Driving – An Information Management Cognitive Approach: Solving the inattentive human ‘autopilot’ problem by effective communication and information management. Part 1 of 2. [Indentifying the problems]

By

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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 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. Effective driving information management achieves proactive driving; inattentive ‘autopilot’ or other poor techniques leads only to dangerously reactive driving response.

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
This research paper is in two parts. Part 1 identifies the problems and part 2 investigates the solutions, studying the role of effective communication in improving driving information management. The variation in road traffic conditions, inclement weather, types of hazards and adverse driving behaviour of many but not all motorists combine together to make driving a complex and sometimes difficult task. This study applies information management theory. It identifies communication is taking place internally and externally across system boundaries in order to properly deal with the different driving conditions. Properly handling all driving conditions requires a strategic, tactical and operational approach. The information management and information systems including the human driver must have fully functional parts to provide management control of the driving plan implementation. The major open system features are shown below [Fig 1 & Fig 2]. The system parts are significantly linked together for control purposes.

To deal with road traffic conditions, effective information management is required at the strategic, tactical and operational levels for every journey. For example in difficult winter driving conditions during or after heavy snow some ‘answers’ are required. Is the trip really necessary? What hills or route should I avoid? What route is passable or most suitable? Is the data reliable? Is my vehicle and myself properly equipped for the trip and what emergency plans and equipment is in place? A driving IM taxonomy sets out these interrelated parts and information management hierarchy. Westlake, (2015).

Fig 1

Driving – An Information Management Taxonomy

With acknowledgments to Anthony (1965) and the later addition Davis (1974).
Anthony viewed all the parts of his management taxonomy significantly linked together for control purposes. The parts are linked together by effective channels of communication.

Communication theory was significantly defined and developed in a seminal paper that enabled the growth of information systems we know of today. The paper contained important counterintuitive ideas. The more random the content appeared in the data stream, the more information was contained within the message flow. (Shannon, 1948). The more random the data content the more processing has to take place to convert data into meaningful information.

Information is the meaningful content of a message. It is encoded using a system of symbols, transmitted via a channel, and decoded again on receipt. The quality of the transmission can be degraded by many reasons, making the message content eventually indecipherable. The full meaning intended by the sender needs to be fully comprehended by the receiver rapidly enough when driving to handle the prevailing driving conditions. Thus the transmission’s integrity, quantity and quality is vital in conveying the complexity of the message content. (Westlake, 2015).

Unfortunately in system theory terms, effective communication is not always taking place between the various sub-system components and the driving information processing and decision making is not always satisfactory.

The sentient human mind uses experience, intuition and hopefully rational decision making to develop ‘answers’ to these typical questions posed in the 2nd paragraph in the introduction, often using highly imperfect or dubious data. It is difficult to envisage computer cognitive technology-based autonomous driving systems being sufficiently capable to accommodate this flexible, highly uncertain and often very imperfect strategic decision making. They may work more effectively at the operational and functional level. (Westlake, 2015). Based on information in the public domain outlining how they could possibly work, these fully autonomous driving systems will input the destination address and work out a route using preset selectable criteria, like a satellite navigation system does today. Unless they are ‘sentient’ (Westlake, 2015) it is unlikely valid strategic thinking will have taken place which the human mind is capable of conducting.
2.0 Nature of the human driving information management problem

The basic human intelligence driving system components and prime communication channels are as follows (Fig 5, Westlake, (2015)):

For a computer cognitive technology [CCT] system the parts can be connected by a significant number of ‘closely coupled’ inter-communication channels. This complex configuration can be subject to disruption. Each communication channel between the system parts must be fully maintained. (Westlake, (2015)). However a human intelligence [HI] system is not closely coupled in a similar deterministic sense and may not perform as desired or expected for a variety of complex reasons. Human intelligence based communication channels may not be sufficiently dependable. These communication channels require ‘active maintenance’ in order to control the different driving conditions. This research study investigates how this ‘active maintenance’ can be achieved. It can be effectively applied in sentient computer cognitive technology driving systems as well. (Westlake, (2015)).
2.1 Literature Review

A former Chief Examiner of the I.A.M. described

“…driving a vehicle as a problem solving activity, and the four key skills of driving – concentration, observation, anticipation and planning – are intellectual skills that we co-ordinate with our handling skills to deal with the problems that confront us on the road……”. (Lunn 1996, page 25-26).

This raises important issues about the capability of human intelligence in dealing with different driving conditions. Why is this particular type of intellectual problem solving activity not carried out as well as it should be? How can improved information management and information systems address this poor performance?

Expert police and advanced drivers apply improved observation and anticipation skills, types of commentary supporting reasoning and further vehicle control techniques. These combined techniques make the overall performance greater than the sum of the system parts, producing a synergy.

2.1.1 Role of Human Information Processing in driving

We take, use and give ‘Information’ as part of our everyday lives, taking its processing and management for granted. With poor driving, it is obvious it is being processed very badly as a driver’s mind is not properly working on the task. Furthermore the human driver may well believe they are driving properly when in fact they may not be for the driving conditions or situation. Effective computer cognitive driving technology can significantly assist in solving this problem in human driving (Westlake, (2015).

Take two common occurrences. ‘Tail-Gating’ or use of excessive speed for the road traffic conditions in a stream of traffic on a typical motorway, dual carriageway or ordinary road when the ‘two-second’ rule is not being applied. Both examples indicate a lack of objective observation and hazard perception.

The Scottish traffic Police Driving School advised the writer that it’s just not about hazard perception. It is more about dangerous driving. Drivers believe they are safe at these distances and can react if something happens when in fact they can't, being unaware or forgetting stopping distances. That's a primary cause of collision. (Inspector Darren Foulds Personal Communication at a meeting at the Police College at Tullyallen Castle and exchange of email 25th March 2013). All vehicles and drivers are not the same but all must obey the
‘laws of physics’. Vehicles have different stopping distances according to the driving conditions and vehicles fitted with the latest technology can stop in shorter distances than shown in the Highway Code. However some vehicles may take even longer to stop than expected in the Highway Code (Rule 126).

What can be done to avoid ‘tailgating’ and other similar dangerous practices? An answer within the ‘laws of physics’, has been available for some while.

If the vehicle ahead slows, **Active Cruise Control** [ACC] keeps you at an appropriate distance behind it by automatically slowing your car. When the vehicle ahead picks up pace again, ACC returns you to your desired speed, maintaining a safe gap at all times. (BMW, 2003). The technology is slow in being adopted but its prevalence is increasing in recent ‘new-build’ vehicles.

However unless such systems are made a mandatory ‘retrofit’ which is technically difficult and very unlikely in the ‘used car market’, an immediate solution to poor driving, properly involving our minds, is therefore still urgently needed.

Applying system theory, system feedback is not being comprehended properly by the driver then acted upon correctly. The feedback is not effective. The system process isn’t modified or enhanced to bring the process back under proper control. Also, an effective external standard or ‘comparator’ is not being properly applied. This problem is not new, is stubbornly difficult to solve and yet as this writer argues in part 2, (Westlake, 2015), effective practical solutions are available.

2.1.2 Stubborn Problem to Solve – initial gathering of some evidence

There are many reasons, some of which may be more obvious than others to identify and practically solve. Much research work has and is being done by many people and university research teams. Many research papers have in-depth detailed statistical analysis about the parameters studied. Several applicable examples from this large body of published work are very informative.

One researcher found that the driver’s understanding of the task developed with experience and novice drivers do not show this sensitivity to road complexity nor observe hazards as well (Underwood, 2007). Another team of researchers observed aggressive driving was related to personality variables, such as hostility, sensation seeking, and competitiveness. (Harris et al., 2008). Sometimes the findings are counter intuitive, finding high-aggression drivers did not underestimate risk. (Davis et al.,1998). Others
investigated more issues about measuring drivers frustration, finding it decreased awareness of potential danger. (Lee, 2010).

Interestingly a researcher found the use of information is adversely affected by time pressure caused by traffic congestion. (Stern, 1999). Drivers could have an inflated opinion of their own hazard perception skills. (Horswill et al., 2004). Later the research team found that experienced drivers underperformed in hazard perception and had little proper appreciation of their skill level. The study also found that for effective training, positive feedback was important and both experienced and expert police drivers benefitted from it. (Horswill et al., 2012). The former point about hazard perception is disturbing, the latter point about positive feedback much more encouraging.

Experienced but inexpert drivers may become complacent, suffering boredom when processing information largely at the automatic level. Desiring a higher arousal level, drivers are searching for thrills, with fast or careless driving at minimal safety margins. (Michon, 1978). There is not a correlation between explicit driving ability that recognises the need for both skill and appropriate caution working together. Instead drivers are resorting to achieving increasing task demand satisfaction by speeding, mistakenly believing driving skills alone are sufficient. (Harre et al., 2007).


As part of the literature review a brief illustrative empirical study gathers evidence of the many changes that have taken place over circa the last 130 years.

3.2.1 Automobile introduction & road layout complexity

The information processing requirements placed upon drivers have increased substantially. During the period from the late Victorian / early Edwardian era, broadly from when the automobile was first introduced circa 1885 it has developed to the highly designed, built and equipped vehicles of today. Anecdotal evidence in pictures and current experience illustrates the huge changes since the early 20th C, in both ‘Street Furniture’, road layout [hence information] and vehicle appearance [hence capability].
Princes Street from the West (c1920) A view looking eastwards along Princes Street shows the Royal Scottish Academy building on the right and beyond that the towers of the Scott Monument and the Balmoral Hotel. There are an open-top tram and old-fashioned cars on the road and in the foreground a cart with two large baskets on it. There are many people walking past the canopied shops.

Photograph by Inglis, Alexander Adam from the Edinburgh and Scottish Collection © With permission of The Edinburgh City Libraries www.capitalcollections.org.uk

3.2.2 Modern Street Furniture and Information Processing Overload

Progressively more and more street furniture has become ‘built-in’ to our road layout in an endeavour to make our roads safer.
By June 2014, a similar view of Princes Street and its environs has become a much more complex area. It has one-way traffic management systems, yellow-box junctions, segregation of vehicle types with bus lanes and mixed traffic streams with the reintroduction of trams. These are all combined with higher traffic speeds and densities. Drivers need to commit being in the right position, speed and gear etc with effective information management in order to negotiate this junction by taking appropriate action some distance before it, within it and on exit from it. They are then faced with similar complexities at the next junctions they come to. This is typical of many major junctions and traffic management schemes in the UK.

3.3 More Modern Trends

Monderman (2008) spent a considerable part of his life as a Road Traffic Engineer investigating and providing radical innovative solutions many of which questioned the perceived wisdom prevailing at the time and were counterintuitive.

“..........His maxim was: "If you treat drivers like idiots, they act as idiots. Never treat anyone in the public realm as an idiot, always assume they have intelligence............" cited from Obituary, The Times (London) 11th January 2008.

Adding a little uncertainty by introducing mini-roundabouts at junctions for example, makes drivers apply their intelligence to think, plan and react thus interact more safely and effectively. This is an improvement along the trend-line towards the above objective, applying the ideas developed by Monderman (ibid).

The trend is towards ‘open-plan’ road layouts where there is more of a mix between pedestrian and car traffic instead of segregation. This makes drivers engage their minds with the hazards around them to avoid collisions. There is a downside. This trend towards these new layouts and the low running noise from trams and electric-hybrid cars, is making it difficult for the current generation of guide dogs to assist the visually or audibly impaired. Solving the problem of vehicles and cyclists coming into contact by larger modification of traffic junctions, separating areas of potential conflict with better cycle lanes, will take much longer to implement.

In 2011 the UK Transport Minister ordered a review of ‘street furniture’ that some people think has become excessive. This will take time to complete and implement changes. Have all these information management problems become
so excessive, beyond our level of human intelligence to effectively comprehend sufficiently well?

3.4 Role of Human Intelligence for Information Processing & Reaction Times in Driving

More evidence has been forthcoming, adding further perspectives and a new dimension which needs addressing. A study in the journal ‘Intelligence’ has published more recent research about declining reaction times and the associated declining intelligence in the population. Both reaction times and general intelligence IQ are important for driving. The latter is important in order to process the necessary information properly, the former to put car control properly into practice to deal with prevailing driving conditions.

It has been shown simple visual reaction time measures correlate substantially with measures of general intelligence with research showing a decline of IQ of fourteen points since Victorian times. (Woodley, M.A et al., 2013). The study argues that mean male and female respectively reaction times of 183-187 milliseconds [ms] in the Victorian era compare equivalently to modern mean reaction times of 250-277 ms respectively. The study found the differences were statistically significant. Furthermore, age was not a significant factor. Woodley M.A. et al., (ibid.)

The above research article is extensive and well referenced. If however comparison is made only with Victorian times rather than more recent data available, its findings are dependent upon the accuracy of ‘reaction times’ measured by Galton (1889). Accessing [electronic copy retrieved 25th July 2013] the proceedings of the British Association for the Advancement of Science describes the measuring apparatus. Its developer, Galton (ibid) maintained the reading graduation scale of his pendulum device was to hundredths of a second. There is no diagram of the apparatus, built in London. Thus whilst no doubt very innovative and acceptable then, it is not as reliable as the timekeeping methods now available. At risk of stating the obvious, it is not possible to replicate these original Victorian results. The research findings have been questioned by leading experts and an extensive technical rebuttal published, (Woodley, M.A et al., 2014) who stand by their research work. More recently published research claims that since the 1920’s each generation is becoming more intelligent than the last with a net IQ gain of circa 3.7 points per generation by the age of 11 already due to the ‘Flynn effect’, but not in this latest study, the ‘Matthew’ effect that could also apply (Staff et al; 2014). Can only one or are both Woodley (ibid) and Staff (ibid) research teams be right?
Each team is working from a different base, measuring different data to define changes in human IQ. The ‘Flynn effect’ (Flynn, 1994) assesses the influence of smaller families, better education and environmental complexity. The ‘Matthew effect’ (Merton, 1968) measures the influence of accumulated economic advantage, prosperity etc that is not evenly distributed, impacting the ability to eat well and follow intellectually stimulating activities. Thus both research teams are arguably assessing the impact on IQ of changes in ‘nature and nurture’ of different strata and different generations of society over time. Thus plausibly both research terms could be right. Human intelligence however you try and measure it is not the same across all the human population.

The socially disadvantaged in terms of ‘nature and nurture’ including the important formative early years of education and roles that stimulate IQ, could be finding driving information processing more difficult. This should be compared with the socially advantaged who have benefitted from nature and nurture’s bounty and extremely good fortune passed down from successive generations thus being blessed with better IQ. More research is needed to answer these complex questions and issues but some further revealing research has already been done.

The teenage mind still needs to develop sufficient information processing capability to fully master all the driving skills. (Isler et al., 2008). The latest generation of young drivers have been brought up with video games, smartphones, mini-pads, text messaging and the like. This equipment requires manual dexterity, limited use of our range of intelligence and some effective reactions. Unfortunately these devices are becoming decision support systems [DSS] and expert systems [ES] focusing on ‘output’. This is not fully engaging the reasoning power of our minds in the data processing of ‘how’ and ‘why’, not stimulating or challenging our intelligence. Thus to off-set these trends, young drivers need to continue to develop further reasoning power and training in order to drive to the highest standard they are capable. Compared to younger drivers, older drivers had a more efficient scanning routine and safer vehicle control. (Lee, 2010). Arguably however, the generations or two before this latest one also has a problem. Not brought up with technology at their fingertips from being youngsters, some are also likely to have difficulties associated with slowed reaction times, but not be aware of it, limiting the ability to deal with different driving conditions. Thus some sections of the driving community arguably have a problem. Even if the strength of association between reaction times and human IQ is rejected by some researchers as being too weak, the measured decline in reaction times alone is still worrying in the driving context.
3.5. Initial findings

3.5.1 Some implications

The above prima facie evidence supports the premise that solving the driving task problem identified by Lunn (1996) involving use of our intelligence and coordination (reaction) capabilities is becoming progressively more difficult for some drivers to do. Information processing requirements appear to have increased and to some, our processing capacity apparently has diminished. The driving information systems must deal with the lowest common denominator of human intelligence abilities so not to exclude anyone from proper comprehension. Developments in decision support systems and expert system ‘driver-assist’ technology are involved in making up for this deficiency but only part of the way towards filling the requirements. Indeed they have several basic weaknesses and problems with human intelligence, driver-assist and current computer cognitive technology driving systems have been identified. (Westlake 2015). This needs solving in order to deal with current and foreseeable driving conditions.

3.5.2 Evaluation of non expert drivers. The distribution of driving skills

Experienced but inexpert drivers requiring an ‘adrenalin-fix’ of increased arousal levels may encourage poor driving. (Michon, 1978). There is not a correlation between explicit driving ability and the need for appropriate caution (Harre, et al., 2007) and drivers could have an inflated opinion of their own hazard perception skills. (Horswill et al., 2004). Only when combined with enhanced safety perception awareness, do driving skills reduce accidents. (Summer et al., 2006).

There is a further problem about mistaken perceptions many non-expert drivers have about their own ‘above average’ level of competence thus leading to complacency. Arguably the common perception is the widely held conviction that non-expert drivers believe they are better than the average of the driving population.

It appears all too plausible how such a claim can be made and the supporting ‘reason’ not to question any doubts about its validity. This error arises because of a lack of understanding of mathematics.
First the problem:

“.....Ask any 100 drivers how good they are and over 90 will tell you they are above average. This is of course a mathematical impossibility – they are fooling themselves......” (Sothern, J; 2009, IAM Driving Handbook, p ‘Epilogue’).

Some or even many drivers may be and probably are fooling themselves about their abilities, but not for the mathematical reasons claimed above. It is not mathematically impossible for many but not all to be better than their population average. The main reasons explaining why this is so is as follows:

The distribution of driving skills is actually a complex topic. A Driver Skill Inventory of 28 items was developed for assessing a Driver’s view of their skill and safety. (Lajunen, et al., Table 1, 1995). It is difficult to statistically measure the magnitude of poor or good driving in the population. Do you measure ‘skills’ or technical reasons for accidents to make such an assessment and are the statistical distributions different for such measures? [They are.] How can the bulk of a particular population be better than its own average? If the frequency distribution of skills is ‘normally distributed’ across a population then the distribution of skills is symmetrical about the arithmetical mean. It thus cannot be different from the median or mode along with other technical qualifying features. If however the distribution is not ‘normal’ but for example skewed on the good skill-side it will have an arithmetical mean, with its median and mode frequency values on that good side of the mean. Then the assertion that a large majority of drivers being better than average is mathematically possible. (Yeomans, 1968, page 115, fig 44). According to a study of driving skills this is indeed so, the distribution of driving skills is not normal and the claim they are above average is mathematically legitimate. (Elvik, R. 2013). There are further technical reasons that have been established by research that are explained and discussed in Elvik’s paper. Thus the LR evidence needs to be gathered impartially and present an overall balanced, not biased level of substantiation.

4.0 Initial Conclusions – the situation is not ‘all-bad’: it needs to be better.

Reviewing the video content of several hours of advanced driving training material (Gilbert, ibid) shows they contain very few examples of dangerous or very poor driving. Some examples are of on-coming cyclists passing through a red traffic light, a cyclist approaching on the wrong side of the road round a blind bend, an approaching motorcyclist that is executing a high speed ‘wheelie’ with the front wheel well off the road surface. An aggressively speeding motorist approaching from behind well into a 30mph speed limit in a village
and a motorist not giving way at a mini roundabout crossing in front and a good number of motorists probably exceeding the speed limit or ‘tailgating’ in lane 1, 2 or 3 on sections of motorway and dual carriageway. A ‘white van’ driver cuts sharply in front of Gilbert’s car in lane 1 braking hard then decides after all not to exit a motorway moving back into lane 1, just by the exit. (Gilbert, ibid, DVD sets 1, 2 & 3). Not everyone on the DVD recordings are bad, mad or beyond redemption at the ‘poor ability’ tail of the driving skill distribution curve. Many are considerate, driving defensively or driving reasonably well, clustered around the mean and towards the ‘good’ side of the skills distribution.

This does not mean there is no need for improvement. Many drivers are not driving with due care and attention or are actually driving dangerously for accidents to occur. The 90% of accidents are due to driver error. (Malone, citing Huber, 2013). 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).

In answer to the above complex issues, explaining how better human driving information management can be achieved is researched in part 2 (Westlake,2015) of this study.

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