as it appears.

Like ‘fuzzy-logic’ cognitive technology information management systems (Westlake, 2015) sometimes such human driving information management processing conclusions are liable to error or are disastrously wrong. This is especially if our mind is not being applied properly to the task. How our mind is applied in all its facets is the subject of ongoing research. However current research shows more understanding, already uncovering many more important features.

There is speculative evidence that our unconscious brain processing helps combine information and problem-solving through a process known as
‘chunking’. Our brains hold only a few things in our working memory at once. Exploratory evidence suggests maybe consciousness is a way of binding components together in order to chunk them (Wilson, Clare; 2013 cited Bor, 2013). Systematic training enables the expert to integrate various parts of a complex skill into one fluent whole. Using this motor chunking, the skills have moved from the explicit to the implicit, from the conscious to the unconscious. The level of ability has graduated from novice level to proficiency. In order to improve a skill once it has been automated, it is vital to continue to undertake tasks that exceed current limitations. The performer must exert conscious control over certain parts of the skill during practice, thus building additional expertise. If you simply cruise along on autopilot, improvement stalls. (Syed, 2010, p 177-178).

3.0 Study of three interrelated methods of driver Information Management

The ability to properly involve our conscious and sub conscious thinking capability to the driving task and process is very important. It uses a combination of visual and other means of observation plus verbalisation. In applying the ‘Police System of Car Control’, (Roadcraft Chapter 2, 2013) does use of any of the following three methods of information management [IM] hinder or help? Viz:-

1. No conscious thinking effort but using a fully continuously primed subconscious. [NOT inattentive ‘auto-pilot’]
2. Conscious non – verbal thinking [trained non-verbal commentary]
3. Conscious verbal expression [trained commentary]

These three information management methods are not mutually exclusive to each other but are interrelated. Arguably both the subconscious and conscious part of the brain is involved in 1, 2 & 3. The latter is arguably being applied slightly differently between technique 2 and 3. These three propositions are investigated next.

When situations become more complicated, a driver needs more decision time therefore the overall reaction time will also be longer. Using the Roadcraft (2013) system of car control provides a structured method for rapid decision-making. It reduces decision time and provides more overall time to react to complex situations. A driver should use ‘commentary’ when distracted or preoccupied (Roadcraft p 31, 2007; p 45, 2013). Expert Police drivers are trained how to use concurrent verbalisation or commentary.
3.1. Conscious and unconscious competence: the inattentive ‘autopilot’ problem

Crundall and Underwood (1997) studied concurrent verbalisation during driving as a method of measurement, in depth. It hypothesised that verbalisation would affect both how and what drivers looked at and the cognitive task of hazard perception. The study concluded that concurrent verbalisation did not interfere with visual strategies or hazard perception. It may affect the type of protocol produced, meaning the commentary style and content must be related to the chosen driving technique to deal with different hazards. (Crundall and Underwood ibid), accessed by British Library document service 29th November 2013).

Thus concurrent verbalisation [commentary] and effective information management can improve driving by:-

- Improving our attention span, executive control and reasoning
- Applying working memory to best effect at the conscious and subconscious level, enabling us to
- Becoming higher ability drivers

A questionable argument has been made that driving proficiency can be learnt to the extent that without any conscious control, driving is practicable, enabling arrival at the destination without even being aware of how you got there. Whilst doing the task this way, the driver’s mind has been on other things, such as what to make for dinner. The argument claims the skills have moved from the explicit to implicit, from the conscious to the unconscious, and the ability has graduated from novice level to proficiency. (Syed, 2010).

In the writer [DCW] of this paper’s view, the above sort of belief in inattentive ‘autopilot’ is a very dangerous fallacy. Many drivers are unaware of the hazardous nature of this type of misplaced competence. This view is supported by the IAM Chief Examiner. It is wrong to drive on ‘autopilot’ and therefore not pay full attention in an environment in which the risks are potentially life threatening. (Rodger, Peter; Email 19th September 2013, Personal Communication).

By proper tuition, control and coordination, some physical movements such as riding a bike for example, do become automated or ‘unconscious’. Our ‘muscle-memory’, more correctly proprioception, provides coordinated feedback to our brain from our limbs and body. Our body and brain together have been sufficiently trained about how to conduct the riding task and process.
But each time a drive or ride is undertaken, conscious competence is required throughout in order to ‘read the road’ in its fullest meaning. Arguably, this conscious thought process has to be properly managed, by information processing or management at all times. This is particularly important for two reasons. The first is in order to avoid performance degradation due to consciously thinking of how to apply the necessary physical and decision making coordination skills, especially whilst learning new ones. The second is the danger of poor observation. Research has shown that some 30% to 50% of attention is given to other objects not related to driving. Only about 15% to 20% of attention is given to traffic control devices which is argued is not sufficient to ensure that all or even most traffic control devices are noticed. (Hughes et al., 1986). This finding is analogous to using dangerous ‘inattentive-distracted autopilot’ as described above and the solution about how to solve it is explored below.

There is more to information processing than that conducted at the conscious level. It is this writer’s premise that it is not just the above colloquial ‘inattentive auto-pilot-mind-focused-elsewhere’ phenomenon described above by Syed, (ibid). It takes longer to react to unexpected events than to expected ones, needing less thinking time if you are anticipating events and not just reacting to them. (Roadcraft, p 107, 2013). The work of Libet and MRI studies conducted more recently, showed subconscious neuronal cognitive processing activity preceded conscious decision making by nearly half a second. This makes the case that unconscious information processing may help make decisions. (Wilson, Clare; 2013, citing work of Libit in 1980’s).

Roadcraft (2013) page 50 states trained drivers are constantly monitoring risks at a subconscious level so they’re ready to respond quickly if the situation develops. The subconscious will have a large number of mental representations created by unconscious information processing, consciously selected for high level decision making. (Anderson 8th March 2014, citing Dehane; 2014).

Arguably therefore this writer’s [DCW] premise in the context of driving, is that in order to do it properly, the subconscious decision making activity needs continuously ‘pre-priming’ with relevant updated information from our senses. This is by real observation, attentively scanning continuously for full ‘situational awareness’. This proposition is given support by studies into how conscious and unconscious vision processing and perception takes place. (Tapia and Breitmeyer, 2011). It is only by properly reconciling the ambiguity of the background ideas in our minds, with the latest relevant data update from our surroundings, that we ‘validate’ our current perceptions and decision making.
The neural mechanisms that underlie consciousness are still not fully understood. A region of the brain called the claustrum is an important part of the architecture. (Koubessi et al., 2014). This is supporting the earlier hypothesis proposing its significant role as the key information processing interface; acting as a hub with many of the networks of the brain. (Crick and Koch, 2005). Ripley postulates human intelligence is using a synaptic architecture that has learnt the technique and stored the experience in changes of the strengths of the synaptic weighting, more than changes in the brain’s neural network topology. (Ripley, 2008).

Our conscious vision contributes to our conscious awareness and perception. (Blake, et al., 2014). The dense concentration of visible light receptor cells in the central area of the retina has the most nerve connections to the vision processing region of the brain. (Evans, 2001, page 49). The architecture is being argued about but vision processing may be being performed in feedback to a series of earlier neural network layers of this massively parallel distributed computation (Ripley, 2008, page 146).

Regular examination by qualified ophthalmologists of a driver’s eyesight is very important. Thus have any required treatment and prescription. The Highway Code minimum vision requirement is reading a number plate in good daylight from 20 meters with glasses or contact lenses (Rule 92) if worn. It is not assessing twilight, night vision abilities, and colour blindness problems. It is wise to keep a vehicle’s windscreen and if worn spectacle/contact lenses as clean and clear as possible. This is to handle difficult lighting conditions, glare from oncoming headlights and low angled sunlight.

The danger is when concentration lapses or wanders ‘off-topic’, observation standards decline and driving becomes reactive. The driver is looking but not positively seeing hazards or potential hazards. Arguably, the dangerously ‘inattentive-autopilot’ is engaged and the subconscious is no longer being continuously primed with valid up to date information to aid driving information processing and decision making. The conscious and unconscious parts of our mind are distracted elsewhere. How much it is fully or partially diverted is hard to quantify at any one moment but the impact of not properly paying attention can be very detrimental to driving performance.

### 3.2 Significance of Initial LR Findings about human driving information management

An initial conclusion is that only the ‘Expert Drivers’ have the above necessary level of training and detailed knowledge of Roadcraft (2013 or 2007) to apply the above information management and associated expert driving techniques.
This raised important issues about how to address this problem of gathering reliable evidence and then apply it in how to develop the abilities of non-expert drivers to use better information management practices. Roadcraft (2007) page 48 indicates very clearly that becoming a better driver is related to achieving better information management.

How easily are expert police drivers and instructors applying the information management techniques as prescribed in Roadcraft (ibid)? What more could be learned from this large amount of experience and expertise that resides in the skills of expert drivers? With the initial help of the Institute of Advanced Motorists [IAM] and later the ‘good-offices’ of the Police Foundation, further research and investigation was conducted in order to answer these questions by survey about driving information management. A qualitative survey study of police drivers showed when at work, these expert advanced drivers formulated a ‘topography of risk’ being highly aware of risks posed by other drivers (Dorn and Brown, 2003).

4.0 Research Methodology for this study.

Hughes & Cole (1986) p 379, cited the work of Ericson and Swan (1980) who argued that driver’s reports can be regarded as valid data when asked to think out loud. This finding could be applied in order to research ‘Driving – an information management approach’. Practical evidence of trained drivers applying different information management techniques was both required and obtainable. There are different ways this ‘data capture’ could be accomplished. Research showed that a particular case recalling features in a questionnaire about an actual ‘live’ drive, compared with the same drive, recorded and shown in a laboratory, achieved equivalent results. (Hughes, et al., 1986). Survey questionnaires have strengths including ease of circulation plus adaptability and weaknesses including being time consuming to complete and being subjective opinion based.

4.1 Questionnaire of driver responses to a series of structured questions

For simplicity and veracity, a small focus group was considered applicable for this study. The three different methods of information management being discussed in Part 2 of this paper [see section 5.0] were investigated. In practice, it is difficult to properly separate them when conducting the driving task. They are not mutually exclusive but interrelated as now being investigated then discussed in this paper. It was found formulating suitable questions proved difficult to do. The safe use of ‘live-road’ conditions was the biggest problem. One practical approach would be to conduct similar drives, the first by applying
continuously primed subconscious thought, the second internally thinking and
the third verbally expressed thinking, to the driving task and answer the
questions before their experience was forgotten. Whilst being ‘real’ the
significant defect is in its ‘single-case-study’ simplicity. No two drives would
ever be the same. It is not a comprehensive sample of the huge range of driving
conditions or situations and effective use of information management that class
1 police drivers have.

4.1.1 Trained Experts

A structured multiple choice questionnaire was issued to a focus group made up
of serving expert police drivers, police driving school instructors or former
instructors. This included the Roadcraft (2013) Reflective [expert] Practitioners
Group who revised and updated the text. The focus group included members of
the Police Federation’s ‘Steering Committee’ overseeing the Roadcraft (2013)
revision. The biggest problem proved to be with defining the first type of
driving and ensuring it was safe to put into practice on a ‘live-road’. Thus after
extensive consultation with some of the above experts, the questionnaire was
made a ‘desk-bound’ survey of expert opinion, not a ‘live-road’ drive.
Arguably, this made it a more representative study of expert opinion about
driving information management techniques.

4.1.2 Inspection of the Table 1 Results

Inspection of the basic tabulated replies in Table 1 shows all of the respondents
agreed that they had been trained in conducting a driving commentary whilst
being trained themselves at police driving school. They all agreed full
situational awareness required ongoing information management during a drive.
All except one agreed information management is the operating envelope within
which all stages of the police system of car control apply. The majority agreed
or strongly agreed the system of car control was the most efficient way to
process information.

4.1.3 Summary Data Analysis and statistical findings

Basic Data Expert Driver Survey Results Table 1

Objective:- This survey is about three different methods of information
management [IM]. 1) Unconscious [but fully trained] attentive ‘auto pilot’, 2)
non-verbal and 3) fully verbal commentary. Experts clearly marked a circle
around one of the ‘radio button’ choices for each question that most closely
agrees with their opinion based on expertise and experience.
<table>
<thead>
<tr>
<th>Question</th>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>I have been trained how to conduct a verbal commentary.</td>
<td>I</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2</td>
<td>Full ‘situational awareness’ requires ongoing IM in a drive.</td>
<td>II</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q3</td>
<td>IM is the envelope within which all stages of the system of car control apply.</td>
<td>I I I</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Q4</td>
<td>The fully verbal commentary is considered the most helpful IM method, encouraging proactive driving.</td>
<td>III</td>
<td>II</td>
<td>I</td>
<td>III</td>
<td></td>
</tr>
<tr>
<td>Q5</td>
<td>Non-verbal conscious commentary not as effective as Q4.</td>
<td>III</td>
<td>II</td>
<td>I</td>
<td>III</td>
<td></td>
</tr>
<tr>
<td>Q6</td>
<td>Applying subconscious ‘competent auto pilot’ is the least helpful method, compared with method Q4 or Q5.</td>
<td>III</td>
<td>III</td>
<td>I</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Q7</td>
<td>Lapses of concentration can occur more with ‘auto-pilot’ compared with non-verbal thinking or verbal thinking commentary, encouraging reactive driving.</td>
<td>III</td>
<td>III</td>
<td>I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q8</td>
<td>The ‘system of car control’ still can be applied effectively whatever method of Information Management is used.</td>
<td>III</td>
<td>I</td>
<td></td>
<td>III</td>
<td></td>
</tr>
<tr>
<td>Q9</td>
<td>Applying the ‘system of car control’ enables the most efficient and effective means of processing information.</td>
<td>II</td>
<td>III</td>
<td>III</td>
<td>I</td>
<td></td>
</tr>
</tbody>
</table>
Q10 | All necessary observation ‘linkages’ are still achievable, whichever IM method used. | III | I | III | I
---|---|---|---|---|---
Q11 | Without due diligence achieved by fully applying IM, ‘Street furniture’, contributes to driver ‘Information Overload’. | I | III | II | II
---|---|---|---|---|---
Q12 | Roadcraft textbook should contain instruction how to conduct a commentary to help train-up new expert drivers in its use. | I | III | III | III
---|---|---|---|---|---

Recasting the table 1 raw data results into a ‘weighted-tabulation’, ranking 5 as ‘strongly agree’, 4 as ‘agree’, 3 as ‘neutral’, 2 as ‘disagree’, and 1 as ‘strongly disagree’ from the raw data returned by each respondent, created suitable results for further small sample size analysis as shown in Table 2.

**Weighted Score - Table 2**

<table>
<thead>
<tr>
<th>Person</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
<th>Q7</th>
<th>Q8</th>
<th>Q9</th>
<th>Q10</th>
<th>Q11</th>
<th>Q12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
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<td>2</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Even though the sample size is small, *t*-test statistical analysis shows the following measures of central tendency viz:-
Descriptive Statistics Results – Table 3

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>9</td>
<td>4.00</td>
<td>5.00</td>
<td>4.889</td>
<td>0.333</td>
</tr>
<tr>
<td>Q2</td>
<td>9</td>
<td>4.00</td>
<td>5.00</td>
<td>4.778</td>
<td>0.441</td>
</tr>
<tr>
<td>Q3</td>
<td>9</td>
<td>2.00</td>
<td>5.00</td>
<td>4.333</td>
<td>1.118</td>
</tr>
<tr>
<td>Q4</td>
<td>9</td>
<td>2.00</td>
<td>5.00</td>
<td>3.556</td>
<td>1.333</td>
</tr>
<tr>
<td>Q5</td>
<td>9</td>
<td>2.00</td>
<td>5.00</td>
<td>3.556</td>
<td>1.333</td>
</tr>
<tr>
<td>Q6</td>
<td>9</td>
<td>2.00</td>
<td>5.00</td>
<td>4.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Q7</td>
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<td>5.00</td>
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<td>0.972</td>
</tr>
<tr>
<td>Q8</td>
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<td>2.00</td>
<td>5.00</td>
<td>3.889</td>
<td>1.453</td>
</tr>
<tr>
<td>Q9</td>
<td>9</td>
<td>1.00</td>
<td>5.00</td>
<td>3.556</td>
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<td>1.00</td>
<td>5.00</td>
<td>3.000</td>
<td>1.581</td>
</tr>
<tr>
<td>Q11</td>
<td>9</td>
<td>2.00</td>
<td>5.00</td>
<td>3.444</td>
<td>1.014</td>
</tr>
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<td>Q12</td>
<td>9</td>
<td>2.00</td>
<td>5.00</td>
<td>2.667</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Valid N (listwise) 9

Chart 1 – Question Weighted Table Mean Scores

Applying the ‘t-distribution’ for small sample statistics at the 5% confidence level in a two-tail test about the ‘neutral’ column value of 3 as the central measure of dispersion, provides the following results.
Small Sample #t - Distribution Analysis Table 4

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>4.889</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Q2</td>
<td>4.778</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Q3</td>
<td>4.333</td>
<td>0.007</td>
</tr>
<tr>
<td>Q4</td>
<td>3.556</td>
<td>0.247</td>
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<tr>
<td>Q5</td>
<td>3.556</td>
<td>0.247</td>
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<tr>
<td>Q6</td>
<td>4.000</td>
<td>0.017</td>
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<tr>
<td>Q7</td>
<td>4.222</td>
<td>0.005</td>
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<tr>
<td>Q8</td>
<td>3.889</td>
<td>0.104</td>
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<tr>
<td>Q9</td>
<td>3.556</td>
<td>0.302</td>
</tr>
<tr>
<td>Q10</td>
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<td>1.000</td>
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<tr>
<td>Q11</td>
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<td>0.225</td>
</tr>
<tr>
<td>Q12</td>
<td>2.667</td>
<td>0.347</td>
</tr>
</tbody>
</table>

The results are statistically significant if their P-Value is less than 0.05 or a 5% threshold in Table 5, or in the Significance column in Table 4.
The Q1, Q2, Q3, Q6 and Q7 results are statistically significant as their scores at the 0.05 or 5% level are significantly better than expected compared with the neutral datum level score of 3. The remaining Question result P values all exceeded the minimum 0.05 threshold thus were not statistically significantly different to what was expected.

A similar analysis using a single-tail *t* distribution test of significance using ‘Strongly Agree’ score of 5 as the central measure datum produced the same results with the p-power values being halved. Applying the ‘neutral’ measure datum enabled analysis using a two-tail *t*-test. This supports a wider statistical interpretation, thus was the chosen datum measure.

*The above analysis was conducted in MS Excel. Ref: Article:- ‘One sample t-test’, when the sample may not be normal but is reasonably symmetrically distributed around the measure of central tendency or mean.*

http://www.real-statistics.com/students-t-distribution/one-sample-t-test/

The skewness coefficient and kurtosis values are not that of a normal distribution. (Yeomans, 1968). However the median, mean and mode were very similar taken across all the answers. Rearranging the Q order score summations from Table 2 evenly around the maximum value produces an indicative scatter diagram that appears approximately ‘normal’ viz:-
The use of a t-test for small samples was thus a reasonably valid method to investigate the dispersion compared to a neutral datum score of 3.

**Neutral Interpretation of the results**

Interpretation of the above P-Values in Table 5 and inspection of Table 1, together tends to indicate the Expert Group statistically significantly agreed with the following rank order of IM technique:

1. No conscious thinking effort but using a fully continuously primed subconscious, NOT inattentive ‘auto-pilot’.
2. Conscious non–verbal thinking [trained commentary]
3. Conscious verbal expression [trained commentary]

Ranking 1 as the least effective, next 2, followed by 3 as being the most effective method of implementation of information management within the police driver’s system of car control. The results showed statistically significant agreement of the experts that driving by ‘inattentive – autopilot’ caused reactive not proactive driving that effective information management technique facilitates.
4.3 Replies received in the ‘additional comments’ section of the survey.

Members of the Expert Group all had some strongly held views about the basics of effective information management [IM] and how it should be achieved.

One believed it could enable an examiner/trainer to understand how well a trainee is conducting effective information management. The instructor had experience of some trainees achieving good information management without a commentary and poor information management with it. This finding is perhaps counterintuitive but indicated the added stress conducting a commentary when driving. This could entail poorer performance until properly trained in what to say, plus when as well as how, to say it, to at least a minimum acceptable standard.

One expert believed that commentary training could only be successfully achieved by personal instruction. Commentary could not be properly taught ‘out-of-a-textbook’. Another expert believed that driving on ‘autopilot’, even as a trained expert, led to one’s eyes looking at the foreground and reactive driving. The expert advised that by use of a fully verbal commentary, scanning resumed for the whole of the field of vision and re-established proactive driving. One instructor noted that some necessary observation links could be wrongly omitted or misread when conducting a commentary. Only by making the commentary verbal, would the errors become known at the time. One expert replied that even information management using ‘trained–autopilot’ the driver would formulate a partially valid driving plan by using only some of the available information, due to lack of concentration leading to poor observation and anticipation skills. Another expert respondent argued that the main purpose of a commentary is to assist a driver maintain a high level of concentration on the driving task in hand.

A further expert found commentary very difficult to do and for an average individual, a difficult skill to learn to apply because it added an extra level of complexity to the driving task. Many of the expert instructor’s students showed a dip in driving skills whilst splitting concentration in order to learn and apply this additional skill. He therefore concluded commentary is not integral to making roads safer for all its users. One instructor stated that commentary is another training tool that may have a place within driver training.

Another found commentary impaired their car driving because it was confusingly taught by different police driving instructors at his driving school, stipulating different requirements. They were thus disagreeing with each other what was acceptable. Therefore there are conflicting opinions and techniques
about the use of commentary for driving or as a training tool. The police driver asked for ‘Roadcraft’ (ibid) to explain how. As one respondent observed, you don’t need commentary on its own, it’s part of the overall system of car control.

5.0 Discussion

5.1 Better Applied Driving Reasoning [aka Information Management]

Colom, R. et al (ibid) [see 4.3] claim working memory capacity [WMC] is a better predictor for multitasking performance. It can be argued that whilst our reaction times and intelligence level are generally speaking ‘given’ attributes for any particular individual assuming they are not downgraded by drink or drugs, that individual can according to Schweizer, K et al (ibid) by executive control of attention and additionally a learning process, improve their reasoning ability. Ideally this improvement should be up to the maximum capability available. Accepting the premise that information management is reasoning by another name, the question then arises about what is achievable by applying better reasoning, in order to improve driving.

Arguably, verbal commentary provides structure and explicit organisation of our thought processes. It suits many people, improving their attention focus on task and process, hence driving ability. Commentary does not suit everyone. Some expert drivers found it extremely difficult to do. They believed it impaired or did not contribute to proper concentration on task and process. Whether or not verbal commentary helps, turns on whether the additional level of complexity it adds to the driving task enables the driving process to be improved. If at the level of each individual it does enable improvement, apply it. If it does not, don’t, would appear to be the mantra. Arguably this indicates different capabilities of verbal IQ are distributed across the population. The shape of the distribution needs fully identifying by further research but some is available already (Isler 2008 et al).

Either way by concurrent verbalisation, [vocal or thinking silently]:-

1. increasing our attention span and observation skills
2. applying working memory to best effect at the conscious and subconscious level
3. together should lead with ongoing expert training to becoming higher ability drivers

Done well, verbal commentary applying the Roadcraft (2013) chapter 2 ‘system of car control’ [or earlier versions] engages the mind fully on the driving task
and ensures that performance is continuously monitored and improved, avoiding any drop in driving standard, especially in difficult driving conditions. Done badly, the writer [DCW] found commentary is a hindrance, confirming the point made in Gilbert’s (2007 ‘Commentary - Adding Speed and Mirror’) tuition DVD. The case being made is that verbal commentary and non-verbal thinking, effectively engaged both the conscious and unconscious processing part of the mind’s ability to process information and manage driving coordination. The writer [DCW] found it was easier to avoid lapses in attention using a verbal commentary, compared to a non-verbal one. Concurrent verbalisation also enabled extended periods of highly active reasoning to be maintained on long journeys thus combating fatigue. Combined with using the visibility limit point technique (Gilbert 2013), it enabled much more enjoyable, proactive ‘stress-free’ motoring. Arguably ‘commentary’ - explicit verbalisation, provides practical executive control of attention and best use of working memory to achieve the desired level of ‘multitasking’.

However concurrent multitasking is a misnomer [see 4.3 (i)] - apparently our working memory does not multitask effectively several tasks in parallel but could be more practically understood as iteratively ‘time-slicing’ its processing task priorities in series until a task/process is completed. Unfortunately if our working memory becomes ‘overloaded’, partially uncompleted tasks may be discarded from the ‘buffer’ or task inventory; being now considered ‘lower priority’ than the recent new ones, Thus some truly vital tasks are discarded even though incomplete. This is distinct from long-term memory that could be considered as having the ability to parallel process many tasks and processes in the background, consciously or unconsciously but is difficult to access them into our working memory without continued training and experience.

Thus there is a learning threshold, metaphorically, a ‘pain-barrier’, or difficulty level crossover performance point that is akin to learning to ride a bicycle for the first time. Cross that threshold and concurrent verbalisation becomes a powerful tool, an aid. Not being able to cross that threshold means that verbal commentary of conducting the driving plan formulation concurrently with the driving plan implementation is a hindrance not a help. In this case, non-verbal thinking or reasoning should apply and be deployed arguably as effectively if diligently applied. The writer [DCW] found by really very diligent concentrated effort, continuous non-verbal thinking commentary to one’s self could be developed to achieve similar standards of performance. It was not easy to learn how to continue to maintain it drive after drive without allowing attention distraction.
An expert, well written driving manual from before the modern era of IS/ICT states there is no substitute for good instruction, a point still valid today. But it then goes on to argue that a ‘Do-It-Yourself’ advanced driving kit did not and never will exist (IAM Manual., 1967, page 16). This latter claim predates the IT revolution and the growth in DVDs et al., which now provide comprehensive driver training aids to class 1 police driver level, including how to develop commentary skills. (Gilbert, ibid). When also supported by individual ‘one-to-one’ personal driving tuition (Gilbert, ibid) or the IAM’s own ‘Observer-runs’ and training programs, such weaknesses can be turned into strengths and enable taking the IAM ‘Masters Drive’ Program, arguably the toughest civilian driving exam available to class 1 Police level.

Why is verbal commentary and probably non-verbal driving commentary difficult for some people to learn? A major wide-ranging in-depth study of young adolescent drivers, found verbal fluency, control of inhibition and verbal IQ all contributed to being able to conduct an effective on-road commentary whilst driving and thus achieved better hazard recognition (Isler 2008 et al.,).

Vision is affected by vehicle speed and explains that our eyes do not naturally look at the road horizon in order to gather all the knowledge available and necessary to conduct a safe drive. (Gilbert 2013,’Natural Focal Point’, DVD disk 1, set 3) This expert adjusts his verbal commentary content to explain this accomplished information processing skill (Gilbert, ibid, ‘Effective Vision Scans’ disk 1) and demonstrates 360 degree effective vision scan awareness in heavy traffic. This is using the vision ‘limit point’ and extensive observation – linkages, supplying a commentary of the reasoning process involved. (Gilbert, ibid, disk 2 ‘London Run’). The DVD set demonstrated the limit point technique, ‘eyes-on-main-beam’ and active scanning in the short, middle and far distance in front, both sides and behind can deal with ‘information overload’ from ‘street furniture’ if applied properly. (Gilbert, ibid).

Arguably verbal and non-verbal commentary is giving order and meaning to the reasoning process. When able to do it effectively by either way, this type of information management supports rapid and effective transitive observation scanning and information processing. This is a view supported by Gilbert, (2007) ‘Epilogue’, who believes the commentary thought process will continue, when not putting your thought process into words.
6.0 Conclusions, Recommendations for future work

Our strength is our mind’s adaptability and ability to learn from mistakes. Its weakness is its unreliability in processing information. This unreliability is related to its unfortunate problem of short and long term recall and limited working memory capacity. To deal with this problem, the important role of trained verbal and non-verbal commentary in order to apply sound Information Management skills to observation, hazard prioritisation and executing driving plans is significant. The findings of this study reconfirm the practical wisdom of Hendon, the Metropolitan Police Driving School, developing and applying many years ago the use of a commentary when driving.

The overall premise is that by sound observation, gathering all relevant types of data, by using non-verbal and even better, verbal commentary, thereby processing the data into meaningful information, that valid effective decision-making is achieved. Continuously pre-priming our subconscious by active observation scanning and concurrent verbalisation enables subconscious and conscious competence to be applied fully and effectively to the driving task. Trained expert drivers know how to do this well.

Less able and inexperienced drivers will probably struggle because they are unlikely to know how to. By personal effort and encouragement, this problem can be practically solved at minimal cost. A practical solution is available in the public domain about learning how to do expert commentary. This should equip the ‘average motorist’ with the ability to drive well in all reasonably foreseeable driving conditions. Thus self-motivated training can provide a vital role.

Dorn and Barker (2005) successfully used a simulator to study the effects of driver training on police and non-police trained driver performance assessing the implications for driver training assessment and skill development. In order to attract the required amount of public support from ‘non-expert’ drivers and effective media attention, fully equipped regional ‘Driver Awareness’ simulator centres should be set up. This is an upgrade from the very good existing ‘young-driver’ training centres currently available. The simulators should be similar or equivalent to those used to train pilots on different types of aircraft or Formula 1 etc training simulators. They would simulate the handling characteristics of different vehicle types, makes, road traffic conditions, distractions and terrain, thus imposing realistic yaw, pitch, roll and centripetal forces onto the vehicle and its occupants. This road research laboratory cabin should include rear and side views and mirrors with 360 degree and full surround audio-video including concurrent verbalisation for day, night, twilight and bad visibility and other adverse road conditions. The advanced telemetry should handle all necessary
technical data including but not limited to visual acuity studies including
saccades, fixations, eye-path focusing points on the road, lateral, longitudinal
displacement, angular and linear velocity, acceleration, momentum, steering
angle, slip angle et al for advanced research purposes. Researchers should be
able to book time on it like that of a major research telescope array, thus support
ongoing human intelligence, computing cognitive technology and mixed
system research ‘proving ground’ that can only be laboratory based. Such
regional facilities should provide ‘bookable-time’ for voluntary or mandatory
driver re-training and education for all ages and abilities in a safe, non-
competitive and informative environment.

Roadcraft (2007, page 13) advises the need to recognises one’s personality type
and unwanted behaviour patterns associated with it. Achieving such self-
awareness of one’s ‘driving-personality’ strengths and weaknesses is a real
challenge and the above facilities should help address this problem.

7.0 Final Summing up

Many people may believe IM/IS/ICT only changes the way we work, do
business and communicate, viewing it as a means to an end. However, when
driving, it is a vital end in itself. Taking, using and giving information,
concentrating on properly engaging our minds to the task of information
processing, enables proactive, not reactive driving. Thus being competently
equipped with effective driving – information management skills, enables a
driver to handle all driving conditions and have a safer yet much more
enjoyable driving experience.

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M.I.A.M.

March, 2015

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9.0 Conflict of Interest Statement

The author reports no conflict of interest related to this work.

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