Evidential Analysis For Computer-Generated Animation (CGA)

by

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Abstract

The purpose of this thesis is to examine the items of legal evidence from cases, which have utilised Computer-Generated Animation (CGA) technology. In particular, it seeks to determine the degree of reliability and accuracy of CGA based on these items of legal evidence. The research design involved both quasi-experimental processes and pragmatic (sensitivity analyses). This design sought to examine the importance of evidence from a number of case studies and addresses the possible measures to be considered when generating such animations for litigation purposes.

A combination of both stages (quasi-experimental and pragmatic, such as comparing written evidence with spatial evidence) was employed in defining the research questions that will be presented in Chapter 1. The analysis in Chapter 7 will show that:

a. evidence has become knowledge (a source of information) to the animator;
b. the items of legal evidence (knowledge) are usually produced by an expert or a police officer with competency, acquaintance and correct information. These items will be discussed in Chapter 4; and
c. the evidence fulfils the conditions for knowledge to authenticate the credibility of (b) above. This will be discussed in Chapter 4.

Furthermore, the research findings that will be clarified in Chapter 8 confirm that each item of legal evidence may be used as information for the animator to generate the CGA. The process of generating an animation may not be possible if a single item of legal evidence is the only source of information for the animator. The findings have been strengthened by the implications of literature from the following three areas - reconstruction of an accident or crime, evidence (both legal and philosophical approaches) and knowledge. These topics are discussed in Chapters 2, 3 and 4.

Consequential to the implications, a sensitivity analysis has been conducted in Chapter 9 to further strengthen the implications indicated in the conclusion part of Chapter 8.

Overall, this research hypothesizes the importance of correct information and evidence from the facts of particular cases as vital in generating an animation. The main objectives are to highlight that:

a. legal evidence is a crucial element in generating an animation;
b. items of legal evidence have been prepared by an authorised police officer or expert.

Apart from the items of evidence classified as written, spatial and visual, eyewitness statements have been analysed based on factors associated with human senses. The eyewitness statements have also been examined based on the types and conditions for knowledge, which are explained in Chapter 4. The assessment

will also be conducted using a different approach based on human senses that will be elucidated in Chapter 5. Similar to other classes of evidence, (written, spatial and visual) the eyewitness must also be present at the collision vicinity or crime scene.

This ultimate aim is to reach a particular level of certainty in determining how reliable and accurate an animation is when it is presented in the courtroom. Although there is no definite level of certainty, the reliability and accuracy can be estimated based on the source of information (items of legal evidence).

Keywords: computer-generated animation, evidence, theory of knowledge, evidential analysis, expert opinion.

Chapter 1

Computer-Generated Animation (CGA): Importance and Concerns

1.1 Chapter Overview

This Chapter describes fundamental aspects of the thesis by explaining the essential background of computer-generated animation (CGA). The emergence and potential dangers of the CGA will be described accordingly. ' The basic definition from the phrases or words used in the title and throughout the research shall be explained. The aims, objectives and contribution to knowledge will be conveyed. The literature topics on accident reconstruction, evidence and theory of knowledge will be described briefly in the latter part of this Chapter.

1.1.1 Computer-Generated Animation (CGA)

The starting point for a computer animation is the creation, by the 3D animator of a computerised three dimensional world in which three dimensional objects or models and their spatial interrelationships with other models, whether human beings, vehicles and so on, are accurately portrayed. Having inserted all the relevant physical objects, the lighting characteristics can be added. Once the scene has been set in this way, the motion of the models and light sources relative to each other is introduced. This necessitates creating a particular locus of movement for each of the objects, lights etc in the animation and can be achieved in a number of ways. A common technique is 'keyframing' in which a particular frame is used to locate and store the precise position and orientation of an object.

As the result of the simulation is a three dimensional scene, it can be viewed from any position within this scene and it is thus necessary to decide which perspectives the event should be viewed from, i.e. where the 'cameras' should be sited. This might be overhead to enable a good overall view of the incident or e.g. from the perspective of a driver in a vehicle involved in the simulated incident. Given the accuracy with which such scenes can be represented, it is even possible to view the scene from a position which would be completely impracticable in real life. Having placed the 'cameras' in strategic positions, it only remains to insert atmospheric effects such as ambient weather conditions which might have a bearing on the way in which the incident occurred (Girvan, 2001).

All of these variables having been defined, the software is then able to convert the descriptions into images and eventually into the final animated sequences which can be recorded in videotape, CD-ROM or LaserDisc. The final process is a precise and accurate rendition of the incident at issue to which, during final editing, can be added descriptive text, labels or even voice transcripts where this is appropriate (Girvan, 2001).

1.2 Emergence and Potential Dangers of the CGA

The importance of this research in examining the reliability and accuracy of the CGA will also be emphasised. Potential dangers and shortfalls in the use of CGA shall be explained. Concurrently, the content of each Chapter shall be included.

One study showed that humans are essentially visual learners; (Vinson, 1993) 87% of the visual information presented to us is retained, while only 10% of the information heard by an individual is retained (Donoghue, 1992). Studies measuring jurors' information retention show that jurors were able to recall 65% of the evidence presented three days earlier if the evidence was presented through a combination of oral and visual testimony. Still other studies show that jurors focus primarily on visual evidence and prefer to use it during trial proceedings (Lederer, 1999). CGA has the capacity to exploit this tendency, possibly relaxing the jurors' critical nature[1]. Jurors may be misled by animated displays that are entertaining but are physically and factually far-fetched. One study, for example, showed jurors a computer animation depicting the trajectory of a body going off a building and asked whether the person slipped and fell, and was therefore negligent, or jumped, thus committing suicide (Kassin, 1997). Jurors were more likely to find negligence if the animation depicted the body falling straight down the building even though the oral testimony clearly stated that the body landed twenty to twenty five feet from the building.

The animation caused jurors to ignore both the reported verbal physical evidence and the common sense understanding that things fall straight down. Thus, the danger a jury will be misled requires strict scrutiny as to the accuracy of the displayed information.

[1] *See* Michael Owen Miller & Thomas A. Mauet, The Psychology of Jury Persuasion, 22 AM. J. Trial Advoc. 549, 563 (1999) (describing how the animation [in question] caused jurors to ignore the reported physical evidence (as well as a common sense understanding that things fall straight down)); *see also* Martha M. Jenkins, Computer-Generated Evidence Specifically Prepared for Use at Trial, 52 Chicago-Kent L. Rev. 600 (1976).

Computer animated displays can captivate a jury while simultaneously making intricate, technical issues understandable[2]. Computer animations can convey the advocate's message with realism and unrelenting power[3]. A lay jury, however, may be misled by forceful visual reconstructions of complex events.

Critics argue that the animation production process may subtly distort reality (Baird, 1992). These critics assert that everyone involved in the production of an animation - the animator, attorney, expert witness, and the party - has a vested interest in the outcome of the case (Ellenbrogen, 1993). The animator often serves as an expert witness and is unlikely to objectively criticise his own work. It has also been argued that current software may not be adequate to support the programs employed by CGA. It has been suggested, "[that] the software is sometimes not sophisticated enough for the accurate depiction of the inputted technical data" (Berkoff, 1994). Assuming the above arguments have strong value, cross-examination may not effectively challenge the reliability of CGA[4]. It also has been suggested that the animation process itself warps images "simply by its production technique." Judge Van Graafeiland voiced this view in *Perma Research and Development v. Singer*[5], stating that the potential for tampering with the CGA "presents a real danger of being the vehicle for introducing erroneous,

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[2] *See* Wesley R. Iverson, Animation Takes the Stand; Judging the Effectiveness of Computer Animations in the Courtroom, Computer Graphics World, Nov. 1991, at 48; Robert F. Seltzer, Computer Animated Evidence Has its Day in Court, Mich. Law. Weekly, Apr. 20, 1992

[3] *See* Elan E. Weinreb, Counselor Proceed with Caution: The Use of Integrated Evidence Presentation Systems and Computer-Generated Evidence in the Courtroom, 23 Cardozo L. Rev. 393, 404 (2001): at 395 (stating, "However, once computer technology is used either for presentation of evidence or as actual evidence in visual format, it leaves an impression upon a person's mind that cannot easily be erased. Moreover, that impression is likely to be perceived as one of truth. Both judges and jurors more easily give credibility to televised information.")

[4] See Sharon Panian, Comment, Truth, Lies, and Videotape: Are Current Federal Rules of Evidence Adequate?, 21 SW. U. L. REV. 1199, 1212 (1992) (quoting Eli Chernow, From the Bench: Video the Courtroom – More Than a Talking Head, LITIG., Fall 1988, at 4).

[5] *Perma Research & Dev. v. Singer Co.*, 542 F.2d 111 (2d Cir. 1976) (Van Graafeiland J., dissenting) (1976). Although this case dealt with computer simulations, Judge Van Graafeiland's concerns apply to animations with just as much force.

misleading or unreliable evidence." Judge Van Graafeiland thought it possible that animators themselves might "introduce speculation" by injecting creativity into a continuous display or making (possibly flawed) personal assumptions about the evidence displayed. Human error may also distort animations because it is an individual who actually enters the information into the computer. Animation is only as good as the information put into it." In sum, the production process itself may cause additional error and prejudice[6].

Additional techniques may subtly enhance an animation's persuasiveness. For example, studies have shown that regular use of colour is a factor in the recognition of an object[7]. High contrast colours are more likely to attract a juror's attention; certain combinations of colours can reduce the impact of the message or convey the wrong message. Colour coding can enhance comprehensibility and recall for the jury. Failure to present appropriately coloured evidence effectively can disadvantage a party because the jury may recall the opponent's superior animation more clearly.

Repetition is another factor that CGA can exploit. In advertising research, repetition improves memory, augments viewer assurance, and encourages the viewer to respond favourably to the communication. The same principles apply to

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[6] *See* Ellenbrogen, *supra* note 11. Forensic Technologies International, one of the largest creators of Computer-Generated Evidence, has even expressed this sentiment. They have stated that the computer animators' evidence will make errors that can significantly affect the outcome of cases.

[7] *See* Aura Hanna & Roger Remington, The Representation of Color and Form in Long-Term Memory, 24 Memory & Cognition 322-330 (1996) (finding that when test subjects were shown items in color first and then the same objects in black and white, the colored items were easier to recall); *see also* Cope Thomas, Computer Generated Animation: Identifying New and Subtle Prejudicial Special Effects, 74 FLA. B.J., Dec. 2000, at 52, 53.

CGA. Running the CGA for an optimal length of time and repeating the same event multiple times should enhance memory.

In summary, the use of animation as a method to present evidence during trial raised a number of issues such as manipulation of images and objects, lack of expertise in the process of generating animation, and human error which may distort the animation.

1.3 Previous Studies

In 1997, research by Kassin and Dunn provided the first systematic attempt to examine the effect of computer-generated displays on juries. Their research was based on earlier work that suggested computer constructions of past events would likely be highly persuasive to a jury.

Kassin and Dunn (1997) tested both the facilitative and prejudicial effects of computer generated displays[8]. When examined together, the two studies indicated that animated depictions of a physical event had a greater impact on the jury than equivalent oral testimony, but that the nature of the impact depended on the characteristics of the display.

[8] This note does not examine the facilitative uses of computer-animated displays. The author concedes and agrees that computer animated displays are the most effective way of communicating information to the jury. However, Kassin & Dunn's facilitative hypothesis, when tested, found that when the sequence accurately represented the event in question, judgment accuracy was improved by bringing verdicts more in line with the evidence.

Gestalt psychology is also useful in understanding how CGA may affect a jury because it focuses on how people organise visual information and elements so that they are perceived as a whole (Vinson, 1993). The principles of Gestalt psychology, which predict how visual images will be perceived, include area, closeness, proximity, continuation and symmetry. More specifically, within Gestalt psychology, each of these principles can be manipulated. As to area, the smaller the closed portion of an image, "the more it is apt to look like a complete figure." Areas with closed boundaries or edges are more likely to be seen as a whole shape. Items placed close together are likely to be assembled collectively in the viewer's mind. Arrangements that have a small number of interruptions in a line will be seen as a complete figure. Regarding symmetry, the more symmetrical an area, the more likely it will be seen as a complete figure. By using these principles, a well-designed exhibit could cause jurors to overlook their pre-existing logical understandings and direct their attention to a specific idea, encouraging them to see what counsel wants them to see.

1.4 Animation as Effective Presentation Method

The following texts explain the effectiveness of visual methods of presenting evidence in the courtroom particularly when animation is used. The studies undertaken will assist this research in identifying gaps of knowledge within the issues.

Drew (1984) found that those who deliver information had to repeat it less often for users to retain it in memory when they presented the information through visual means as compared to auditory means.

Dombroff (1983) reports on research finding that users retain information more effectively when it is presented visually and orally rather than just orally. After three hours, participants retained 20% more information introduced in a combination visual-oral presentation than in a purely oral one. After 72 hours, they remembered more than six times more of a combination visual-oral demonstration than a purely oral one. This attention to visual means of communication is hardly surprising when considering that humans have used their eyes to process information far longer than they have used formal language.

Many judges see the value of these computer graphics to assist the jurors in their facts presentation process and have admitted them into court. The case of Datshow v. Teledyne Continental Motors Aircraft Products (1993), elucidates this fact further when the district court judge allowed computer animations to be shown - "...to help the jury understand the expert's opinion as to what happened and that it's not meant to be a re-creation. It's some visualisation to allow the jury to conceptualise and appreciate the expert's opinion as to what happened here." The importance of animation has been emphasised in this case.

The following study by Morell (1999) shows how a group of participants responded when presenting information with the following containing expert testimony:

1. Without visual aids.
2. With diagrams.
3. With computer animation.
4. With diagrams and computer animation.

She concluded that "Participants who viewed testimony with computer animation (Condition 3) recalled information more accurately and in more detail than participants who did not view animation (Conditions 1 and 2). This finding suggests that providing animation concurrently with verbal explanation is currently the most effective means of communicating complex concepts when compared to traditional forms of presentation."

A trial is largely structured around the control, analysis and presentation of evidence (physical evidence, witness and expert testimony). Dervin and Nilan (1986) describe the traditional model of information dissemination: "It is one in which information is seen as the objective and users are seen as input-output processors of information". This information has been seen as vital in this thesis as one of the main points that generates the research questions in Section 1.4 of this Chapter.

Additionally, Schamber, Eisenberg and Nilan (1990), in discussing design concepts of information retrieval systems, write "...the problem remains one of designing systems able to respond to the internally generated information needs of users. Thus attention has also come to focus on users' knowledge states: what constitutes their internal knowledge in terms of values and expectations concerning the external world; how they use this knowledge in relating to the external world; or how they deal with what they perceive as gaps in that knowledge." Jurors experience knowledge "gaps": what happened and whom to hold responsible. It is the goal of trial counsels to fill these gaps.

Based on the fact that knowledge is vital for the jurors to arrive at a verdict, the question of how information (evidence) has been presented during the trial is significant. A complete understanding of any facts presented during the trial is vital. Therefore, evidence is necessary for the animator to generate the animation for the counsel during the trial. Savolainen (1993) described a sense-making theory, associated primarily with Dervin (1986), to explain the information-gathering process of learners. "The central activities of sense-making are information seeking, processing, creating, and using. Sense-making is a process; *sense* is the product of this process." Jurors set out to make sense of the evidence presented to them, within the framework of the court, to render their verdict.

In summary the key previous work encompasses the following:

1. Morell's (1999) had done a study on how the jury perceived the evidence from various methods of presentation.
2. Dervin and Nilan's (1986) discussion on information dissemination.

3. Schamber, Eisenberg and Nilan's (1990), discussion on design concepts of information retrieval systems.
4. Savolainen's (1993) sense-making theory, associated primarily with Dervin (1986), which aims to explain the information-gathering process of learners.
5. Dombroff's (1983) reports on research finding that users retain information more effectively when it is presented visually and orally rather than just orally.

1.5 The Research Questions

The previous section discussed the emerging use of animation for courtroom trials, the potential problems, and previous studies pertaining to the use of animation in the courtroom. With regard to the studies undertaken by Schamber, Eisenberg and Nilan, this thesis proposes a number of research issues pertaining to the use of animation in the courtroom:

1. How can each item of evidence be analysed (Chapter 7), based on the reliability of the information pertaining to each individual case?
2. How can the theory of knowledge be applied to investigate whether the items of evidence fulfil the description of particular types of knowledge and conditions for knowledge? (Chapter 4).
3. Which means of analysis (Chapter 7), when applied to individual items of evidence, would generate a number of decisive factors (Chapter 9) that ensure the reliability and accuracy of the animation?

CGA will usually be built upon evidence provided by the expert, for example a police officer. Forensic animators usually have their own work processes, which then follow to generate the animations. In this research, certain information and knowledge has been identified as essential for a forensic animator to work on a CGA. Knowledge and information originate from the hierarchy that begins with data. Data consists of symbols, information is data that is processed to be useful; providing answers to "who", "what", "where", and "when" questions. Knowledge refers to application of data and information; answering "how" questions.

In this research, knowledge will be referenced to courtroom evidence and information will be classified as the details relating to items of evidence. The whole spectrum of evidence should explain "how" an incident or accident took place including details (information) which describe the "who", "what", "where", and "when" of the incident or accident.

The analysis will then demonstrate the correlation between the theory of evidence and the theory of knowledge described as a sound method for investigating whether a forensic animation reflects reliable and accurate information from the substantial evidence.

1.6 The Current Research

This research focuses on "how" and "why" propositions. These types of questions are usually clarifying the research questions. According to Yin (1994),

questions are explanatory due to the fact that the subject matter has been derived from a particular case study. In this research, the questions are explanatory due to the fact that the items of legal evidence are used from the case studies with CGA. Consequential to the shortfalls identified by the previous work, this research hypothesizes the importance of correct information from the facts of particular cases, which were vital in generating animations to be presented in courtroom. The main objective is to highlight the legal evidence as a crucial element in generating such an animation and that the items of legal evidence have been prepared by an authorised police officer or expert. In addition to the objective, this research aims to reach a level of certainty in determining how reliable and accurate the CGA is for each case. However, there is no definite level of certainty, the reliability and accuracy can be measured to a certain degree for some purposes and in this research the purpose is to fill in the gap based on the previous work within this area of interest. This covers four main aspects:

a. firstly, the analytical problems of knowledge;
b. the expert and the admissibility of expert evidence;
c. the method of investigation and bodies of evidence; and
d. knowledge without evidence.

These four segments have been further elaborated in Chapter 8.

1.7 Aims and Focus of the Thesis

The aim of this research is to investigate the theoretical basis of the use of animation in the courtroom. The broad contention of this proposed research

focuses on the question of how reliable and accurate animation is in the courtroom. A further contended area focuses on why items of legal evidence become crucial in determining the reliability and accuracy of CGA, also why the expert investigating the case (collision or crime), or the eyewitness must fulfil a number of criteria.

It is nonetheless conceded that the reliability and accuracy of CGA rely heavily on a number of factors including the credibility of the expert, sound and reliable technical support, items of legal evidence and authenticity of the software used.

More formally, the specific research objectives can be listed as follows:

i. To evaluate the individual items of evidence that has been used as information by an animator to generate a CGA.

ii. To evaluate the reliability and accuracy of the information gathered at the scene of accident or crime.

iii. To determine the extent to which information at the scene contributes to the reliability and accuracy of the animation generated for litigation purposes.

iv. To develop a methodology based on the evidence and knowledge literature, which is theoretically rigorous and practical and can be applied to this analysis (Chapter 7).

v. To provide guidance on the deciding factors of whether a particular animation is reliable and accurate based on the items of evidence available.

The thesis presents the findings of this research, conducted to explore comparatively, items of legal evidence from six cases. It also discusses the background of three vital literature areas on accident reconstruction, evidence and the theory of knowledge.

In summary, this thesis aims to shed light on the information furnished to the animator, to promote critical guidelines in admitting CGA into the courtroom and to facilitate the way forward through its findings and conclusions. Additionally, this research aims to measure the reliability and accuracy of CGA in the courtroom. In legal cases, whether civil or criminal, evidence will be the eminent aspect in the investigation. For the purpose of admitting a CGA in the courtroom, an expert, whether a claim officer from an insurance company, a police officer or a medical practitioner will seek a forensic animator to animate a particular incident or accident based on the available evidence. The main purpose of CGA is to be used in the courtroom to illustrate the expert testimony. CGA shall not hold any probative value to the case. It is merely a tool for illustration.

1.8 Structure of the Thesis

In this Chapter, the basic rationale for this research is presented. It sets the basic arguments for the necessity of the work and presents the main research questions. The second Chapter defines general and specific characteristics of accident reconstruction. Analyses on items of legal evidence in this research were available from three actual cases on road traffic accidents. Hence, it is essential that Chapter 2 discuss the basic principles of the accident reconstruction process, which is fundamental to the construction of any forensic animations.

The third Chapter of the thesis discusses the literature on evidence. Evidence is defined from both legal and philosophical standpoints. The Chapter presents the wide range of admissibility issues, legal cases, and jurisdiction from the United Kingdom (U.K.) and the United States of America (U.S.). It also offers a philosophical approach including bodies of evidence. The subject on bodies of evidence in this Chapter corresponds with the analysis undertaken on the items of legal evidence with regard to the literature on knowledge in the next Chapter.

The fourth Chapter explains the literature on the theory of knowledge. This research concentrates on the types of knowledge and conditions for knowledge. The analysis of the types of knowledge allows this type of information to be distinguished, for any particular item of evidence. The conditions for knowledge can be used to undertake a specific analysis to determine the truth, acceptance and justification values inherent in the evidence used to create an animation.

The fifth Chapter discusses the research methodology. It presents the arguments for the choice of particular research strategies, their advantages and disadvantages and how they were used to best explore the research topic. The methodology implements analytic techniques (Miles and Huberman, 1984). For the purpose of this research the analytic techniques embrace three steps:

a. putting information into different arrays;
b. placing the evidence within such classifications; and
c. putting information in specific order.

In addition to this, a theory of certainty has been added into the methodology. The certainty factors are formed and discussed in Chapter 5.

Chapter 6 offers the background and details of all of the six case studies used during this research. Three cases involve road traffic accidents, one case is a criminal investigation, the fifth case is on the data recovery process for a computer forensic investigation and the final case is a marine accident.

The quasi-experimental analysis begins in Chapter 7 applying the method demonstrated in Chapter 5. All the scores assigned to each analysis from Chapter 7 are presented in Chapter 8.

In Chapter 8, a number of histograms have been created according to the four classes of items of legal evidence for all six cases. There are three main findings at the end of Chapter 8:

a. it is important for an expert or eyewitness to be at the scene of collision or crime;
b. the expert's admissibility and the eyewitness' knowledge; and
c. the investigation procedure.

These findings have been fractioned into four proposed segments:

a. analytic problems with the knowledge;
b. the expert and the admissibility of expert evidence;
c. the method of investigation and bodies of evidence; and
d. knowledge without evidence.

Table 8.11 summarises the findings and proposed segments, this is placed at the end of Chapter 8.

Chapter 9 contains the pragmatic analysis, which involves the sensitivity analysis. Centrality to this Chapter is a discussion of the significance of the proposed segments. The certainty factors from the quasi-experimental stage have been manipulated based on each of the proposed segments. This is followed by a discussion to demonstrate the significance of each proposed segment.

Finally, Chapter 10 presents the findings and conclusions from the previous sections in a comprehensive manner. It compares them against the wider literature, jurisdictions, discusses the strengths and limitations of the approach followed and presents some recommendations for future research.

1.9 Conclusion

The multidisciplinary approach followed in this research has a sound coherency. This is due to the strong interrelation between the literature on accident reconstruction, evidence and knowledge (Chapters 2, 3 and 4). The interrelation of these literature topics has been demonstrated in Chapter 5, by their relevance and importance in creating the research methodology. Evidence and knowledge have been applied as main elements in the methodology. The continuity and coherency have been clarified in the series of analyses in Chapter 7. The findings resulting from Chapter 7 have been further refined in Chapter 9 as proposed segments to further strengthen the continuity and coherency. Ultimately, the proposed segments have been generalised in Chapter 10 to underline decisive factors in determining the reliability and accuracy of a CGA when used in a court of law.

Chapter 2

Accident Reconstruction

2.1 Introduction

In this Chapter, the literature pertaining to accident reconstruction will be discussed. The discussion shall encompass definitions, general views and the application of reconstruction techniques in forensic animation.

This section attempts to explain the fundamental components of accident, reconstruction and forensic animation. While the most widely known form of accident reconstruction often involves automobile accidents, there are also many other types of accident reconstructions involving structural collapses, personal injuries, slips and falls, explosions, biomechanics, and human or machine interactions. In this Chapter, the terminologies used to describe accidents or collisions refer to automobile accidents.

One of the major road accidents in Britain was recorded on the 23 February 1899. While attempting to turn a corner at a speed of over 25mph the car's wheels collapsed. The occupants were thrown out and the driver and front seat passenger killed (RoSPA, 2001). Newspapers of the day hoped that this terrible accident would convince drivers to take greater care and keep their speed down. At the inquest the coroner commented that he hoped this type of accident would never happen again (RoSPA, 2001).

2.2 Accident: Background

The cost of road accidents in 2000 was estimated to be an incredible £16,920 million (£32,000 per minute); this included hospital costs, damage to property and vehicles, police and insurance costs, lost output, and a notional sum for pain, grief and suffering (RoSPA, 2001). In the bulletin published by The Royal Society for the Prevention of Accidents (RoSPA) some facts were stated that:

a. 95% of all road accidents involve some human error. In 76% of road accidents the human is solely to blame.

b. Between 30 – 40% of all fatal accidents occur on the road.

The bulletin has also published a summary of road casualties in the year 2000 as illustrated in Figure 2.1.

	Killed	Injured
Motor vehicle users	1,801	225,690
Motorcycle users	605	27,607
Pedestrians	857	41,176
Pedal cycle users	127	20,485
Total *	3,409	316,874

* includes horse riders, etc. and "road user not known" casualties

Figure 2.1: Reported Casualties in 2000

Over the past few years there has been a move away from using the word accident to describe an incident involving damage, injury or death on the road. Instead the police, media and some insurance companies have taken to using more descriptive words. The change has been driven by those who have suffered damage, or relatives of those injured or killed, who do not accept the actions, or lack of action, on the part of the responsible driver, falling into the normal

understanding and meaning of the word accident. Consequently the words crash and collision are being more widely used (Clayton, 2004).

2.2.1 Road Traffic Collision

Most road accidents have several causes, the main ones being human error, environmental problems and mechanical faults (Collision Research, 2004).

a. *Human error* is a factor in 95% of all road accidents. It can take many forms:

- Alcohol: This is the biggest single factor in road deaths, especially among young people. It adversely affects decision-making, balance, co-ordination, sight, touch, hearing and judgement.
- Inexperience: With young people particularly, this can lead to mistakes, errors of judgement and irresponsible behaviour, especially driving too fast.
- Tiredness/illness: This reduces a road user's ability to cope with road conditions and situations.
- Other reasons (children 0-15 years) include: Poor parental/adult supervision, small physical stature, stress or being upset, curiosity and taking risks, spirit of adventure, ignorance of the world and its dangers, lack of knowledge and training, inability to judge speed and distance, lack of attention, being easily distracted. All of these can result in children dashing out into the road without looking.

- Other reasons (Adults) include: Impatience, stress, carelessness, negligence, absentmindedness, irresponsible behaviour, inadequate knowledge and training, ageing, drugs and medicines, a general disregard for personal health and safety.

b. *Environmental problems* (weather conditions, road and junction design, and road surfaces) are a factor in around 18% of road accidents. Weather: rain can reduce visibility and make it harder to stop. Strong winds can be hazardous for cyclists.

- Road design: busy junctions, which are fine for cars may be dangerous for other road users.
- Road surface: potholes, bumps and badly maintained roads can cause problems, especially for cyclists.

c. *Mechanical faults* are a factor in 5.5% of road accidents. This is a relatively small factor because of annual Ministry of Transport (M.o.T.) tests to check vehicles' roadworthiness and improved vehicle construction (Collision Research, 2004).

The next section discusses accident reconstruction in general. Although such reconstructions have been described with regard to the accident or collision cases under consideration, such techniques have also been used in criminal cases.

2.3 Reconstruction

Often in analysing a collision or crime, a reconstruction may be undertaken to investigate the evidence gathered at the scene or to test hypotheses based on the eyewitness interviews. A reconstruction is an attempt to recreate the events, which are the subject of the litigation. In contrast, a test, experiment, or demonstration, is intended to illustrate or depict some principle, which is relevant to the litigation, but not in a manner meant to simulate the actual events which gave rise to the litigation (Dunn, 1990). The analysis formulated in this research has been applied to three accident or collision cases. The following section shall discuss the fundamentals of accident or collision reconstruction.

2.3.1 Accident: Evidence and Reconstruction Techniques

A collision investigation begins with data collection. Accuracy is crucial as this data serves as the foundation for the evidence. At a collision scene traditionally an investigator would take field measurements, undertake a rough field sketch, capture a set of photos and then draft up plans of the accident scene (Schofield, 2000).

For the road traffic accident, the analysis of the collision may determine who or what was a proximate cause in the collision, what may have occurred in the collision sequence and who had the best opportunity or last clear chance to avoid the collision. In the case of multiple impacts, the expert may be able to

determine the impact sequence, timing, actions and dynamics, as well as the damage and personal injury for each sequence or action.

Other collision questions such as the following might be answered by conducting the accident analysis (Lock, 2004):

1. What was the speed at impact?
2.
3. What were the actual events that transpired in the accident sequence?
4. What would have occurred if a pre-impact travel speed or driver action had been different prior to the impact? (Lock, 2004)

After a collision occurs physical evidence needs to be recorded. Details such as road and weather conditions, position of vehicles involved, road markings and signing together with any defects or obstructions. The presence and type of street lighting needs to be noted, and any defects if appropriate. The exact positions of any marks made in or on the road or verges, pre-collision or, as a consequence of the collision including dimensions are vitally important.[9] Additionally detailed records, with photographs, of damage sustained by any vehicle together with details of injuries to pedestrians must be obtained. Consequently it is imperative that the investigators visit the scene as soon as possible after the incident to observe and record evidence before it is destroyed disappears or remedial works are conducted (Clayton, 2004).

[9] Jackson v. Fletcher, 647 F.2d 1020, 1020 (10th Cir. 1981) (holding that an experiment to prove a truck had stopped at intersection with weight, engine power and different skid marks was an abuse of discretion).

Collision reconstruction is the process of using the physical and factual evidence, in conjunction with mathematics and physics, to determine how an accident occurred. The expert in the investigation may use the 'scientific method' in the investigation.

The scientific method is a process of inquiry, which relies on four elements: observation, hypothesis, theory, and experiment. The underlying objective may possibly be the same even though interaction between these four elements may differ from one situation to another.

Collision re-enactment or dynamic illustration is possible in several ways. The experts may replicate the conditions of the collision and provide video and photographic documentation to determine the complicity of vehicles, pedestrians or objects. The experts may also conduct full scale crash testing to recreate certain crush patterns and impact forces (Lock, 2004).

In the 1950's a geodimetre was developed to measure the speed of light, and subsequently utilised measuring distances based on the invariant velocity of light or electromagnetic waves in a vacuum. This device was called an Electronic Distance Metre or Measurer (EDM). EDMs send out a beam of light from a reference point towards a point of interest, where a reflector returns the beam to the instrument. The EDM analyses the beam to solve the distance between the two points[10]. Many UK police accident investigation units now survey accident scenes using EDM technology (such as the Nikon D-50 total station). EDM

[10] Goodwin, L.M. Ph.D. Thesis Subject: Accident Investigation - Data Visualisation and Admissibility in Court. September 2004. The University of Nottingham.

systems have the advantage of feeding data directly into PC CAD software to provide instant plans (Schofield, 2000).

2.3.2 Computer Reconstruction

With the aid of various computer programs, it is possible to reconstruct the variables under which accidents occur. The expert often needs to determine the speed of vehicles prior to impact, as well as the speed at impact. Other factors such as the exact angle at which impact occurred and the impact forces, for use in determining the occupant kinematics and injury causation can also be determined. By evaluating physical evidence and/or vehicle event data recorder information, the accident investigator can determine if and when brakes locked up, what steering inputs the driver applied, and how the vehicle responded to those inputs. Computer programs are often used to analyse and simulate road collisions, these programs can help the investigators to determine what happened in a collision.

There are two different methods used when reconstructing a vehicle collision using simulation software: trajectory analysis and damage analysis. While trajectory analysis uses scene data like skid marks and rest positions, damage analysis uses structural deformation measurements for each accident vehicle to determine the energy required to produce that particular crash.

PC-Crash relies entirely on trajectory analysis. The other programs described later utilise both trajectory and damage analysis. Trajectory analysis is based on the Conservation of Momentum and the First Law of Thermodynamics, and thus the amount of work done (or energy used) and the momentum (mass and velocity) of the system are important for calculating the vehicle movement (Söderberg and Tidborg, 1999).

PC-Crash is a Windows-based collision and trajectory simulation tool, created by MacInnis Engineering Associates, which analyses and presents a wide variety of information on vehicle collisions. It integrates model control with tables, diagrams and animations (Cliff, 1999). PC-Crash's model for predicting the 3D kinematics of a vehicle's pre- and post-impact trajectory is based on a discrete-kinetic time forward simulation of vehicle dynamics rather than experimentally derived coefficients (i.e. the simulation is run by calculating the kinetic energy change as the vehicle is run forward through time). This is because the vehicles used are defined as stiff bodies that move under the influence of external forces such as air resistance and gravity. A tyre-force model accounting for ABS is used, and the effects of steer angle, wheel braking, weight shift and suspension are accommodated (Steffan and Moser, 1996)[11].

The program handles pre-impact yaw[12], braking, acceleration and pre-impact steering. It also has a defined method for dealing with secondary impacts, inter-vehicle friction, and impulse vectors with a vertical component. PC-Crash utilises

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[11] Goodwin, LM; "Visualising Vehicle Accidents - Evidence Uncertainty, Presentation and Admissibility"; Ph.D. Thesis, University of Nottingham, to be submitted 2005

[12] 1. Nautical. To swerve off course momentarily or temporarily: The ship yawed as the heavy wave struck abeam.
2. To turn about the vertical axis. Used of an aircraft, spacecraft, or projectile.
3. To move unsteadily; weave.
Definition availaible online at http://www.answers.com/yaw&r=67

a momentum-based collision model, which relies on restitution (an input parameter depending on the level of vehicle deformation) instead of vehicle crush or stiffness coefficients.

PC-Crash divides the crash model into two phases: the *compression* (or loading) phase and the *restitution* (or unloading) phase. This latter phase looks at what happens after the impact of two vehicles. There is an amount of elasticity within the structure of the two vehicles, so they will separate again. The coefficient of restitution is defined as the ratio between restitution momentum and compression momentum (Steffan and Moser, 1996). Restitution is the unloading stage, and consists of two separate aspects, namely partial dimensional recovery and partial restoration of kinetic energy (McHenry, 1999).

The combination of this momentum-based model with the trajectory model allows accidents to be reconstructed starting from the point of reaction to the end position for all involved cars simultaneously. The reconstruction is performed in an interactive graphical environment, which allows a sketch of the accident scene to underlay the reconstruction. Simple 3D animations can be created directly from the calculated results (Steffan and Moser, 1996).

Other reconstruction reconstruction software such as the SMAC and CRASH range of programs is able to utilise both trajectory and damage analysis. Software employing damage analysis usually will make a number of assumptions in order to perform the required calculations (Söderberg and Tidborg, 1999):

- The work achieved when deforming the accident vehicle is equal to the kinetic energy loss during the collision.
- The relationship between the total force acting on the vehicle during the crash and the depth of the residual crush (the crush taking place after the crash (i.e. the moment of first impact) is completed) is linear.
- The force needed to produce any permanent damage to the accident vehicle is minimal, and as the force increases, so too does the amount of permanent damage.

The most important information required for damage analysis to take place is the values for two stiffness coefficients, A and B, needed to define the force-damage curve. These values must be appropriate for a vehicle in order to estimate the speed of change. Stiffness coefficient A represents the maximum force per unit width of the contact area not causing a residual crush, where residual crush is the crush remaining when all parts of the vehicle have ceased moving, after any restitution, following impact. Coefficient B represents the ratio of the force per unit width of the contact area to the crush depth (Söderberg and Tidborg, 1999).

Trajectory-based analysis examines the total energy dissipated as the vehicles travel from separation to their positions of rest and determines their corresponding linear and angular velocities at separation. The principles of conservation of linear and/or angular momentum are applied to the directions and magnitudes of the system momentum at separation to determine the velocities that must have existed prior to the collision.

Usually, the minimum information required for a trajectory-based reconstruction is (McHenry, 1999):

1. Impact and rest positions and headings.
2. Approximations of wheel steer and drag.
3. Vehicle specifications.

The types of vehicle specifications that will most likely be required for trajectory analysis are length, width, wheelbase, weight and the centre of gravity (Söderberg and Tidborg, 1999)[13].

This section presents the background of several types of computer reconstruction programs. The explanation is essential for the general knowledge of computer reconstruction but does not have specific impact to develop methodology for this research. The next Section defines on the term of "forensic animation".

2.3.3 Forensic Animation

What turns an animation into a forensic animation is the "process". The process depends on accuracy. All objects must obey the laws of physics and conform to a set of facts that are determined by a reconstructionist or forensic expert.

In summary this forensic process is: (Gold, 2004)

- See all vehicles involved in an accident; assess their physical condition, and measure impact damage and location.

[13] Goodwin, LM; "Visualising Vehicle Accidents - Evidence Uncertainty, Presentation and Admissibility"; Ph.D. Thesis, University of Nottingham, to be submitted 2005

- Perform a site survey and complete measurement of the scene.
- View photographs, if available taken at the accident scene and analyse physical evidence if it is still available.
- Prepare police reports and witness statements.
- Review all other data available.
- Transform all data into a logical and accurate scenario.
- Furnish data to the animator.

The animator will then use this information, build models of the environment and vehicles, and visually create an animation that conforms to the forensic data. The animation is reviewed by the reconstructionist for accuracy and approved to be used as a corroborative exhibit.

It is thought that the first forensic animation to be used in a UK Crown Court was a criminal case involving a road traffic accident. P.C. Doyle of the West Midlands Crash Investigation Training Unit created this animation. Since then a number of forensic animations have been admitted to a range of U.K. courtrooms (Schofield, 2000).

In November 1998 at Birmingham Crown Court a fifteen-second-computer simulation was adduced in evidence for the prosecution in the case of R v Ore. Although a computer simulation was used before this case in the appeal of Private Lee Clegg, the R v Ore case was the first to be used at Crown Court level in front of a jury.

In this case the defendant was charged with causing death by dangerous driving and the prosecution, after a *voir dire*[14], called their expert P.C. Doyle to give evidence as to the prosecution reconstruction of the accident. As a part of his evidence he produced and displayed by means of a video the computer simulation. The simulation consisted of two vehicles, representing those driven by the defendant and the victim, colliding and coming to rest in their respective post collision positions. The reconstruction did not show representations of actual drivers (Girvan, 2001).

A computer simulation construction has three steps (Weinreb, 2001). First, variable sets representing the co-ordinates of objects present at the scene are inputted (Berkoff, 1994). Next, the information is processed and synthesized to calculate the motion of each object involved in the incident. Finally, the information inputted yields output in the form of a visual presentation that conforms to the laws of science and physics (Thomason, 1994). Once a computer simulation is "verified by an expert as being scientifically sound and based on scientific knowledge and physical laws, [it] should demonstrate not what 'might' have happened or what 'could' have happened, but what *actually did* happen" (Hoenig, 1993)[15].

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[14] The term "voir dire" comes from a from French word "to see to speak," the questioning of prospective jurors by a judge and attorneys in court.(1) Voir dire is used to determine if any juror is biased and/or cannot deal with the issues fairly, or if there is cause not to allow a juror to serve (knowledge of the facts, acquaintanceship with parties, witnesses or attorneys, occupation which might lead to bias, prejudice against the death penalty, or previous experiences such as having been sued in a similar case). Actually one of the unspoken purposes of the voir dire is for the attorneys to get a feel for the personalities and likely views of the people on the jury panel. In some courts the judge asks most of the questions, while in others the lawyers are given substantial latitude and time to ask questions. (2) any hearing outside the presence of the jury held during trial.. Definition availaible online at http://legal-dictionary.thefreedictionary.com/voir+dire.

[15] The primary difference between the two evidentiary forms is that a simulation can be outcome determinative; the simulation has reached a conclusion on how the event occurred and provides that conclusion at trial. Quite obviously, simulations are a more forceful form of Computer-Generated Evidence as it can present concrete proof as well as perform the illustrative functions of an animation. The visual force of today's simulations allow counsel to show jurors dynamic processes that were previously impossible to depict and equally difficult to understand with verbal testimony alone.

Based on this explanation, forensic animation involves a series of steps taken to generate the animation. In the latter part of this thesis, the forensic process summarised earlier has also reflected on the analysis of items of legal evidence based on the theory of knowledge discussed in Chapter 4.

2.4 Conclusion

The use of computer animations in the courtroom has been very controversial. Past arguments against it have included that the animation was based on factual evidence and the way the animator wants them to happen. On the other hand, when a reconstruction has been created, the camera can be placed anywhere in a scene. The accident may be seen from either driver's perspective, or even bird's eye view. Another reason for which computer animation in a collision or crime reconstruction may be useful is that it may show that an object obstructed a certain view.

In the article by O'Flaherty (1996), the advantages and potential misuse of CGA has been highlighted. Some of the advantages proposed that include CGA and simulations provide effective means of conveying evidence to a jury, particularly in complex or technical trials. It is also evident that visual displays have a greater psychological impact on juries than purely verbal presentations. Surveys have shown that humans are essentially visual learners. This fact demonstrates that the CGA has been a useful tool to present evidence in the courtroom. This research perceives that there is a need to ensure that the CGA presented is reliable and accurate to a certain extent.

Nonetheless, the potential misuse highlighted by Selbak (1994) puts emphasis on the persuasive influence of computer-generated displays on jurors. This is compounded when an opposing party does not use the technology at trial. It is also highlighted in the case of *Perma Research & Development* v *Singer* (542 F 2d 111 (2d Cir) cert denied, 429 US 987 (1974)), mentioned earlier in the beginning of Chapter 1, that there is potentially a great deal of scope for tampering with the evidence in computer-generated displays.

This research has identified that the evidence or information obtained from the scene is very important to investigate and reconstruct a collision or crime. CGA can be created based on the items of this evidence collected or obtained from the scene. Based on the importance of evidence, the next Chapter will discuss the evidence from both legal and philosophical standpoints.

Chapter 3

Evidence

3.1 Introduction

In this Chapter, the continuation of the literature review will cover the evidence produced from the gathering of information due to a collision. In the other cases that have been analysed, there is also information gathered from a crime scene and a marine accident. The information is in the form of facts from the cases and has been termed as evidence from the legal point of view. In this Chapter, apart from the explanations on the relevant jurisdictions and legal admissibility, evidence has also been discussed from philosophical aspects. The discussion in this Chapter will include various case law and jurisdiction pertaining to the use of CG in the courtroom, expert opinion and its admissibility issues. The explanation will encompasses civil and criminal points of view based on both the United Kingdom (U.K.) and United States (U.S.) case law and jurisdiction.

3.2 Evidence: Legal Definition

Evidence is generally defined as a piece of information that supports a conclusion. Evidence from the legal point of view refers to every type of proof legally presented at trial (allowed by the judge), which is intended to convince the judge, and/or jury of alleged facts material to the case. It can include oral testimony of witnesses, including experts on technical matters, documents, public records,

objects, photographs and depositions (testimony under oath taken before trial). It also includes so-called "circumstantial evidence" which is intended to create belief by showing surrounding circumstances, which logically lead to a conclusion of fact. Charts, maps and models, which are used to demonstrate or explain matters, are not evidence themselves, but testimony based upon such items and marks on such material may be evidence (Hill, 2000). In this research the legal evidence refers to the items of evidence listed, which will be used in Chapter 5 under the four classes of evidence.

When, where and why are questions that can lead to the explanation of sequence in an accident. The reconstruction of events that led to the accident or crime has to be done in such a way as to enable the facts to be presented in a court of law, and to be accepted as admissible evidence.

3.3 Evidence: Philosophical Approach

The law of evidence emerged from a variety of fields including logic, epistemology, sociology, psychology and the forensic sciences. From the philosophical point of view, evidence has been defined as follows: evidence E is potential evidence on hypothesis H if and only if (Achinstein, 1983),

1. E is true;
2. E does not make H necessary;
3. the probability of H on E is substantial; and

4. the probability of an explanatory connection between H and E is substantial.

For the purpose of developing a methodology for this research, this definition of evidence has a relationship with discussion of knowledge in Chapter 4.

In addition to the above definition, the following explanation expands hypotheses (H) and evidence (E). The first question in relation to the bodies of evidence is that, *When is E evidence for hypothesis H, for a subject S?* Two conditions seem to be required. First, *E* should speak in favour of *H*. Second, *E* should have some kind of creditable standing (Williamson, 2000). This is one of the essential grounds for argument in the later part of this research, such bodies of evidence form part of the four segments explained in Chapter 9.

Although the following text has not been applied in the particular methodology or findings of this research, it may be essential to include the explanation of the essential facts about bodies of evidence.

At least as a first approximation, a model can be drawn on the first condition in probabilistic terms: *e* should raise the probability of *h*. That is, the probability of *h* conditional on *e* should be higher than the unconditional probability of *h*; in symbols, $P(h|e) > P(h)$ (Williamson, 2000). The conditional probability $P(h|e)$ is defined by the ratio $P(h \wedge e)/P(e)$ when $P(e) \neq 0$, and is otherwise undefined.

Thus the condition that $P(h|e) > P(h)$ is obtained if and only if $P(h \wedge e) > P(h)P(e)$. The second question is, *what kind of probability is P?* It is not a priori[16], then whether e raises the probability of h may depend on background information. For example, the proposition that John belongs to a certain club might raise the probability that he is single, relative to the background information that it is a club for singles, but lowers it relative to the background information that it is a club for spouses. However, e itself should not be built into the background information, for that would give $P(e)$ the value 1, in which case $P(h|e)$ and $P(h)$ would be equal and e would not be evidence for anything. At this point, e may raise the probability of h in the sense that $P(h|e) > P(h)$ even if S knows that e is false or has no idea whether e is true; but then, for S, e would not be evidence for h. That is why the second condition is important, that e should have a creditable standing. A natural idea is that S has a *body of evidence*, for use in the assessment of hypotheses; that evidence should include e. The probability distribution P is informed by some but not all of S's evidence. Therefore a simple schematic proposal may be proposed as:

EV e is evidence for h for S is and only if S's evidence includes e and $P(h|e) > P(h)$.

[16]
1. Proceeding from a known or assumed cause to a necessarily related effect; deductive.
2. a. Derived by or designating the process of reasoning without reference to particular facts or experience.
   b. Knowable without appeal to particular experience.
3. Made before or without examination; not supported by factual study. Definition available at, http://www.answers.com/topic/a-priori

In the discussion made by Williamson (2000), the explanation on bodies of evidence has been extended to a schematic argument. The schematic argument for E=K:

> All evidence is prepositional.
> All prepositional evidence is knowledge.
> All knowledge is evidence.
> ---
> All and only knowledge is evidence.

In relation to this schematic, Williamson further discuss that since 'knowledge' here means prepositional knowledge, each premise follows from the conclusions; thus the conclusion is equivalent to the conjunction of the premises.

The discussion extends to an in-depth philosophical point of view. However, for the purpose of the legal evidence produced and available for this analysis, the fundamental definition relating to bodies of evidence has been regarded as sufficient. This is based on (as explained earlier in this Section) the fact that that the definition on bodies of evidence corresponds with the discussion in theory of knowledge in Chapter 4.

3.4 Legal and Philosophical: Discussion

The use of evidence as material in the reconstruction of past events makes a number of important philosophical (*specifically epistemology*) assumptions. Among these are that past events occur independently of human knowledge and that it is possible in principle to attain present knowledge about past events, and that the accumulation of evidence and derivation of rational inferences from the evidence is a correct method of achieving such knowledge (Murphy, 2003).

In addition to the earlier definition and explanation, evidence can be perceived in various forms. The behaviour of animals in a learning task, the pattern of light in the view-piece of a telescope or microscope, a letter confessing to an action; all these and many others could count as evidence in suitable circumstances. Evidence produced by the defence in a court case might be testimony that even a juror who was inclined to convict would take seriously. Similarly, evidence for a scientific theory might be the results of an experiment that even someone who believed a rival theory would have to admit was definitely carried out and definitely gave the result it did (Morton, 1997).

The legal aspect of evidence in this research refers to the classification of evidence for each of the items from the cases. On the other hand, the philosophical aspects of evidence will be expanded in Chapter 4 as a correlation in the theory of knowledge.

3.5 Jurisdiction

Under this Section, details of jurisdiction will be elucidated based on U.K. legislation and the U.S. constitution. CGA is often classified as demonstrative evidence. This type of evidence is one of the methods by which the expert communicates with the attorney, judge, and jury. In the instance where two vehicles collided, a CGA may be useful as a visible culmination of the accident reconstructionist's work which *allows the jury to understand and remember the important evidence, concepts and opinions* developed during the analysis of the

collision. This type of evidence usually involves experts in a particular field. The testimony given by the expert falls under opinion evidence, such as the common law rule in the U.K.

Whilst in the U.S., evidence is said to be admissible or receivable if it is relevant and if it is not excluded by the rules of evidence. The rules of evidence are rules of law, and it follows that, unlike relevance, which is determined solely by reference to the logical relationship between the evidence and a fact in issue, admissibility is a matter of law. To be admissible, evidence must be relevant, but relevance is not enough to result in admissibility. While evidence must be relevant to be admissible, the converse proposition is not true (Murphy, 2003) -not all relevant evidence is admissible[17].

3.5.1 Direct and Circumstantial Evidence

In the U.K., evidence may be described as having one of the following qualities (Murphy, 2003):

a. Direct evidence, and
b. Circumstantial evidence.

Direct evidence is evidence, which requires no mental process on the part of the tribunal of fact in order to draw the conclusion sought by the proponent of the evidence, other than acceptance of the evidence itself. Circumstantial evidence is

[17] Cf. American Federal rule of Evidence 402:"All relevant evidence is admissible, except as otherwise provided by the Constitution of the United States, by Act of Congress, by these rules, or by other rules prescribed by the Supreme Court pursuant to statutory authority. Evidence which is not relevant is not admissible".

evidence from which the desired conclusion may be drawn but which requires the tribunal of fact not only to accept the evidence presented, but also to draw an inference from it.

For example, if D is charged with robbery of a bank, and is seen by W running from the bank clutching a "wad of banknotes", W's evidence is direct evidence that D was running away from the bank, and circumstantial evidence that D committed the robbery. To arrive at the latter conclusion, the jury must draw certain inferences from the facts perceived by W, namely that D stole the banknotes from the bank and was running away to avoid being caught. This example also shows that circumstantial evidence is not necessarily inferior to direct evidence, if the inference required is obvious and compelling. The jury does not need any special direction merely because some evidence is circumstantial [18].

In expanding the example above, if W's testimony has been made to the police officer investigating the robbery, and the fact from that testimony has been presented without W's presence in the court, then under the common law principles in the U.K., this evidence refers to the hearsay rule. Many definitions of hearsay have been advanced. In Sharp [1988] 1 WLR 7, Lord Havers' definition follows: (Murphy, 2003)

> An assertion other than one made by a person [19] while giving oral evidence in the proceedings is inadmissible as evidence of any fact asserted.

[18] *McGreevy v DPP* [1973] 1 WLR 276.

[19] The rule against hearsay does not apply to evidence consisting of the observed behaviour of animals *Pieterson* [1995] 1 WLR (police tracker dog). Such evidence is more aptly regarded as real evidence. It may properly be made subject to safeguards of reliability other than hearsay rule.

In addition to Sharp, Section 1(2) of the Civil Evidence Act 1995 provides a definition of hearsay as the definition as (Murphy, 2003):

> In this Act –
>
> a. 'hearsay' means a statement made otherwise than by a person while giving oral evidence in the proceedings which is tendered as evidence of the matters stated; and
>
> b. references to hearsay include hearsay of whatever degree.

For the purpose of CGA, the hearsay rule may be seen as an instance where an expert delivering a statement in a court of law by demonstrating their work using a CGA. In relation to this, the U.K. law expands the hearsay rule to the area of opinion evidence. The common law rule that opinion evidence is inadmissible to prove the truth of the matter believed is subject to three important exceptions, but otherwise remains in full effect. The exceptions are (Murphy, 2003):

(a) General reputation is admissible to prove matters of public concern, which would otherwise be impossible or very difficult to prove.

(b) Expert opinion evidence is admissible to prove matters of specialised knowledge, on which the court would be unable properly to reach a conclusion unaided.

(c) Non-expert opinion evidence may be received on matters within the competence and experience of laypersons generally.

Similarly, in the US, Federal Rules of Evidence 701 (FRE701) states that,

> *If the witness is not testifying as an expert, the witness' testimony in the form of opinions or inferences is limited to those opinions or inferences which are (a) rationally based on the perception of the witness and (b) helpful to a clear understanding of the witness' testimony or the determination of a fact in issue, and (c) not based on scientific, technical, or other specialised knowledge within the scope of Rule 702.*[20] *[As amended effective December 1, 2000]* (Harvard Law School)

Table 3.1 summarises both the common law rule in the U.K. and the FRE701 in the U.S. on the expert opinion.

Common Law	FRE701
o Very difficult to prove	o Perception of the witness
o Prove matters of specialised knowledge	o Helpful to clear understanding
o Matters within the competence and experience of laypersons	o Not based on scientific, technical or other specialised knowledge

Table 3.1: Common Law Rule and FRE701

It is an ancient rule of common law that on a subject requiring special knowledge and competence, evidence is admissible from witnesses who have acquired, by study or practice, the necessary expertise on the subject. Such witnesses are known as 'experts'. The evidence is justified by the fact that the court would be unable, unaided, to draw proper inferences and proper opinions from such specialised facts as might be proved, and even perhaps to judge what facts have been satisfactorily proved. As long ago as the mid-sixteenth century, Saunders J in Buckley v Rice Thomas (1554) Plowd 118, 124 was able to express pride in the readiness of the law to accept guidance from suitably qualified experts. Based on

[19] Rule 702 now provides: [A] witness qualified as an expert . . . may testify . . . in the form of an opinion or otherwise if
(1) the testimony is based upon sufficient facts or data,
(2) the testimony is the product of reliable principles and methods, and
(3) the witness has applied the principles and methods reliably to the facts of the case.

his statement[21], CGA can be seen as a commendable method of presenting evidence. This statement supports the previous studies pertaining to visual presentation of evidence in court as discussed in Chapter 1 of this thesis (Morell, 1999). The next Section will discuss the admissibility of expert reports. The next Section strengthens the justification of this research on items of legal evidence particularly from expert opinion which may be useful to determine the reliability and accuracy of CGA. The findings in Chapter 8 and the sensitivity analysis in Chapter 9 will clarify the importance of expert opinion or testimony.

3.5.2 Admissibility of Expert Reports

In the U.K., before the advent of the Criminal Justice Act 1988, there was no provision for the admissibility of expert's reports in criminal cases. The hearsay provisions of the Criminal Evidence Act 1965 and the Police and Criminal Evidence Act 1984 applied only to statements of fact. Based on s. 30 of the Criminal Justice Act 1988[22], the expert report pertaining to this research refers to

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[21] ... if matters arise in our law, which concern other sciences or faculties, we commonly apply for the aid of that science or faculty which it concerns. Which is an honourable and commendable thing in our law. For thereby it appears that we do not despise all other sciences but our own, but we approve of them and encourage them as things worthy of commendation.

[22] s. 30 of the Criminal Justice Act 1988

(1) An expert report shall be admissible as evidence in criminal proceedings, whether or not the person making it attends to give oral evidence in those proceedings.

(2) If it is proposed that the person making the report shall not give oral evidence, the report shall only be admissible with the leave of the court.

(3) For the purpose of determining whether to give leave the court shall have regard- to the contents of the report;

(a) to the reasons why it is proposed that the person making the report shall not give oral evidence;

(b) to any risk, having regard in particular to whether it is likely to be possible to convert statements in the report if the person making it does not attend to give oral evidence in the proceedings, that its admission or exclusion will result in unfairness to the accused, or, if there is more than one, to any of them; and

(c) to any other circumstances that appear to the court to be relevant.

(4) An expert report, when admitted, shall be evidence of any fact or opinion of which the person making it could have given oral evidence.

In this section 'expert report' means a written report by a person dealing wholly or mainly with matters on which he is (or would if living be) qualified to give expert evidence.

the written report included in the analysis in Chapter 7 of this thesis. An expert report may contain matters of fact as well as opinion, and may be extremely cogent. Subsection (4) makes admissible relevant findings of fact by the expert, such as facts, which he has investigated in the course of forming his opinion. In committal proceedings in the magistrates' court, this section applies only in a very limited form. Subsection (1) has effect without the words 'whether or not the person making it attends to give oral evidence in those proceedings,' and subsections (2), (3) and (4) have no application (Criminal Procedure and Investigations Act 1996, Sch. 1, para.32). The rule enacted by s. 30 seems sensible and entirely appropriate in cases in which it is proposed that the expert should give oral evidence. The admission of his report in addition to his oral evidence will generally assist the jury in understanding both his evidence in chief and cross-examination (Murphy, 2003).

In Folkes v Chadd (1782) 3 Doug KB 157, Lord Mansfield confirmed that the opinion of scientific men upon proven facts may be given by 'men of science within their own science'. Qualification to give expert evidence is technically a matter of competence, and the court should investigate the credentials of a proposed witness before permitting him/her to give expert evidence. The court is concerned with actual expertise, not with the means by which that expertise is acquired. Paper qualifications by themselves may not be sufficient guarantee of actual skills relevant to the questions before the court, and expertise gained by substantial relevant experience certainly renders an expert witness competent, and may invest his evidence with considerable weight. The aspects pertaining to the

paper qualification and substantial relevant experience are characteristics that have been assessed in the analysis Chapter. Additionally, in Silverlock [23] a solicitor, who had made a study of handwriting, was allowed to give evidence as an expert, notwithstanding his lack of formal qualification on the subject, because of his demonstrable actual skill.

The issue on qualification will be discussed in Chapter 5 of this thesis. Qualification is one of the criteria in the evidence analysis in Chapter 7.

An expert witness, if competent, is, like any other witness, also compellable. In Harmony Shipping Co. SA v Saudi Europe Line Ltd [1979] 1 WLR 1380, a handwriting expert, having been consulted on behalf of the plaintiffs, was later consulted by solicitors for the defendants. After giving them his opinion on certain documents relevant to the action, the expert realised that he had inadvertently advised both sides and, in accordance with his professional rules, declined to accept further instructions from the defendants. The defendants served on him a *subpoena and testificandum*, which he sought to have set aside. The Court of Appeal held that he was compellable to give evidence for the defendants, and that there was no contractual relationship between the expert and the plaintiff, which would (even if enforceable, which must be doubtful) bind the expert not to appear for the defendants. The competency aspect has been incorporated in the analysis Chapter (Chapter 7) on each of the items of evidence.

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[23] [1894] 2 QB 766. Cf. *Oakley* (1979) 70 Cr App R 7; *Murphy*[1980] QB 434, and Federal Rule of Evidence 702: 'If scientific, technical or other specialised knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by *knowledge, skill, experience, training or education* may testify thereto in the form of an opinion or otherwise'.

3.5.2.1 The Function of The Expert

The following text in this Section embraces U.K. and U.S. legal aspects and case law. The content of this Section emphasises the importance of expert opinion. In relation to this research, the items of legal evidence have been analysed (Chapter 7) in the quasi-experimental (explained in Chapter 5).

The requirement of independence is derived from the provisions of rule 35.3 of the Civil Procedure Rules 1998 [24]. This does not mean, however, that an expert witness should not express an opinion favourable to one party and against another as strongly as he feels it is appropriate to do so. The function of the expert is to assist the court in reaching the correct conclusion on the facts, and if he considers, after an objective scientific review of the facts, that those facts favour the party on whose behalf he is retained, he should say so. No breach of the obligation to be independent is involved in the forceful expression of scientifically defensible opinion; indeed, the expert has a positive duty to the court to render it.

The function of an expert witness is to assist the court by giving evidence of his opinion on the matters of specialised knowledge on which his assistance is sought. In common law, this was held to mean that the expert might not be asked his opinion on the 'ultimate question', or in other words he might not be asked directly his opinion on an issue in the case. The aspects of independence and specialised knowledge have been embraced in the analysis Chapter.

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[24] Rule 35.3, Civil Procedure Rules 1998
1. It is the duty of an expert to help the court on the matters within his expertise.
2. This function overrides any obligation to the person from whom he has received instructions by whom he is paid.

It is submitted that the English common law should now permit expressions of opinion by experts on ultimate issues, subject to the power of the judge in a jury trial to limit testimony in any case where there is a danger of the jury according the testimony undue weight, cases involving such defences as insanity or diminished responsibility being examples of cases where this may be desirable. This was the view of the Criminal Law Revision Committee in its 11th report (Cmnd 4991, para.270) and of Lord Parker CJ, judicially, in DPP v A & BC Chewing Gum Ltd [1968] 1 QB 159 at 164. In civil cases, the common law position has been abolished, sensibly, by s. 3 of the Civil Evidence Act 1972[25].

The court should reject claimed expert evidence on a subject whose scientific validity cannot be demonstrated, even though the expert may be very well qualified personally to express an opinion on it. For example, the fact that a party may have retained the best available psychic to reconstruct the facts of the case does not mean that the psychic's evidence should be received.

Similarly, in the United States Supreme Court in Frye v U.S. 293 F 1013 (1923) had laid down the test that the scientific validity of the subject or the expert's methodology must be 'generally accepted by the scientific community'. The Court held that this accorded with the test in English law. This may not have been a particularly apt choice of authority, inasmuch as in Daubert v Merrell Dow Pharmaceuticals Inc 509 US 579 (1993) held that Frye should no longer be followed. The Court in Daubert, reflecting a widely felt dissatisfaction with

[25] s. 3 of the Civil Evidence Act 1972,
(1) Subject to any rules of court...where a person is called as a witness in any civil proceedings, his opinion on any relevant matter on which he is qualified to give expert evidence, shall be admissible in evidence...
(2) In this section 'relevant matter' includes an issue in the proceedings in question.

Frye (on a number of grounds, including the ground that Frye hands over the judicial responsibility for ruling on the admissibility of evidence to a vaguely-defined community of scientists) substituted a much wider test. The essential elements of the Daubert test, though expressed at much greater length in the opinion of the Court, are essentially that the evidence must be relevant, that it must be reliable and that there must be no reason to suppose that the evidence would mislead the jury or make the case unnecessarily complicated for them. An amendment to Federal Rule of Evidence 702 (FRE 702), the expressed intent of which is to make that rule conform to Daubert, defines the component of reliability as meaning that:

1. 'the testimony is based upon sufficient facts or data,
2. the testimony is the product of reliable principles and methods, and
3. the witness has applied the methods reliably to the facts of the case'[26].

The Frye, Daubert and FRE 702 correlates with the grounds applied in the analysis adopted from the philosophical aspect of evidence and the theory of knowledge.

[26] See also Kumho Tire Co v Carmichael 119 S. Ct. 1167 (1999) extending the rule in Daubert to all expert evidence and not just evidence in traditionally scientific fields. It should be said that, in addition to reflecting general dissatisfaction with the Frye test, the Court in Daubert overruled the case on the technical ground that Frye had been decided on common law principles before the coming into effect of the Federal Rules of Evidence, and was not authoritative under those rules now used in the federal courts. This means that State courts need not necessarily follow Daubert for the purpose of state rules of evidence, and some state jurisdictions have chosen to continue to follow Frye, though the clear majority view is now against the older case.

3.5.2.2 The Function of The Non-Expert

Under the same legal aspect of evidence, non-expert witnesses are allowed to express their opinion on issues which do not call for specialist knowledge and where it would be impossible to separate observed fact from inference, such as identification or the speed of a car. It is impossible to be exact but generally the non-expert witness can give an opinion when the opinion is necessary for the coherence and comprehensibility of the testimony and when the opinion involves everyday matters calling for no special expertise. The explanation of this Section is vital to the items of legal evidence classified under eyewitness statements (Chapter 5) in the analysis (Chapter 7).

There are a number of exceptions to the general rule that the non-expert may not give evidence of his/her opinion (Bar Vocational):

a. As a way of expressing facts: A witness may express an opinion if it is the only way of expressing the facts he has perceived. In civil cases, this is expressed in the Civil Evidence Act 1972 s3(2), which is thought to be declaratory of the common law:

   "It is hereby declared that where a person is called as a witness in any civil proceedings, a statement of opinion by him on a relevant matter on which he is not qualified to give expert evidence, if made as a way of conveying relevant facts personally perceived by him, is admissible as evidence of what he perceived."

b. Identity: A witness may identify a person. E.g. identifying a person as student or staff.

c. Age: A witness is allowed to give evidence as to his opinion of some one's age.

d. Speed: A witness may give his opinion as to the speed of a vehicle, but note that his evidence must be corroborated: Road Traffic Regulation Act 1984 s89.

e. Weather, temperature and the passing of time.

A witness statement is a document recording the evidence of a person to whom the investigator has spoken, which is signed by that person to confirm that the contents of the statement are true. In general the statement should only contain information on what the witness saw, and not what others have said to him or her. However it is important to record anything that may open up a new line of enquiry or help in corroborating other information (Health and Safety).

Witness statements should normally be taken as soon as possible to ensure that:

a. the events are still fresh in the mind of the witness;

b. the evidence is recorded before the witness is tempted/has opportunity to discuss their evidence with others.

This approach will give the investigator the best evidence from the witness and make it more difficult for the defence to challenge the witness's evidence. All witnesses should be treated with courtesy and every attempt should be made to

put witnesses at their ease. The primary aim of taking a statement from a witness is to find out what happened.

Any statement should be written and signed in ink. Witness statements should be drafted so that they are concise and to the point. It should only deal with matters within the direct knowledge of the witness. As far as is possible, the statement should be recorded in the witness's own words. Sections 8 and 13 of the Civil Evidence Act 1995 provide the admissibility clause and the definition of "document" [27].

3.6 Admissibility

This section deals with the issue of admissibility on CGA in the court of law. The admissibility problems and issues may well be described based on some of the U.S.' constitution and legal cases. This merely the fact that CGA has been widely admitted in most U.S.' courts compared to U.K. courts of law.

In discussing the admissibility of CGA, it is essential to redefine the definition of CGA from legal standpoints. CGA can be either substantive or demonstrative, or both. The extent of the evidentiary foundation analysis and application of other

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[27] Section 8 of the Civil Evidence Act 1995 provides: (Murphy, 2003)

(1) Where a statement contained in a document is admissible as evidence in civil proceedings, it may be proved-
   (a) by production of that document, or
   (b) whether or not that document is still in existence, by the production of a copy of that document or of the material part of it, authenticated in such manner as the court may approve.
(2) It is immaterial for this purpose how many removes there are between a copy and the original.

Section 13 provides, *inter alia*:

'document' means anything in which information of any description is recorded, and 'copy', in relation to a document, means anything onto which information recorded in the document has been copied, by whatever means and whatever directly or indirectly.

evidentiary rules depends upon whether the CGA is used to prove the existence of a fact (substantive) or is used merely to illustrate a witness's testimony or to augment counsel's presentation (demonstrative) (Pratt, 2001). CGA is a series of computer-generated images that are run sequentially to create the illusion that the illustrated objects are in motion (Joseph, 2000). When used to reconstruct or re-create an event, the animation is based upon information collected from the scene. In a criminal case, the animation may be factually demonstrative, for example to reconstruct who was where and when in a robbery, in which case it is subject only to the evidentiary requirements for other forms of demonstrative evidence. The animation may be scientifically demonstrative, for example to illustrate a ballistics expert's testimony of the trajectory of a bullet in a homicide, in which case it must meet the heightened requirements for scientific and technical evidence (Fulcher, 1996).

The admissibility of CGA has also been reflected in the U.S. constitution in the Federal Rules of Evidence, Rule 901 (FRE 901). The essential part of FRE 901 relating to the admissibility of the CGA will be discussed in the next Section.

3.7 Conclusion

The essential fact at this point is that evidence has been elucidated as legal items from a collision or crime scene. Each item of evidence can been elaborated as primary information and knowledge to the expert in reconstruction as well as to the animator. The justification can be drawn by firstly considering the literature

on bodies of evidence. It has been explained in Section 3.3 of this Chapter that "evidence supports hypotheses". Secondly, to strengthen further, the U.S. constitution may be taken into consideration based on the similarity from the content of FRE 901. For an animation to be admitted, Rule 901 of the Federal Rules of Evidence and the common law test of "substantial similarity" must be met. All evidence must meet the minimum authentication requirements of Rules 901(a) and 901(b)(9). Rule 901(a) requires the production of evidence sufficient to support a finding that the evidence is what it purports to be[28]. Rule 901(b)(9) explains that FRE 901(a) is met by establishing the reliability of the system used to create the animation and by establishing the accuracy of the system's output.[29] Collectively, Rule 901(b)(9) reflects in the inference made in Chapter 5 "whether the animation has been produced based on the items of legal evidence".

In summary, this Chapter has discussed the legal aspects of evidence with interrelations on the jurisdiction and admissibility issues. There are two vital aspects for the admissibility of the animation:

a. the accuracy of the data used to create it; and

b. the assumptions made by the computer animator.

The data (evidence) are usually collected at the scene and the assumptions made by the animator are frequently based on the information or knowledge from the case.

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[28] FED. R. EVID. 901(a) "The requirement of authentication or identification as a condition precedent to admissibility is satisfied by evidence sufficient to support a finding that the matter in question is what its proponent claims."

[29] FED. R. EVID. 901(b)(9) "Process or system. Evidence describing a process or system used to produce a result and showing that the process or system produces an accurate result."

The next Chapter will be explicating "evidence" as knowledge. An analytical approach based on the theory of knowledge will be embraced. The importance of knowledge can be seen in a case whereby the boat sank in the middle of the sea with no surviving witness, knowledge of how the crew would react to the conditions they found themselves in was another key ingredient (John, 2002). In addition to this, how the boats would handle in stormy seas, and their seaworthiness, was a necessary part of the total equation of facts that had to be pieced together.

Chapter 4

Knowledge

4.1 Introduction

In the previous Chapter, "evidence" has been defined from legal and philosophical points of view. The interrelation between evidence, information and knowledge from the scene of an accident or crime has been previously discussed in Section 3.7. This third part of the literature review focuses on the topic of Knowledge. The importance of evidence will be further expanded in this Chapter as it relates to data, information and knowledge. In addition to this expansion, knowledge will be discussed as a theory in this Chapter. In sciences, a theory is a model or framework for understanding. The process leading to understanding a certain matter itself involves knowledge.

This section will define knowledge as a concept that emerges from data and information. Data are numbers, characters, images, or other methods of recording, in a form, which can be assessed by a human, or (specifically) input into a computer, stored and processed there, or transmitted on some digital channel. Computers nearly always represent data in a binary format. Data on its own has no meaning, only when interpreted by some kind of data processing system does it take on meaning and become information. Information therefore, is a collection of facts or data. These facts can then be perceived as knowledge.

Knowledge is the combination of a state or fact of knowing, understanding gained through experience or study.

For the purpose of this research, knowledge will be discussed from the philosophical point of view. The philosophical aspect on the theory of knowledge correlates with evidence as a theory. Further explanation of this correlation, will be drawn in Section 4.5 of this Chapter. It is essential to note that the topic on bodies of evidence has been discussed in Section 3.3 of Chapter 3. In order to link the evidence and knowledge the next Section offers the discussion on fundamental aspects of knowledge.

4.2 Epistemology

Epistemology involves the study of theories of knowledge or ways of knowing, particularly in the context of the limits or validity of the various ways of knowing. Knowledge includes, but is not limited to, those descriptions, hypotheses, concepts, theories, principles and procedures, which to a reasonable degree of certainty are either true or useful (Wikipedia). The first philosopher to define knowledge was Plato. He claimed knowledge as when someone says that he or she knows something (Southwell, 2003). The conditions are that:

(1) It must be true;

(2) one must actually believe it; and

(3) there must be sufficient evidence for it (it must be justified).

These three conditions have been taken into account in the latter part of this research. Chapter 5 will demonstrate the three conditions in the research methodology. In summary, the three conditions establish the structure of knowledge as "truth", "belief" and "sufficiency". The subject has to be true; one must actually believe and that it has to be sufficient (justified). The next Section extends the conditions by introducing the belief qualities.

4.3 Theory of Knowledge

In order to have knowledge, one has to have a belief, which is both true and justified (Morton, 1997). Both the facts and reasoning have to be right. A belief qualifies as knowledge if, in acquiring it, one has achieved the basic aim in the enquiry that led to it.

In discussing belief, there are two categories namely, internal and external. Figure 4.1 shows some qualities for beliefs:

External	Internal
o truth	o justification
o reliability	o coherence
o fact-tracking	o reasonability
o usability by others	o not undermined by others' belief

Figure 4.1: Qualities for Beliefs

There is a fundamental contrast between the internal and external qualities. The *external* qualities describe ways in which beliefs relate to the world around the

individual. Some theories of knowledge, internalist theories, emphasise internal aspects and qualities, while other, externalist theories, emphasise external aspects and qualities. The more a theory emphasises justification, evidence and reasoning, the more internalist it will be, and the more it emphasises reliability and the objective conditions under which a person's belief will be true, the more externalist it will be. Knowledge basically is based on both the internal and external qualities of a belief. The old definition of knowledge as justified true belief was in agreement with this fact, since it emphasised one external quality (*truth*) and one internal quality (*justification*) (Morton, 1997). The *internal* qualities describe ways in which beliefs relate to the functioning of the individual, aspects of the individual's reasoning and perceptual processes.

External	Internal
beliefs related to the world around the individual	individual's function, reasoning and perception

Table 4.1: External and Internal

Based on the summary in Table 4.1, an individual's function, reasoning and perception can be linked to the expert investigating each item of evidence listed in Chapter 5 and also the eyewitness statement. On the other hand the beliefs related to the world around the individual can be connected to the procedure and method in the investigation. In connection to the qualities of beliefs, the next section shall elaborate the types of knowledge and conditions for knowledge.

The area of knowledge pertaining to the items of legal evidence in this thesis refers to the *a priori knowledge*. *A priori knowledge* is usually defined as "*what is*

known independently of experience", or perhaps as "*what is known on the basis of reason alone*". The first one refers to the experience, which will be dealt with under the first two types of knowledge in the next section. The second one that refers to the basis of reason, refers to the standard literature (procedure or practice of investigation) that has been used by the investigator in each case. The background of the cases will be explained in Chapter 6. The next Section demonstrates five problems in discussing theory of knowledge. The problems will be addressed with basic introduction on each of them.

4.3.1 Problems of Knowledge

From the philosophical approach, there are five problems in knowledge. The five problems are (Williams, 2001):

1. The analytical problem (*analysis of the conditions of knowledge*)
2. The problem of demarcation (*external vs. internal*)
3. The problem of method (*how to obtain knowledge*)
4. Sceptism (*is it possible to obtain knowledge at all?*)
5. The problem of value (*if knowledge is worth having*)

In the context of this research, all five problems have been reflected in the research questions in Section 1.4 of Chapter 1[30]. The relevance has been discussed in the following points:

Problem 1: The analytical problem of knowledge refers to the vital question of *What is knowledge?* For example, how is (or should) knowledge be

[30]
1. How can each item of evidence be analysed (Chapter 7), based the reliability of the information pertaining to each individual case?
2. How can the theory of knowledge be applied to investigate whether the items of evidence fulfil the description of particular types of knowledge and conditions for knowledge? (Chapter 4).
3. Which means of analysis (Chapter 7), when applied to individual items of evidence, would generate a number of decisive factors (Chapter 9) that ensure the reliability and accuracy of the animation?

distinguished from mere belief or opinion (Williams, 2001)? At this point, what should be determined is a precise explication or analysis of the concept of knowledge. In the context of this research, legal evidence has a strong correlation to knowledge analysis in this problem due to the confidentiality, reliability and validity of source of information. The analytical problem of knowledge emphasises the concept and conditions of knowledge. These conditions together with the types of knowledge will be applied in the research methodology in Chapter Five. In conditions for knowledge that discusses truth, acceptance and justification, the legal evidence requires evidence must be supported by hypotheses and that the evidence must be produced with credentials (expert).

Problem 2: This divides into two sub-problems. (a) the external problem asks : given some account of what knowledge is, one can determine in a principled way what sort of things one might reasonably expect to know about? (b) the internal problem asks whether there are important boundaries within the province of knowledge (Williams, 2001). The segregation problem based on qualities has been discussed in the earlier Section. In the context of this research, the legal evidence must fulfil the internal qualities in a manner of what the expert (producing the evidence) would know in the investigation. On the other hand, the legal evidence should also fulfil the external qualities in the manner of whether there is restriction within the availability of information pertaining to the case under investigation.

Problem 3: This is the problem of method. The question to put forward is "*Is there just one way of acquiring knowledge, or are there several,*

depending on the sort of knowledge in question?" (Williams, 2001). In the context of this research, obtaining evidence, from the legal point of view, requires a reference to the appropriate jurisdiction of law. This has been discussed in Section 3.5 of Chapter 3.

Problem 4: The question about sceptism refers to the question: *Is it possible to obtain knowledge at all?* (Williams, 2001). In philosophical scepticism, this question has been linked with the theory of justification. Section 4.3.4 will discuss on theory of justification. In the context of this research, the facts and information must be obtained to conduct an investigation or inquiry.

Problem 5: The question put forward for this problem is *if knowledge is worth having?* (William, 2001). In the context of this research, the knowledge (evidence from the case) is worth obtaining or for the purpose of determining the cause and other litigation purposes. Secondly, the knowledge has then become information for the animator to generate the CGA.

Having said this, the correlation that exists in all the problems with the legal evidence will form the significant points for this research. At this point it is essential to revisit the definition of knowledge offered earlier in this Chapter. According to the analysis of the concept of knowledge, S knows that p (where 'S' stands for an arbitrary person and 'p' for an arbitrary proposition) if and only if:

(1) S believes p - the belief condition;

(2) p is true - the truth condition; and

(3) S's belief that p is appropriately justified - the justification condition.

The belief condition excludes ignorance, the truth condition excludes error, and the justification condition excludes mere opinion. In summary it follows as: (1) S believes p; (2) p is true; (3) S is personally justified in believing p; and (4) S believes p on the basis of adequate "grounds" (Williams, 2001).

"Grounds" refer to legal evidence obtained from the collision or crime scene. This legal evidence is the information or facts for the case under investigation. The investigation based on the legal evidence is the knowledge that will be presented in a court of law, and to be accepted as admissible evidence. This explanation broadens the basic definition of knowledge made by Plato earlier.

The "adequate grounds" in this Chapter forms a relationship with "creditable standing" from Chapter 3. The essential facts from bodies of evidence in the previous chapter show that "*e* (evidence) should speak in favour of *h* (hypotheses); and *e* should have some kind of creditable standing".

4.3.2 Types of Knowledge

Types of knowledge based on Lehrer (2000) classification, can be divided into three main categories as follows:

- *Competence.* An example of competence is when an individual displays competence, the interpretation is, that he or she knows how.

- *Acquaintance.* An example of acquaintance is when an individual may be said to know that with which he or she is acquainted. To say that one knows something, in this sense, is to say that they have had some experience with what they know.
- *Recognition of information as being correct.* This is knowledge in the (correct) "information" sense. To know is to recognise correct information as being correct.

These types of knowledge have been described pertaining to the police officer or expert producing the item of evidence in Chapter 5. The eyewitness has also been described pertaining to the statement that he or she made in, Chapter 5. In this research, the types of knowledge will be interpreted in the pragmatic stage based on the expert producing the evidence (training, qualifications, experience and the presence of the expert at the collision vicinity or crime scene).

4.3.3 Conditions for Knowledge

The second element refers to the conditions for knowledge. Here '*S*' and '*p*' are variables. '*S*' represents any individual that can know information, and '*p*' represents any information that can be known. Based on the same classification by Lehrer, knowledge must satisfy three natural conditions (Lehrer, 2000):

- *That the information p be correct.*

  The first condition is that the information *p* be true.

  S knows the information *p*.

- *That S accepts the information p.*

  To recognise information as correct is to have an attitude toward it. The knower *S* endorses the information in the sense that *S* stands behind it or endorses it as being correct. Another way to describe the endorsement is to say that *S* thinks that *p* is correct or true information.

- *That the acceptance of the information that p be justified.*

  Justification lies between reasonableness and complete certainty. There is a lot of ground between reasonableness and complete certainty. This condition has been expanded in the following paragraphs under "*justified true belief*" and *theory of justification*".

The explanation in this section widened the definition given earlier by Plato and sub-section 4.2.1. Conditions for knowledge have been described pertaining to the specific rules applied in the investigation process to the items of evidence in, Chapter 5. The eyewitness has also been described pertaining to the human perception in, Chapter 5. Similar to the explanation in 4.3.2, the conditions for knowledge will be interpreted in the pragmatic stage based on the method of investigation undertaken by the expert.

4.3.4 Theory of Justification

This section acknowledges the importance of the theory of justification as part of the concept in the analysis. Justification appears as the third condition. In other words, the general rule pertaining to the theory of justification is that:(Wikipedia)

If a belief, Q, is justified by another belief, P, then P must itself be justified. If P is not justified, then it surely cannot justify Q. The only way that P could justify Q is if P is itself first justified.

The important connection between knowledge and justification refers to the questions of: (a) "*How do you know?*"; and (b) "*What justifies you in believing?*" . One way of thinking about the connection is to view knowledge as an achievement that can be further understood as having good reasons for a belief. Some philosophers generally acknowledged that epistemic justification is a necessary condition for knowledge (Pollock, 1999). Until 1963, it was almost universally agreed that knowledge was the same thing as justified true belief. That is, a person knows something, *P*, if and only if (1) she believes it, (2) it is true, and (3) her belief is justified.

In this research, the justification theory strengthened the earlier definition on knowledge. Justification is the third condition that will be referenced in the methodology (Chapter 5). Problem 4 that has been discussed in section 4.3.1 asks whether is it possible to obtain knowledge that has been linked with theory of justification. In the context of this research, the procedure to obtain legal evidence must conform to appropriate jurisdiction. The justification aspect has also been considered as the third conditions for knowledge (explained in Section 4.3.3).

4.4 Justified True Belief (JTB)

This Section will discuss "justified true belief" posed by Gettier (1963). Gettier had challenged the traditional definition of knowledge as proposed by Plato almost two and a half thousand years before (explained in Section 4.2). In his objection, Gettier imagined a situation where all the traditional conditions for knowledge were fulfilled - and yet one could not say that it constituted knowledge. For instance, (a) Kate believes that John is in his room; (b) Kate sees John in his room; and (c) Kate is justified in believing John is in his room.

This fulfils the traditional conditions of knowledge. John is in his room, Kate believes that he is and is justified in doing so. However, unknown to Kate, what she sees in John's room is not John at all, but his twin brother Jack. Also, John is hiding under the bed. From this point of view, it would appear that Kate is right, but only by coincidence. John is in the room (albeit under the bed), Kate is justified in believing he is, except that it cannot be said to be a genuine case for knowledge because Kate is only correct through coincidence (Southwell, 2003).

Based on this example, there have been 4 main attempts to alter the tripartite theory by Gettier by introducing another condition to the triangle (*making it a square*).

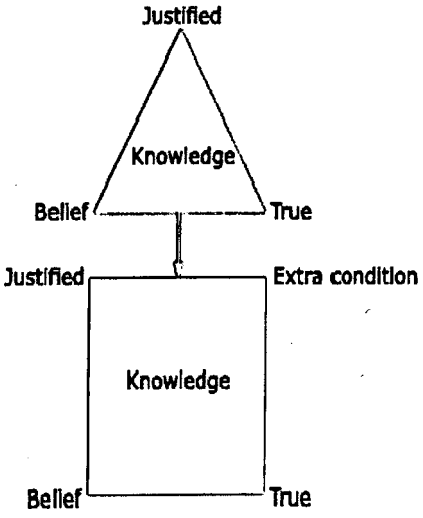


Figure 4.2: Tripartite Theory by Gettier

The extra condition in Figure 4.2 can be described as: (1) *No False Belief Condition*: Beliefs cannot be based on a false belief. This attempt argues that no knowledge can be claimed if it relies on a false belief. E.g., it is false that Kate is actually looking at John. (2) *Causal Connection Condition*: There must be a causal connection between the knowledge and the belief. This first argument states that a belief must have an appropriate connection to the knowledge claimed (Goldman, 1967). E.g., *Kate should not be able to claim that she knows John is in the room because there is no 'appropriate connection' between her viewing Jack (John's twin brother) and her conclusion that John is in the room.* (3) *Conclusive Reasons Condition*: A reason must exist for the belief that would not be true if the belief itself were false. Dretske (1988), stated that , if, for example, one believes that there is a chair in front of him/her, the reason for believing that it is there would not exist if the belief were false (that is, if the chair were not there). (4) *Defeasibility Condition*: Something is known as long

as there is no evidence to the contrary. This is a common sense view, argued by Lehrer. Paxson (1969), argues that Kate would be perfectly entitled to claim that she knows that John is in the room because she is not aware of anything to the contrary. Another example would be the flat earth theory, or the concept that the earth was the centre of the universe. These were once claimed as knowledge by the majority of people - until further knowledge arrived to prove differently.

With regard to the extra conditions, the ground on causal forms a relationship with the items of evidence classified under eyewitness statement in Chapter 5. The following section shall describe the ground on causal theory.

4.4.1 Causal Theory

The causal theory is appealing especially as an account of perceptual knowledge because in perception one enters into a causal relationship with the object perceived. The Goldman's analysis states that (Mattey, 2002),

> *S* knows that *p* if and only is the fact that *p* is causally connected in an "appropriate" way with *S's* believing *p*.

Since this causal connection is what provides the information about perceived objects, it would seem that the knowledge of the objects is a product of that causal connection. A direct example to this connection is,

> *S* does not know that *S* sees a sheep because the belief that he sees a sheep is caused by the presence of the dog in the foreground, not the sheep in the background.

In the context of this research, the example described here can be associated with the fact that an eyewitness heard a shot that he or she believes came from a gun. When the eyewitness arrived at the scene, he/she saw the victim lying on the ground. The eyewitness believed that the gun shot that he/she heard was the one that killed the victim.

Parallel with what has been stated, the eyewitness statement consists of a series of observations and perceptions through the five human senses (Chapter 5). These observations and perceptions are regarded as empirical knowledge for the eyewitnesses.

4.5 Conclusion

It may be obvious at this point based on Plato (in Section 4.2), *knowledge must be true and one must believe it based on justification (sufficient evidence).* Sufficient evidence in the definition may be seen as items of legal evidence that constitute knowledge to the animator. Hence, for the purpose of this research theory of knowledge will be applied on the grounds that:

(1) Knowledge refers to the items of evidence from the accident or crime scene (*that it must be true*).

(2) The types and conditions for knowledge correspond with the characteristics of evidence obtained from the accident or crime scene (*this will be demonstrated in the next Chapter on research methodology*).

These two elements, the types and conditions of knowledge are

interrelated with the condition that *one must believe it* (the item of evidence). (*E.g., the expert investigating a particular accident or crime must believe that the evidence obtained is true*). It may now be perceptible that knowledge (facts on the accident or crime) are based on sufficient evidence and therefore, justified.

(3) Bodies of evidence, discussed in Chapter 3, can be summarised as evidence supporting hypotheses; and that the evidence must have a creditable standing. The interrelation of bodies of evidence and conditions for knowledge can be seen as;

a. *e* supports *h*; (evidence supports hypotheses)

b. *e* has a creditable standing (evidence produced by expert with credibility); therefore,

c. *truth*, *acceptance* and *justified* (conditions for knowledge)

This is the final Chapter of the three literature topics that form the foundation of the research methodology and the analysis undertaken. The findings and implications drawn at the end of this thesis have been based on this foundation. Chapter 1 has described the emergence and potential dangers of animation. Chapter 2, on reconstruction of an event highlights the background of accident and forensic animation process. Chapter 3 explains evidence in two approaches, legal and philosophical. Chapter 3 also describes the jurisdiction and case law pertaining to the admissibility of expert opinion.

As a result of the three literature topics, this research envisages the importance of evidence as information for the animator to generate the animation. The question on reliability and accuracy of CGA for court litigation matters can be determined by analysing the items of legal evidence produced by the expert. The process in determining the reliability and accuracy of CGA in this research begins with the research methodology that incorporates the literature on evidence and knowledge. In the next Chapter, the research design will be explained for the purpose of constructing the methodology that will be applied to the analysis in Chapter 7. The knowledge elements have been integrated as essential parts of the methodology.

Chapter 5

Research Methodology

5.1 Introduction

This Chapter explains the methodology based on both quasi-experimental and pragmatic approaches. A quasi-experiment is one that resembles an experiment but lacks at least one of its defining characteristics. Quasi-experiments are sometimes called *ex post facto* or after the fact experiments because the experiment is conducted after classification has been made (McBurney, 2001). In the context of this research, the classification refers to the evidence classification discussed in the latter part of this Chapter. In the context of this research, the *ex post facto* refers to the analysis in Chapter 7.

The second part of the analysis embraces a pragmatic approach. It emphasises the usefulness of the scores assigned in the quasi-experimental stage. Quasi-experimental stage begins with the classification of evidence into four groups:

(a) written evidence;

(b) spatial evidence;

(c) visual images; and

(d) eyewitness statements.

On the other hand, the pragmatic stage, encompasses the conversion of vital aspects from quasi-experimental stage into the imperative features pertaining to the expert producing the items of legal evidence. This stage will also demonstrate a sensitivity analysis, which involves manipulation of scores assigned from the quasi-experimental stage in order to determine whether it does in fact have an influence on the items of legal evidence.

5.2 Quasi-experimental Stage

The quasi-experimental stage has four main elements. The elements are:

a. the case studies,
b. legal and forensic evidence,
c. the computer-generated animation and
d. the integration of elements from theory of knowledge.

5.2.1 Cases and Items of Evidence

This stage begins by analysing items of evidence from six cases. The summary of each case is:

a. The first case involves a collision between two motorbikes and a motorcar (C1).
b. The second case involves a collision between a single motorbike and a motorcar (C2).
c. The third collision involves two motorcars on a head-on collision (C3).
d. The fourth case is a murder investigation (C4).

In all four cases (C1-C4), evidential items have been provided by a group of experts involved in the generation of CGAs.

The remaining two cases namely C5 and C6 are a computer forensic investigation and a maritime accident respectively. The details of both C5 and C6 have been obtained through various sources, mainly from the Internet. These two cases have been included in this research to demonstrate the importance of explaining some of the complex technical facts.

The following list, shows the case reference and description. The reference uses a using the letter "C" followed by a number accordingly in Table 5.1:

Case 1	C1	Road traffic collision between a motorcar and two motorbikes.
Case 2	C2	Road traffic collision between a motorcar and a motorbike.
Case 3	C3	Road traffic collision between two motorcars.
Case 4	C4	A murder investigation.
Case 5	C5	Computer Forensics Investigation.
Case 6	C6	Marine Accident investigation.

Table 5.1: Referencing table for case studies used in the research

The evidence concerned with each of the cases will be referenced using the letter "E" and a digit according to number of evidential items under consideration for a case. For example, "E1" is item of evidence No. 1; the bracket "(1)" after "E" shows that the item is from Case 1. The summary of each items listed below in Table 5.2 will be expanded upon in Chapter 6.

Case 1		
(i)	E1(1)	Crash Investigation Report
(ii)	E2(1)	Police Statement
(iii)	E3(1)	Plan (road layout)
(iv)	E4(1)	Eye-witnesses' statements
Case 2		
(i)	E1(2)	Book of Accident
(ii)	E2(2)	Police Statement
(iii)	E3(2)	- Vehicle Examination Report and - Forensic Scientist Report
(iv)	E4(2)	Eye-witnesses' statements
(v)	E5(2)	Two Reconstruction Reports
Case 3		
(i)	E1(3)	Police Statement
(ii)	E2(3)	Coroner's Inquest Report
(iii)	E3(3)	Police Reports prepared at the collision vicinity
(iv)	E4(3)	Eye-witnesses' statements
(v)	E5(3)	Two Survey Maps
(vi)	E6(3)	Two Overhead Plans of debris
(vii)	E7(3)	Paper copy of digital image reference material
(viii)	E8(3)	Photographs
Case 4		
(i)	E1(4)	Report by the police authority
(ii)	E2(4)	Report from Independent Consultant
(iii)	E3(4)	Plan (environment of crime scene)
(iv)	E4(4)	Eye-witnesses' statements
Case 5		
(i)	E1(5)	Data Recovery Report
Case 6		
(i)	E1(6)	Report on the investigation
(ii)	E2(6)	Drawings and Sketches
(iii)	E3(6)	Photographs

Table 5.2: Summary of each item from case studies used in the research

5.2.2 Classification of Evidence

CGAs have been prepared for four cases, three cases were road traffic collisions and one was a murder investigation. Each of the items of evidence will be classified based on the type of evidence. This classification has been adopted

and developed from the definitions and introduction in Chapter 3. Four types of evidence have been identified from these definitions. For the purposes of this research, the four types are:

1. Written evidence. Written evidence in this research refers to all reports prepared by the expert such as the police officer, forensic scientist, crash investigator, collision reconstructionists, and other experts' reports.
2. Spatial Evidence. Spatial evidence in this research refers to the maps, charts, and models. It is essential to note that this type of evidence is used to demonstrate or explain matters and is usually corroborated with other items of evidence such as a report on the collision.
3. Visual images. Visual images in this research refer to photographs and digital image reference material[31].
4. Eyewitness. Statements by eyewitnesses will be included under this type of evidence.

[31] In the context of this research, the conditions for knowledge (Section 4.3.3, Chapter 4) refer to the specific or scientific rule that was applied in the process of capturing images and taking photographs. This ranged from visiting the collision scene to verifying the images with the authorised person in-charge. For conventional photography, the negatives are often referred to as the primary or original images and prints and copies are made from them. For video and analogue recording the first tape is sealed as a Master once the first copy has been made from it. A copy of an analogue tape is always a degraded version because noise is added at each copying. This is compounded by the physical wear and tear of the tape. Digital image files can be used in exactly the same way as conventional photography and video with written audit trails. Electronic audit trails if available can augment the written audit trails. Digital images should not be thought of as replacements for conventional photographs and videos but alternative technologies. These elements of the procedure include the preparatory steps before images are captured. This may be directly before the images are taken, or at an earlier stage or date where work can be anticipated. The steps identify the importance of: (Home Office, 2002)

- obtaining relevant authorisations;
- starting an audit trail at the earliest opportunity when it is known that images are to be captured; and
- checking equipment, either routinely or at the commencement of the image capture activity.

Table 5.3 summarises the position of each item under four classes of evidence from the case studies.

Classification	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
A Written evidence	E1(1)	E1(2)	E1(3)	E1(4)	E1(5)	E1(6)
	E2(1)	E2(2)	E2(3)	E2(4)	-	-
	-	E3(2)	E3(3)	-	-	-
	-	E5(2)	-	-	-	-
B Spatial evidence	E3(1)	-	E5(3)	E3(4)	-	E2(6)
	-	-	E6(3)	-	-	-
C Visual images	-	-	E7(3)	-	-	E3(6)
	-	-	E8(3)	-	-	
D Eye-witness	E4(1)	E4(2)	E4(3)	E4(4)	-	-

Table 5.3: Referencing table for items of evidence

5.2.3 Types of Knowledge and Condition for Knowledge

The types of knowledge and conditions for knowledge, which then lead to the theory of justified true belief and theory of justification, have been perceived as having a strong correlation with the fundamentals of evidence. This correlation was discussed at the end of Chapter 4. The types of knowledge and conditions for knowledge will be referenced as K1a, K1b, K1c, K2a, K2b, and K2c shown in Table 5.4.

K1	Types of Knowledge	K2	Conditions for Knowledge
K1a	Competence	K2a	Truth
K1b	Acquaintance	K2b	Acceptance
K1c	Recognition of information as being correct	K2c	Justification

Table 5.4: Referencing the selected concepts

All the six aspects will be feasible to the analysis in Chapter 7. These aspects will be referred to as concept throughout the analysis. The six aspects will be referenced using the letter "K" from the word "knowledge".

5.2.4 Correlation Between Various Elements

Table 5.3 summarises the correlation between various elements during the quasi-experimental stage of this research. The explanation of this correlation follows Table 5.5.

C: case	E: evidence	A: animation
K1 — K1a, K1b, K1c	K2 — K2a, K2b, K2c	

Inference

1. E for each C may differ.
2. Whether A has been produced based on E.
3. If yes, how many of E.
4. E, whether the animator has used one or more that, shall be numbered. For example E1, E2.
5. Each E will be measured against K1-K2.
6. The purpose of measurement is to evaluate the reliability and accuracy of A based on E.

Table 5.5: Correlation between various elements

The inference (Table 5.5) made from these correlations begins with the fact that each item of evidence is different from one case to another. For example, a speed calculation may be produced for a road traffic collision case; on the other hand, a ballistic analysis may be produced in a murder investigation case involving firearms. The second aspect is to determine whether the animation has been generated based on items of evidence. All the items furnished by the client (such as police officer, reconstruction expert, data recovery laboratory) to the animator will be numbered as in Table 5.3. The items will then be measured against the concepts summarised in Table 5.4. The ultimate purpose of the analysis is to

evaluate the reliability and accuracy of the animation based on the items of evidence. Although there is no absolute certainty in determining the reliability and accuracy, the analysis aims to achieve a particular degree of certainty (based on the concept) of the reliability and accuracy of a CGA.

5.2.5 Theory of Certainty (Certainty Factors)

Standard statistical methods are based on the assumption that an uncertainty is the probability that an event (or fact) is true or false. Certainty theory relies on the use of certainty factors. Certainty factors (CFs) express belief in an event (or fact or hypothesis) based on evidence (Turban, 2001).

A certainty factor is a number, often in the range -1 to +1, which is associated with a condition or an action of a rule. In more detail, each component of a condition may have an certainty factor associated with it - for example if the condition is of the form A and B, then there could be a certainty factor for A and a certainty factor for B.

A certainty factor of 1 means that the fact (or proposition) is highly certain. A certainty factor of 0 means no information about whether the proposition is true or not. A certainty factor of -1 means that the proposition is certainly false. A certainty factor of 0.7 means that the proposition is quite likely to be true, and so on (Wilson, 2004). This description has been shown in Table 5.6.

Concurrently, in defining knowledge, there are two further matters to be taken into consideration, namely the degree of certainty and the degree of precision. All knowledge is more or less uncertain and more or less vague (Russell, 1926).

No.	Conditions
0	never
0.1	very uncommon
0.2	uncommon
0.3	not usual (general)
0.4	sometimes
0.5	neutral (similar)
0.6	quite common
0.7	common
0.8	very common (exactly)
0.9	principally
1	always

Table 5.6: Range of certainty factors from 0 to 1.0

In this research, the standard scores represent the description. Table 5.7 may also be seen as a probability table that exists for estimating the likelihood that a certain score will appear in the evidence evaluation. Each of the concepts (K1a-K2c) has been assigned standard scores as described in Table 5.7. These scores have been divided into three categories referred to as general, similar or exactly, and have been identified based on the description of each concept. The middle score for *general* category is 0.3; *similar* is 0.5 and *exactly* is 0.8.. The list below shows that for each condition, there is a certainty factor characterised by a key word, which represents the important degree of the description defined in Table 5.7.

Concept(*)	Score	Data/Description	Category
K1a	0.1 0.2 0.3	*had qualification and training on general investigation process*	GENERAL
	0.4 0.5 0.6	*had qualification and training pertaining to a similar case*	SIMILAR
	0.7 0.8 0.9 1	*had qualification and training on exactly the same type of case under investigation*	EXACTLY
K1b	0.1 0.2 0.3	*had previous experience on general investigation process*	GENERAL
	0.4 0.5 0.6	*had previous experience pertaining to a similar case*	SIMILAR
	0.7 0.8 0.9 1	*had previous experience on exactly the same type of case under investigation*	EXACTLY
K1c	0.1 0.2 0.3	*had obtained only a list of evidence*	GENERAL
	0.4 0.5 0.6	*had obtained the physical evidence from a third party (description/summary)*	SIMILAR
	0.7 0.8 0.9 1	*had visited the scene and obtained physical evidence*	EXACTLY
K2a	0.1 0.2 0.3	*had applied a scientific/specific rule based on experience, training and qualification for other types of case*	GENERAL
	0.4 0.5 0.6	*had applied a scientific/specific rule based on experience training and qualification for a similar type of case*	SIMILAR
	0.7 0.8 0.9 1	*had applied a scientific/specific rule based on experience training and qualification for the case under investigation*	EXACTLY
K2b	0.1 0.2 0.3	*ability to endorse the scientific/specific rule based on experience, training and qualification for other types of case*	GENERAL
	0.4 0.5 0.6	*ability to endorse the scientific/specific rule based on experience, training and qualification for a similar type of case*	SIMILAR
	0.7 0.8 0.9 1	*ability to endorse the scientific/specific rule based on experience, training and qualification for the case under investigation*	EXACTLY
K2c	0.1 0.2 0.3	*ability to validate the scientific/specific rule based on experience, training and qualification for other types of case*	GENERAL
	0.4 0.5 0.6	*ability to validate the scientific/specific rule based on experience, training and qualification for a similar type of case*	SIMILAR
	0.7 0.8 0.9 1	*ability to validate the scientific/specific rule based on experience, training and qualification for the case under investigation*	EXACTLY

(*) K1a: competence; K1b: acquaintance; K1c: correct information; K2a: truth; K2b: acceptance; K2c: justification

Table 5.7: Certainty factors and description based on item of evidence

In supplement to Table 5.7, eyewitness statements are considered as the fourth classification. These require a different description from the concepts of K1 and K2. Eyewitness' statements can be valuable even though these statements are not usually based on any scientific rule. In the court, when a CGA demonstrates a collision or event sequence based on the expert testimony, the judge or the counsel may ask the eyewitness to confirm that the CGA is an accurate representation of the events leading up to the collision or incident. Information obtained and gathered from these statements is useful in the reconstruction process to clarify:

1. The chronology of the events leading to the collision.
2. The position of vehicles, people and objects within the vicinity of the collision or crime.

Apart from clarifying these essential aspects in the reconstruction, the eyewitness' statements may possibly be analysed based on other factors relating to the eyewitness such as:

1. The five aspects related to human senses (sight, hearing, touch smell, taste).
2. Intellectual capabilities (levels of education, ability to communicate well, potential influence due to physical illness). This may also include neurological conditions and metabolic and related diseases of the eyewitness. For example, an eyewitness with diabetes may experience hypoglycaemia[32]. This could affect the reliability and accuracy in the

[32] Hypoglycaemia most commonly affects patients receiving treatment for their diabetics, either in the form of injectable insulin or tablets designed to lower blood sugar (oral hypoglycaemia). Anybody suffering from hypoglycaemia will prove to be a poor witness to events that occur during the episodes. Available at www.bbc.co.uk/health

statement made by the eyewitness due to this type of condition (this is only an example- none of the eyewitness in the analysis suffers from this condition).

For the purpose of analysing the eyewitness statements, the concept of K1 and K2 will be applied in a different way to what has been developed for the items of evidence in the Table 5.7. Table 5.8 summarises the description for eyewitness statements.

Concept	Interpretation for eyewitness statement
K1a: competence	The capabilities of the eyewitness as he or she was involved during the collision or crime.
K1b: acquaintance	The experience in relation to how he or she was involved during the collision or crime.
K1c: correct information	The eyewitness was at the collision or crime vicinity.
K2a: truth	The description based on five human senses.
K2b: acceptance	The endorsement from the eyewitness on his or her description based on intellectual capabilities.
K2c: justification	The eyewitness' affirmation on what he or she has described earlier.

Table 5.8: Certainty factors and description based on eyewitness statements

The category and the middle score remain the same as the earlier section. Table 5.9 describes an overview of the proposed methodology in this Chapter. The "A" box shows Case 1 as example. The "B" summarises the elements of knowledge that will be incorporated in the research methodology. Finally the "C" box illustrates the three categories and the middle score from each of the category.

A	Case 1		
	Written Evidence (Crash Investigation Report) & Police Statement E1(1) & E2(1)	Spatial Evidence (Plan) E3(1)	Eyewitness' Statement (Testimony) E4(1)

B	Elements from Theory of Knowledge	
	K1 (Types of Knowledge)	K2 (Conditions for Knowledge)
	K1a (competence)	K2a (truth)
	K1b (acquaintance)	K2b (acceptance)
	K1c (correct information)	K2c (justification)

C	Category	
	General	0.3
	Similar	0.5
	Exactly	0.8

Table 5.9: Overview of the proposed methodology

5.2.6 Reference for Analysis

A series of analysis has been done in Chapter 7. Each analysis has been done based on the four classifications of evidence stated earlier. The list of analysis reference and summary are shown below. A sample of description is shown with the mark (*) at the end of each classification.

1. Written evidence

Analysis Reference	*Analysis Summary*
a1	E1(1): Case 1; K1a, K1b *
a2	E1(2), E1(3), E1(4), E1(5), E1(6): Case 2, Case 3, Case 4, Case 5 and Case 6; K1a, K1b
a3	E1(1), E1(2), E1(3), E1(4), E1(6): Case 1, Case 2, Case 3, Case 4 and Case 6; K1c
a4	E1(5): Case 5; K1c
a5	E1(1): Case 1; K2a, K2b, K2c
a6	E1(2), E1(3), E1(4), E1(5), E1(6): Case 2, Case 3, Case 4, Case 5 and Case 6; K2a, K2b, K2c
a7	E2(1), E1(2): Case 1, Case 2 (Police 1); K1a, K1b
a8	E2(2), E1(3): Case 2 (Police 2), Case 3; K1a, K1b
a9	E2(4): Case 4; K1a, K1b
a10	E2(1), E1(2), E1(3), E1(4): Case 1, Case 2, Case 3 and Case 4; K1c
a11	E2(1), E1(2): Case 1 and Case 2; K2a, K2b, K2c
a12	E2(2), E2(3), E1(4): Case 2, Case 3 and Case 4; K2a, K2b, K2c
a13	E3(2): Case 2; K1a, K1b
a14	E3(3): Case 3; K1a, K1b
a15	E3(2), E3(3): Case 2 and Case 3; K1c
a16	E3(2): Case 2; K2a, K2b, K2c
a17	E3(3): Case 3; K2a, K2b, K2c
a18	E5(2): Case 2 ; K1a (Expert A)
a19	E5(2): Case 2 ; K1b (Expert A)
a20	E5(2): Case 2 ; K1a, K1b (Expert B)
a21	E5(2): Case 2; K1c (Experts A and B)
a22	E5(2): Case 2 ; K2a, K2b, K2c (Experts A and B)

Table 5.10: Analysis reference and summary for written evidence

Note: K1a: competence; K1b: acquaintance; K1c: correct information;
K2a: truth; K2b: acceptance; K2c: justification. (See Table 5.)
E1 has been produced from each case studies. E1(1): Crash Investigation Report (Case 1), E1(2) Book of Accident (Case 2), E1(3) Police Statement (Case 3), E1(4) Report from police authority (Case 4), E1(5) Data Recovery Report (Case 5), E1(6) Report on investigation (Case 6) (See Table 5.2)
E2(1) and E2(2):Police Statement (Cases 1 and 2), E2(3) Coroner's Inquest Report (Case 3), E2(4) Report by an independent consultant (Case 4).
E3(2): Vehicle Examination Report and Forensic Scientist Report (Case 2), E3(3) Police Reports prepared at the collision vicinity (Case 3).
E5(2): Two Reconstruction Reports (Case 2)

* In analysis a1, the Crash Investigation Report (E1(1)) has been assessed for K1a (competence) and K1b (acquaintance).

2. Spatial evidence

Analysis Reference	*Analysis Summary*
b1	E3(1): Case 1; K1a, K1b
b2	E5(3),E6(3): Case 3, E3(4): Case 4, E2: Case 6; K1a, K1b*
b3	E3(1): Case 1, E5(3), E6(3): Case 3, E3(4): Case 4, E2(6): Case 6; K1c
b4	E3(1):Case 1, E5(3), E6(3): Case 3; K2a, K2b, K2c
b5	E3(4): Case 4, E2(6): Case 6; K2a, K2b, K2c

Table 5.11: Analysis reference and summary for spatial evidence

Note:
K1a: competence; K1b: acquaintance; K1c: correct information;
K2a: truth; K2b: acceptance; K2c: justification. (See Table 5.4)
E2(6): Drawings and Sketches (Case 6)
E3(1): Plan (Road Layout) (Case 1); E3(4): Plan (Environment) (Case 4)
E5(3), E6(3): Two Overheads Plans (Case 3)

* In analysis b2, the two Survey Maps and two Overhead Plans (E5(3) and E6(3)) from Case 3; the Plan (E3(4)) from Case 4 and Drawings and Sketches (E2(6)) from Case 6 have been assessed for K1a (competence) and K1b (acquaintance).

3. Visual images

Analysis Reference	*Analysis Summary*
c1	E7(3), E8(3): Case 3, E3(6): Case 6; K1a, K1b
c2	E7(3), E8(3): Case 3, E3(6): Case 6; K1c
c3	E7(3), E8(3): Case 3, E3(6): Case 6; K2a, K2b, K2c *

Table 5.12: Analysis reference and summary for visual images

Note: K1a: competence; K1b: acquaintance; K1c: correct information;
K2a: truth; K2b: acceptance; K2c: justification. (See Table 5.4)
E3(6): Photographs (Case 6)
E7(3), E8(3): paper copy of digital images and photographs

* In analysis c3, the paper copy of digital images and photographs (E7 and E8) from Case 3 and the photographs (E3) from Case 6 have been assessed for K2a (truth), K2b (acceptance) and K2c (justification).

4. Eyewitnesses' Statements

Analysis Reference	*Analysis Summary*
d1	E4(1): Case 1 (W1(1)); K1a, K1b *
d2	E4(1): Case 1 (W1(1)); K1c
d3	E4(1): Case 1 (W1(1)); K2a, K2b, K2c
d4	E4(1): Case 1 (W2(1)); K1a, K1b
d5	E4(1): Case 1 (W2(1)); K1c
d6	E4(1): Case 1 (W2(1)); K2a, K2b, K2c
d7	E4(1): Case 1 (W3(1)); K1a, K1b
d8	E4(1): Case 1 (W3(1)); K1c
d9	E4(1): Case 1 (W3(1)); K2a, K2b, K2c
d10	E4(1): Case 1 (W4(1)); K1a, K1b
d11	E4(1): Case 1 (W4(1)); K1c
d12	E4(1): Case 1 (W4(1)); K2a, K2b, K2c
d13	E4(1): Case 2 (W1(2)); K1a, K1b
d14	E4(1): Case 2 (W1(2)); K1c
d15	E4(1): Case 2 (W1(2)); K2a, K2b, K2c
d16	E4(2): Case 2 (W2(2)); K1a, K1b
d17	E4(2): Case 2 (W2(2)); K1c
d18	E4(2): Case 2 (W2(2)); K2a, K2b, K2c
d19	E4(2): Case 2 (W3(2)); K1a, K1b
d20	E4(2): Case 2 (W3(2)); K1c
d21	E4(2): Case 2 (W3(2)); K2a, K2b, K2c
d22	E4(3), E4(4): Case 3 and Case 4 (all eyewitnesses); K1a, K1b
d23	E4(3), E4(4): Case 3 and Case 4 (all eyewitnesses); K1c
d24	E4(3), E4(4): Case 3 and Case 4 (all eyewitnesses); K2a, K2b, K2c

Table 5.13: Analysis reference and summary for eyewitness' statements

Note: K1a: competence; K1b: acquaintance; K1c: correct information;
K2a: truth; K2b: acceptance; K2c: justification. (See Table 5.4)
E4(1), E4(2), E4(3) and E4(4): Eyewitness' statements
W1(1): the car driver in Case 1; W2(1) and W3(1) are two eyewitnesses at the collision vicinity
W1(2): the car driver in Case 2; W2(2) and W3(2) are two eyewitnesses at the collision vicinity
For cases 3 and 4, the eyewitness will be referred to as "all eyewitnesses"

* In analysis d1, the statement (E4(1)) made by the first eyewitness (W1(1)) has been assessed for K1a (competence) and K1b (acquaintance).

5.3 Pragmatic Stage

These are the pragmatic factors derived from the quasi-experimental process conducted from K1 and K2 upon evidence collected from the case. The concepts from K1 and K2 have been pragmatically referred to as R1 – R6. These factors are described in Table 5.14. Based on the concepts of K1 and K2, three vital qualities are derived pertaining to the item of evidence that has been used to animate the CGA. The qualities are,

1. Concerning the expert. This relates to the status of competency and experience of the expert handling such investigation.
2. Concerning the real evidence. This refers to the physical evidence obtained from the scene.
3. Concerning the expert working process. This encompasses the process of investigation as to whether specific rules or procedures have been observed.

	Concerning the expert
R1	*Status of competency. This would cover training and qualification of the expert.*
R2	*Experience in handling such cases.*
	Concerning the real evidence
R3	*Whether the testimony has been based on real/physical evidence from the scene*
	Concerning the expert working process
R4	*Whether the testimony has been based on specific or scientific rule pertaining to the case.*
R5	*Whether the expert can endorse his/her inference by applying those specific or scientific rules pertaining to the case.*
R6	*Whether the expert can validate/justify the inference/conclusion of his/her investigation pertaining to the case.*

R1-R6: Reference for factors

Table 5.14: Reference and qualities for factors in pragmatic stage

5.3.1 Conversion from Concepts to Factors

It is essential to note that the quasi-experiment based on K1 and K2 has been interpreted into R1 to R6. Table 5.15 offers a summary of factors (R1-R6) in Table 5.13 The use of capital "R" to reference the factors has been rationalised from the analyses in Chapter 7 based on the concepts K1(a-c) and K2(a-c). The factors are the results from all the analysis.

The quasi-experimental analysis undertaken in Chapter 7 will demonstrate that the K1 (types of knowledge) and K2 (conditions for knowledge) are qualities that can be transformed into factors described in Table 5.14.

Quasi-experimental stage	Pragmatic stage
o K1a	o R1 (expert)
o K1b	o R2 (experience of the expert)
o K1c	o R3 (physical evidence)
o K2a	o R4 (scientific/specific rule)
o K2b	o R5 (endorsement)
o K2c	o R6 (validation)

Table 5.15: Conversion from concepts to factors

Based on all the concepts in Table 5.7, Table 5.16 summarises the descriptions for each of the factors accordingly. Chapter 8 will be emphasising the underlying findings resulting from the quasi-experimental analysis. Accordingly, Chapter 9 will present the findings as implications to the research questions in Section 1.4 of Chapter 1. In a further attempt to determine the reliability and accuracy of CGA based on evidence analysis, Chapter 9 will undertake a sensitivity analysis based on the findings and implications. In order to conduct the sensitivity analysis, it is necessary to manipulate the factors (R1-R6) in order to determine whether then

does in fact have an influence on the items of legal evidence. Manipulation, then, entails intervening in a situation to determine which of two or more things happen to subjects (Bryman, 2001).

Result	*Score*	*Examples*	*Category*
R1	0.1 0.2 0.3	Expert Y has had qualification and training pertaining to a broader field in the investigation	GENERAL
	0.4 0.5 0.6	Expert Y has had qualifications and training in road collision or criminal investigations	SIMILAR
	0.7 0.8 0.9 1	Expert Y has had qualification and training based on a fatal road collision or murder involving firearms	EXACTLY
R2	0.1 0.2 0.3	Expert Y has had previous experience on the general investigation process	GENERAL
	0.4 0.5 0.6	Expert Y has had previous experience on road collision or criminal investigations	SIMILAR
	0.7 0.8 0.9 1	Expert Y has had previous experience investigating a fatal road collision or murder involving firearms	EXACTLY
R3	0.1 0.2 0.3	Expert Y has obtained only a list of evidence pertaining to the case from his/her subordinate	GENERAL
	0.4 0.5 0.6	Expert Y has obtained a summary or description of the collisions or crime scene from his/her fellow investigator	SIMILAR
	0.7 0.8 0.9 1	Expert Y has visited the collision or crime scene and obtained the physical evidence by him/herself	EXACTLY
R4, R5 and R6	0.1 0.2 0.3	Expert Y has applied the scientific or specific rule based on his/her experience accident investigation or crime, and that he/she has the ability to endorse and validate that rule based on his/her training, qualification and experience investigating such accident or crime	GENERAL
	0.4 0.5 0.6	Expert Y has applied the scientific or specific rule based on his/her experience in a collision or crime, and that he/she has the ability to endorse and validate that rule based on his/her training, qualification and experience investigating that type of road collision or criminal investigation	SIMILAR
	0.7 0.8 0.9 1.0	Expert Y has applied the scientific or specific rule based on his/her experience in a fatal road collision or criminal investigation, and that he/she has the ability to endorse and validate that rule based on his/her training, qualification and experience investigating this type of road collision or criminal investigation	EXACTLY

Table 5.16: Examples of description for factors

The following points explain the correlation of the concepts and factors based on the analyses in Chapter 7:

a. In the quasi-experimental stage, K1a refers to competency. In the pragmatic stage competency refers to the training and qualification of the expert and has been referenced as R1.
b. In the quasi-experimental stage, K1b refers to acquaintance. In the pragmatic stage acquaintance refers to the experience of the expert and has been referenced as R2.
c. In the quasi-experimental stage, K1c refers to correct information. In the pragmatic stage correct information refers to the physical evidence (presence at the scene) and has been referenced as R3.
d. In the quasi-experimental stage, K2a refers to truth. In the pragmatic stage truth refers to the specific rule and has been referenced as R4.
e. In the quasi-experimental stage, K2b refers to acceptance. In the pragmatic stage acceptance refers to ability to endorse the specific rule and has been referenced as R5.

In the quasi-experimental stage, K2c refers to justification. In the pragmatic stage justification refers to the ability to validate the specific rule and has been referenced as R6.

5.4 Conclusion

This Chapter provides an overview of the methodology based on the two primary stages called quasi-experimental and pragmatic. These two stages have been meticulously determined, on the grounds that all the elements under quasi-experimental, are items derived from a particular event and theory. On the other hand the elements from the pragmatic stage are the interpretation of analysis based on the quasi-experimental. In the next Chapter, the background of the six cases shall be explained.

The classification of evidence into four classes (written, spatial, visual and eyewitness' statement will be the basis of analysis in the Chapter 7. The certainty factors are the scores that will be determined in each analysis. This evaluation will be assessed on the types of knowledge (K1) and conditions for knowledge (K2).

The pragmatic stage that emerged from the result of each analysis in Chapter 7 will be dealt with at the end of Chapter 8 and the sensitivity analysis will be conducted in Chapter 9. The research design has been formed to complement the literature topics on reconstruction of an event, evidence and knowledge.

Chapter 6

Background of Cases

6.1 Introduction

In this Chapter, details of the cases to be used in this research will be presented. Cases 1 – 4 are actual legal cases that have been investigated by the police authority. In each of these cases, the police had engaged an expert, or a group of experts to generate a CGA. Copies of evidence (items for Case 1 and Case 2) and a list of evidence (Case 3 and Case 4) have been obtained from the animators for the purpose of this research. Evidence items from Cases 5 and 6 have been obtained from various sources including the Internet. However, in these two cases, animation has not been used as a method to present the evidence. For the purpose of this research an assumption is made that the animation has been used to present the evidence from Cases 5 and 6.

Cases	Evidence (information) to be analysed
Cases 1 and 2	Copies of evidence
Cases 3 and 4	List of evidence used by the animator (copies are not available)
Cases 5 and 6	Information ranging from the investigation process to published report are obtained from various sources

Table 6.1: Summarising the evidence (information) to be analysed

6.2 Case 1 - Facts

This is a criminal investigation of a case involving a fatal road collision between a car and two motorbikes. The collision took place in Birmingham at a junction between Road A and Road B. The car was turning from Road A into Road B when two motorbikes came from the opposite direction and collided with the car. The West Midlands Police had instructed an animator to reconstruct the collision based on certain items of evidence.

6.2.1 Items of Evidence

For the purpose of this research, the following items of evidence will be assessed based on the types of knowledge (K1a-c) and conditions for knowledge (K2a-c).

1. *Crash Investigation Report.* This item of evidence will be referred to as E1(1). A police constable (will be referred to as Police 1(1) has prepared E1(1).

Exhibit Reference No [redacted]

To calculate the speed of the crash vehicle at the commencement of the single tyre skid mark, assuming full braking and that the vehicle came to a halt at the end of the skid mark.

Substituting values:

$$u = \sqrt{0^2 + (2 \times 0.885 \times 9.81 \times 24.15)}$$

$$= 20.48 \text{ m/s}$$

$$= 46 \text{ mph}$$

Therefore the calculated speed of the [redacted]e at the start of the single skid mark, assuming full braking and that the vehicle stopped at the end of the mark is 46 mph.

The calculated speed takes no account of speed lost due to any deceleration or braking done prior to the skid mark being left upon the road surface, nor of any lost in any impacts.

To calculate the speed of the crash vehicle at the commencement of the single tyre skid mark, assuming full braking and that the vehicle was brought to a halt at the end of the skid mark with an impact speed of 10 mph (4.47 metres per second).

Substituting values:

$$u = \sqrt{4.47^2 + (2 \times 0.885 \times 9.81 \times 24.15)}$$

$$= 20.96 \text{ m/s}$$

$$= 47 \text{ mph}$$

Therefore the calculated speed of the [redacted] at the start of the single skid mark, assuming full braking and that the vehicle had an impact speed at the end of the mark of 10 mph is 47 mph.

The calculated speed takes no account of speed lost due to any deceleration or braking done prior to the skid mark being left upon the road surface, nor of any lost in any other impacts.

3

Figure 6.1: A section from E1(1) stating the information available to produce the crash investigation

Figure 6.1 shows a section extracted from E1(1) pertaining to the skid testing performed for Case 1. In E1(1), Police 1(1) had applied a number of mathematical formulae to investigate the crash. The K2 concepts refer

to the application of mathematical formulae to the measurements and information from the scene. The mathematical formulae applied have been regarded as standard literature for this type of collision investigation.

2. *Police Statement.* This item of evidence will be referred to as E2(1). Figures 6.2-6.4 show information extracted from E2(1) with explanation by Police 1(1) concerning calculation of the distance that it would take to emergency brake a vehicle to a halt at the crash scene from various speeds.

> *I have calculated the distances that it would take to emergency brake a vehicle to a halt at the crash scene from various speeds.*

Figure 6.2: A section from E2(1) stating the calculation at various speeds

> *At 40 mph, the speed limit, it would take just over 18 metres.*
> *At 46 mph, 6 mph over the speed limit, it would take just over 24 metres.*
> *At 47 mph, 7 mph over the speed limit, it would take just over 25 metres.*
> *At 50 mph, 10 mph over the speed limit, it would take just over 29 metres.*
> *At 55 mph, 15 mph over the speed limit, it would take just over 34 metres.*

Figure 6.3: A section from E2(1) stating the various calculations of distances

> *This confirms that small increases in speed make bigger increases in emergency braking distances. A doubling of speed making for a quadrupling of emergency braking distance.*

Figure 6.4: A section from E2(1) stating the validation facts pertaining to speed

3. *Scene Survey Plan.* This item of evidence will be referred to as E3(1). All three items of evidence (E1(1), E2(1) and E3(1)) are prepared by the same police constable (i.e. Police 1(1)).

4. *Eyewitness statements.* These items of evidence will be collectively referred to as E4(1). Although there are several eyewitnesses in this case, for the purpose of this research, only four will be assessed based on the fact that there is more information on the collision from these four eyewitnesses. The car driver will be referred to as W1(1) and the other four eyewitnesses will be referred to as W2(1), W3(1), and W4(1) respectively. E4(1) will be assessed as an item of evidence that has been referred to by the animator to position the vehicles in the CGA environment.

Table 6.2 shows the summary of all the items of evidence, the expert and the eyewitnesses in Case 1.

Items of Evidence	Expert/Eyewitness
E1(1)	Police 1(1)
E2(1)	Police 1(1)
E3(1)	Police 1(1)
E4(1)	W1(1): Car driver, W2(1), W3(1), W4(1): nearby eyewitnesses

Table 6.2: Summary of all the details in Case 1

Case 2 - Facts

This is a civil investigation into a fatal road crash that occurred in a busy road in London, July 1999. The speed limit for this road is 30mph. The collision involves a car and a motorbike. Similar to Case 1, the car was making a turning from Avenue C into the junction of Gardens D. The motorbike came from an opposite direction and collided with the car.

6.3.1 Items of Evidence

1. *Collision/Accident Report Book.* This item of evidence consists of a collision/accident report book that has been prepared at the collision scene. The three police officers that were present at the scene and prepared the report book will be referred to as Police 1(2), Police 2(2) and Police 3(2). This item will be referred to as E1(2).
2. *Police statements.* The witness statements in this category refer to the police statement and will be referred to as E2(2). . The police officers preparing E2(2) will be referred to as Police 2(2) and Police 4(2). Police 4(2) had examined the car involved in the accident (see Figure 6.5)

Figure 6.5: Photograph showing the scratch marks as the side of the car

3. *Written Reports.* There are two written reports that make up this item of evidence. The first report concerns the vehicle involved in the collision. A Police Vehicle Examiner, who will be referred to as Expert A, prepared this. The second report concerns the examination of the helmet belonging to the rider in the collision. A forensic scientist, who will be referred to as Expert B, prepared this report. Both written reports will be referred to as E3(2).

4. *Eyewitnesses' Statements.* The eyewitnesses' interviews, which were taken at the collision scene by the police officers will collectively be referred to as E4(2).

5. *Reconstruction Report.* The reconstruction reports were prepared by two experts under instruction from different civil solicitors. These reports will be referred to as E5 and the experts will be referred to as Expert C and Expert D. The experts had used the evidence furnished by the solicitors. One of the items of evidence shows the probable path of the vehicle at the point of impact (see Figure 6.6).

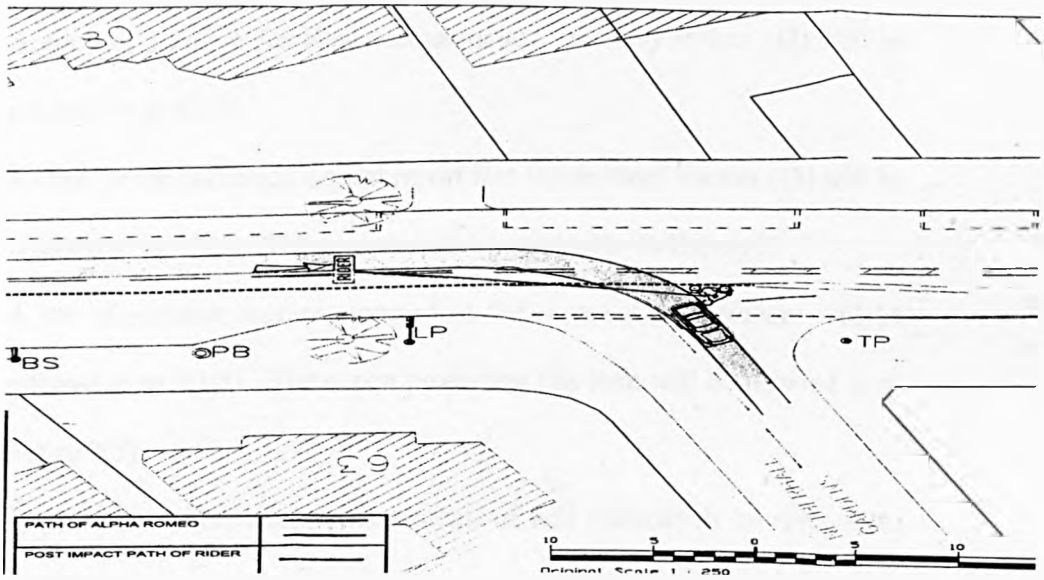


Figure 6.6: Plan with probable path of the car and location of vehicle at impact shown.

Table 6.3 shows the summary of all the items of evidence, the expert and the eyewitnesses in Case 2.

Items of Evidence	Expert/Eyewitness
a. E1(2)	Police 1(2), Police 2(2), Police 3(2)
b. E2(2)	Police 2(2), Police 4(2)
c. E3(2)	Expert A, Expert B
d. E4(2)	W1(2): Car driver W2(2), W3(2): nearby eyewitnesses
e. E5(2)	Expert C, Expert D

Table 6.3: Summary of all the details in Case 2

6.4 Case 3 - Facts

The fatal collision in this case involves two motorcars. There are no physical copies of evidence for this Case. However, the animator provided a list of items of evidence used to generate the animation to be used in this research.

6.4.1 List of Items of Evidence

1. A copy of a Police Accident reconstruction report by Police 1(3) will be referred to as E1(3).
2. A copy of the coroner's inquest report into the death of Victim 1(3) will be referred to as E2(3). The coroner will be referred to as Expert E.
3. A set of accident reports prepared at the scene of the accident will be referred to as E3(3). The expert producing this item will be referred to as Police 2(3).
4. Copies of ten eyewitnesses' statements of will collectively be referred to as E4(3).
5. Two survey maps of the area around the crash will be collectively referred to as E5(3). The expert preparing the maps will be referred to as Police 3(3).
6. Two overhead plans of the crash debris will be collectively referred to as E6(3). The expert producing this item will be referred to as Police 4(3). The crash debris has been shown in the image in Figure 6.7.

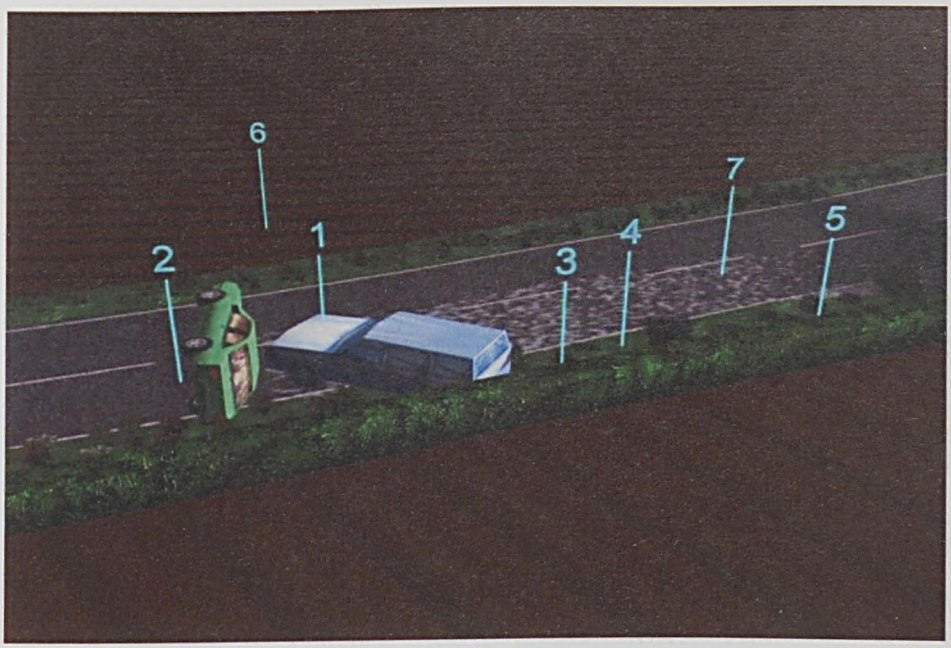


Figure 6.7: Image showing the crash debris at the collision vicinity

7. A paper copy of the digital image reference material will be referred to as E7(3). The expert producing this item will be referred to as Police 5(3).

8. A set of photographs of the road upon which the accident occurred will collectively be referred to as E8(3). The expert capturing the photographs will be referred to as Police 6(3). One of the photographs is shown in Figure 6.8.

Figure 6.8: Photograph showing the environment of the collision vicinity

All the items listed above will be analysed in the next Chapter. The analysis will adapt the quasi-experimental approach as explained in Chapter 5. The summary of all the items of evidence, the expert and the eyewitnesses in Case 3 will be shown in Table 6.4.

Items of Evidence	Expert/Eyewitness
a. E1(3)	Police 1(3)
b. E2(3)	Expert E
c. E3(3)	Police 2(3)
d. E4(3)	Ten eyewitnesses' statements
e. E5(3)	Police 3(3)
f. E6(3)	Police 4(3)
g. E7(3)	Police 5(3)
h. E8(3)	Police 6(3)

Table 6.4: Summary of all the details in Case 3

6.5 Case 4 - Facts

Two teenage girls were shot dead in Birmingham and two others seriously wounded during an all-night party at a hairdressing salon to celebrate the New Year. Figure 6.9 (Telegraph, 2003) shows the picture taken shortly before the crime occurred. Using the latest computer techniques, a virtual reality environment (Figure 6.10) of the crime scene has been put together for the police by Aims Solutions Ltd., a Nottingham company that specialises in incident reconstruction (Telegraph, 2003). Similar to Case 3, original copies of the evidence were not available due to confidentiality or sub-judice issues. However, the list of items, which was provided to the animator for the purpose of this research, is to be analysed.

Figure 6.9: Picture taken on New Year's Eve, hours before the shooting

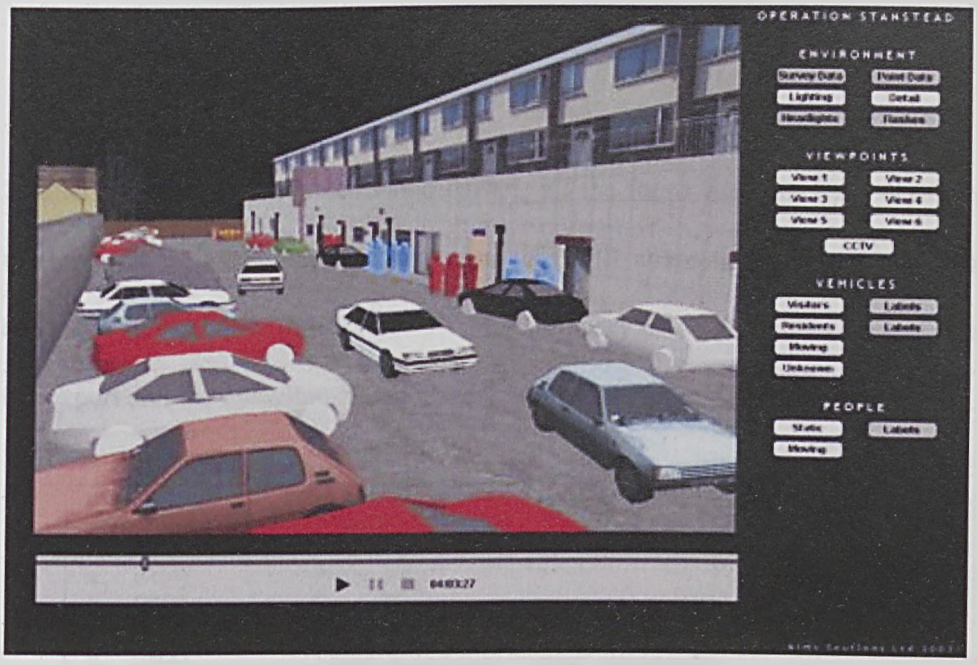


Figure 6.10: Interactive Virtual Environment: Reconstructing The Crime Scene

6.5.1 List of Items of Evidence

1. A written report done by the police (will be referred to as Police 1(4)) based on the available CCTV footage will be referred to as E1(4).
2. A written report from an independent expert (will be referred to as Expert F) in imaging providing more accurate timings based on the CCTV footage will be referred to as E2(4).
3. The survey plans (in digital format) have been furnished by the police (will be referred to as Police 2(4)) based on the investigation, these will be referred to as E3(4).

4. Three anonymised witness' statements describing the position of the vehicles, people around the scene and chronology of movement will be referred to as E4(4).

Similar to all three cases described earlier, all the items listed in Case 4 will be analysed in the next Chapter. The analysis will adapt the quasi-experimental approach as explained in Chapter 5. The summary of all the items of evidence, the expert and the eyewitnesses in Case 4 will be shown in Table 6.5.

Items of Evidence	Expert/Eyewitness
a. E1(4)	Police 1(4)
b. E2(4)	Expert F
c. E3(4)	Police 2(4)
d. E4(4)	3 anonymised eyewitnesses' statements

Table 6.5: Summary of all the details in Case 4

6.6 Case 5 – General Facts and Item of Evidence

Computer forensic investigation begins when an incident is reported to the response team in a particular country. Items of evidence pertaining to the computer forensic cases include data recovery report, screen shots and log file analysis. For the purpose of the analysis conducted in Chapter 7, the data recovery report will be included in the written evidence. This report will be referred to as E1(5) and was produced by Expert G. The literature of computer forensic investigation and its connection with the knowledge literature will be attached to the Appendix at the end of this thesis.

Items of Evidence	Expert/Eyewitness
a. E1(5)	Expert G

Table 6.6: Item of evidence and the expert in Case 5

6.7 Case 6 - Facts

The reports on a marine accident extracted from the Marine Accident Investigation Branch (MAIB) homepage refers to the investigation of a fatal accident (Figure 6.11) on board *Arco Adur* (the name of the dredger) referred to as Arco on the river Medway on the 25 February 2003 (Arco Report, 2003).

SYNOPSIS
At 0925, on 25 February 2003, the bosun of the UK registered aggregate dredger *Arco Adur* was fatally injured on board the vessel when she was outbound on the River Medway. The accident occurred when the aft cargo loading tower on the port side main deck of the vessel was rotated. The bosun, who had not been expecting the aft tower to be operated, became trapped between the aft loading tower reject chute and the port coaming of the cargo hopper. The bosun and an able seaman were in the process of hanging off the outhaul wire for the port drag scraper cargo bucket on to the port coaming. This was a normal operation carried out on completion of the discharge of the cargo. *Arco Adur* was the only one of four similar vessels in the fleet to use the forward cargo loading tower to assist with hanging-off the outhaul wire on to the coaming. The forward tower was used to lift the wire above the coaming with the assistance of a lifting strop. The tower was then rotated to bring the wire over the coaming so that a crew member could hang the wire over a hook, which was attached to the coaming. Both loading towers were operated from the bridge loading console, from where the towers could be clearly seen. However, the second mate, who was relatively new to the company, had not been instructed in the operation to hang off the outhaul wire and believed, mistakenly, that both cargo loading towers were required. The Maritime and Coastguard Agency had issued the vessel with her Safety Management Certificate in July 2001. However, the vessel did not have any written procedures for the operation of the loading towers, and the induction procedures were open to misinterpretation by the senior officers of the vessel. Actions have been taken by the vessel's operator to prevent a recurrence of the accident.

Figure 6.11: Synopsis extracted from the report

On the assumption that the investigation requires a CGA as a briefing tool, the evaluation of the items of evidence based on the types of knowledge (K1a-c)

and conditions for knowledge (K2a-c) will be included in the research. It is essential to note that the guidelines and definition of 'accident' has been defined by the MAIB as, "*An accident is an undesired event that results in personal injury, damage or loss. Accidents include loss of life or major injury to any person on board, or when a person is lost from a ship; the actual or presumed loss of a ship, her abandonment or material damage to her; collision or grounding, disablement, and also material damage caused by a ship. An accident can also be an occurrence such as the collapse of lifting gear, an unintended movement of cargo or ballast sufficient to cause a list, a loss of cargo overboard or a snagging of fishing gear which results in the vessel heeling to a dangerous angle, if the occurrence could have caused serious injury or damage to the health of any person. It is the duty of every master or skipper to examine any accident occurring to, or on board, his/her ship.*" (MAIB, 2003)

6.7.1 Items of Evidence

1. The written evidence in this instance refers to the investigation report and will be referred to as E1(6). The expert preparing the report will be referenced as Expert H.
2. The spatial data for Arco refers to the drawings and sketches. These items of evidence will be referred to as E2(6). The expert producing this item of evidence will be referred to as Expert I. Spatial data in the marine accident may refer to the environmental information. In Arco, the environmental information states that: *At the time of the accident the wind was southeast force 3, the sky was clear and bright*

with good visibility. Drawings can also be seen to illustrate the preparation for loading. This involved lowering a strop (Figure 6.12) with a grapple attached into the cargo hopper, to hook on to the outhaul wires. This strop was then attached to the loading chute of the forward loading tower (Figure 6.13). The tower was used to assist in lifting and swinging the wires away from the hold (Figure 6.14). Moving the wires clear of the hold prevented them being damaged by aggregate during the loading operation, and also prevented the aft tower loading chute from fouling the wires MAIB (2003).

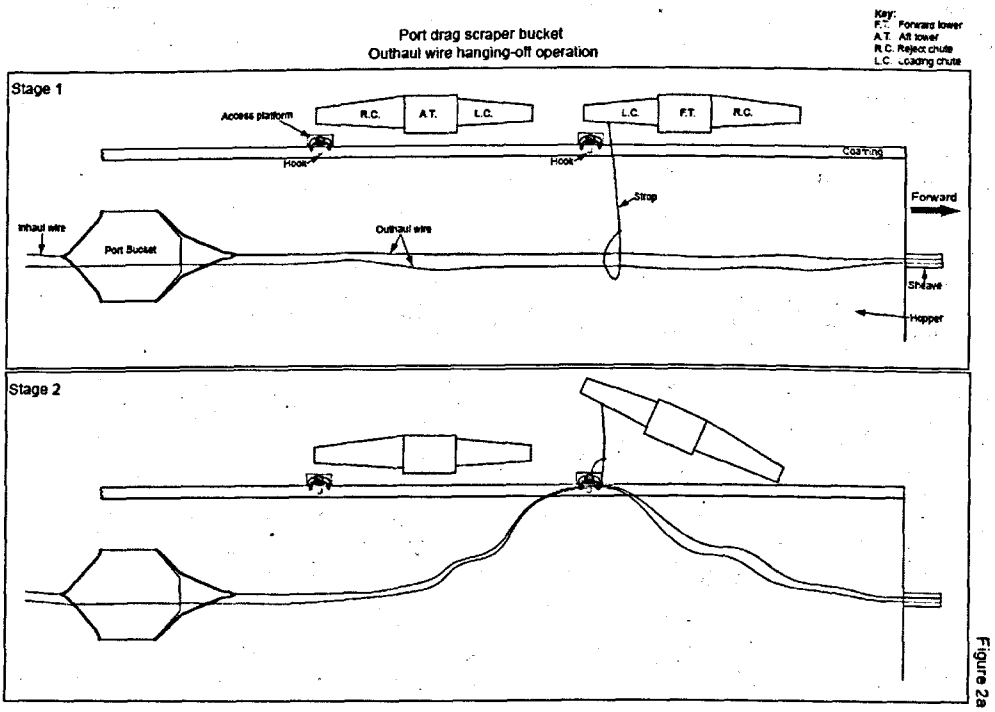


Figure 6.12: Drawing shows the scrapper bucket and overhaul wire

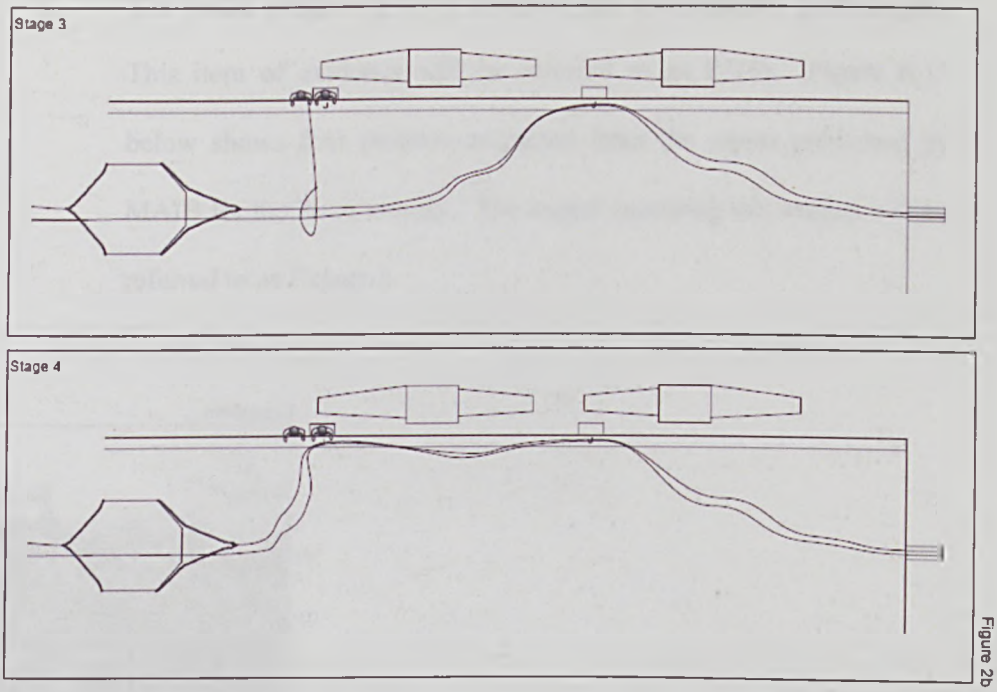


Figure 6.13: Drawing shows stages 3 and 4 of the loading operation

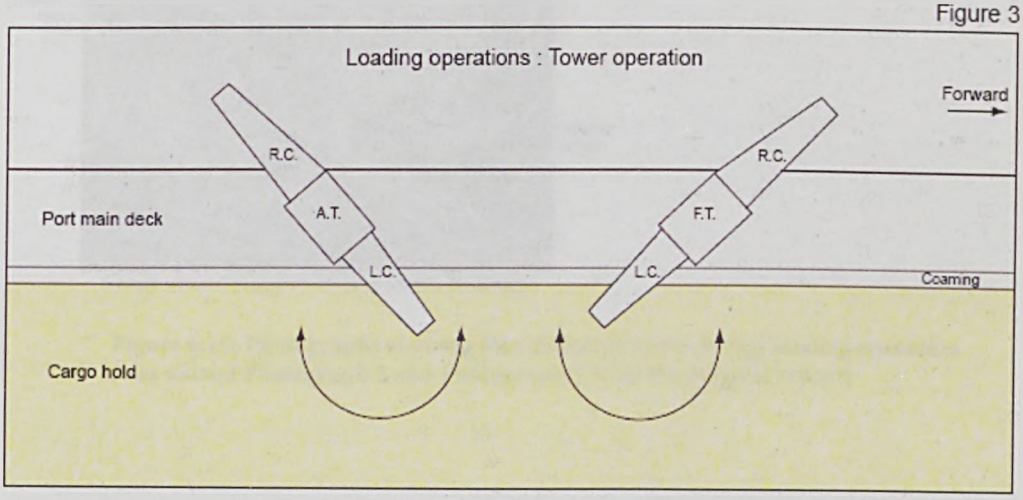


Figure 6.14: Drawing shows the tower-loading chute during loading operation

3. The visual image for Arco refers to the conventional photographs. This item of evidence will be referred to as E3(6). Figure 6.15 below shows four pictures extracted from the report published by MAIB for the Arco inquiry. The expert capturing the images will be referred to as Expert J.

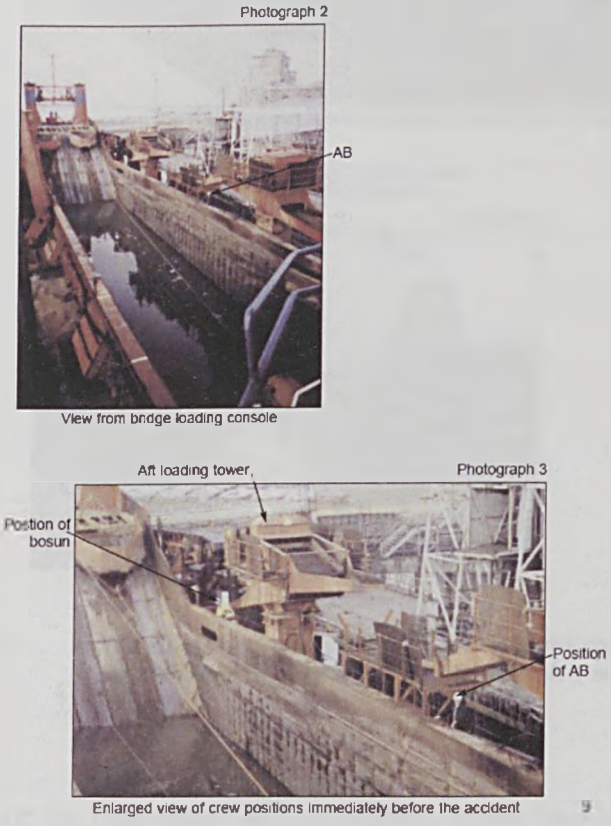
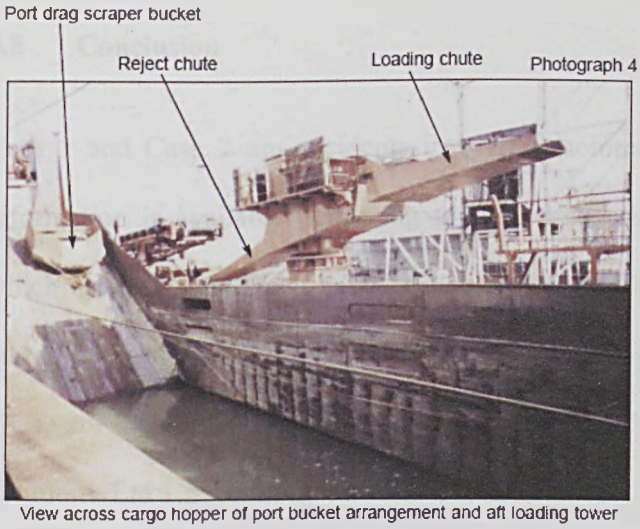
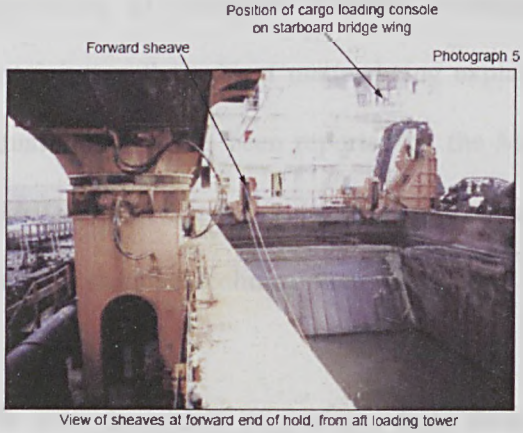


Figure 6.15: Photographs showing four different views during loading operation (was named Photograph 2 and Photograph 3 from the original report)



View across cargo hopper of port bucket arrangement and aft loading tower



View of sheaves at forward end of hold, from aft loading tower

(continuation of Figure 6.15:) Photographs showing four different views during loading operation (was named Photograph 4 and Photograph 5 from the original report)

All the three items will be analysed in the next Chapter based on the types of knowledge and conditions for knowledge explained in the methodology in Chapter 5. Table 6.7 summarises the three items listed earlier.

Items of Evidence	Expert/Eyewitness
E1(6)	Expert H
E2(6)	Expert I
E3(6)	Expert J

Table 6.7: Item of evidence and the expert in Case 6

6.8 Conclusion

Case 1 and Case 2 are accidents involving motorcars and motorbikes. More information is available pertaining to these two cases compared with Case 3, which involves a collision between two motorcars. In Case 4, which involves a murder investigation has some restriction on the availability of information. These are four actual cases that have been obtained for a group of experts (Aims Solutions Ltd.) generating forensic animations for those cases. Case 5 is an illustration of computer forensic investigation with relevant fundamentals pertaining to the subject matter being explained in the Appendix. Case 6 is an actual case and has been reported by the Marine Accident Investigation Branch (MAIB). Both Cases 5 and 6 have been assumed to use the animation as a tool to illustrate complex technical facts.

The individual items of evidence from these cases will be analysed in the next Chapter. The methodology (Chapter 5) applied in the analysis will facilitate the assessment based on the types of knowledge and conditions for knowledge. Chapter 7 will begin with quasi-experimental analysis on items of evidence classified under written evidence. The analysis will continue on the items of evidence classified under spatial evidence, visual images and eyewitnesses' statements.

Chapter 7

Quasi-experimental Analysis

7.1 Introduction

In this Chapter, the analysis will be presented based on quasi-experimental method. The quasi-experiment in this Chapter will be divided into four parts. The first part involves analysis for written evidence. The second part includes analysis for spatial evidence. The third and fourth consists of analysis on visual images and eyewitness statements.

The individual items of evidence will be assessed based on the types of knowledge and conditions for knowledge. Each of the items will be assigned with a score from Table 5.7 from Chapter 5.

7.2 Quasi-experimental for Written Evidence

Items of evidence classified under the written evidence in this Section have been previously described in Chapter 5. The written evidence from all six cases is as follows:

Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
E1(1)	E1(2)	E1(3)	E1(4)	E1(5)	E1(6)
E2(1)	E2(2)	E2(3)	E2(4)		
	E3(2)	E3(3)			
	E5(2)				

Table 7.1: Items of evidence for written evidence

Note:
E1(1): Crash Investigation Report, E2(1): Police Statement. E1(2): Book of Accident, E2(2): Police Statement, E3(2) : Vehicle Examination Report and Forensic Scientists Report and E5(2): Two Reconstruction Reports. E1(3): Police Statement, E2(3): Coroner's Inquest Report and E3(3): Police Reports. E1(5): Data Recovery Report. E1(6): Investigation Report

Analysis a1

Figures 7.1 and 7.2 below have been extracted from the Crash Investigation Report (E1(1)) from Case 1.

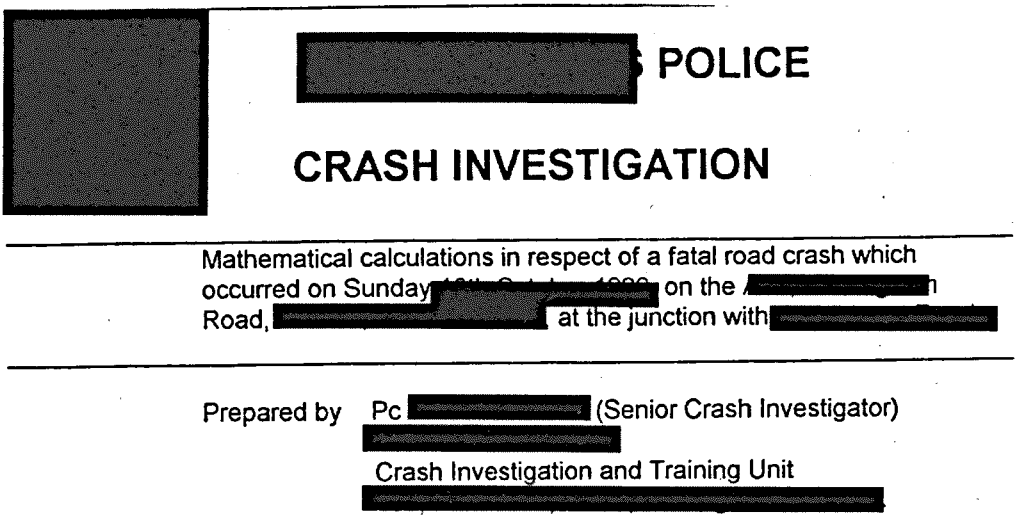


Figure 7.1: The front page of the Crash Investigation (E1)

I am Police Constable [ ] of the [ ] currently engaged as a Senior Crash Investigator on the Crash Investigation and Training Unit, [ ]

My main responsibilities are the training of police officers in Crash / Accident Investigation and the subsequent verification of road crash reconstruction's performed by them. I also attend at the scenes of fatal and serious road crashes with a view to their reconstruction and establishing their cause.

Figure 7.2: The text from E1 stating some details regarding the police constable

The police constable undertaking this investigation (Police 1(1)). Police 1(1) is a Senior Crash Investigator. This fact demonstrates that Police 1 has qualifications, training and experience, particularly in crash investigation. The concept of competency refers to the training and qualification of the expert. On the other

hand, the concept of acquaintance refers to the experience of the expert. Based on this fact, Police 1(1) will be assessed under the *exactly* category which stated that *the expert had qualifications, training and experience on a very similar collision investigation.* Police 1(1) will be assigned a score of 0.8. The score of 0.8 has been derived from the certainty factors in Table 5.7, from Chapter 5.

Analysis a2

Case 2, Case 3, Case 4, and *Case 5.* There are no detailed descriptions concerning the experts, their training, qualifications and experience in E1(2), E1(3), E1(4) and E1(5). On the assumption that all the experts had *general training, qualifications and experience pertaining to investigation process*, they will be assessed under the *general* category.

Case 6. For the purpose of marine accident investigation, the expert will be assumed to have *general training, qualification and experience to undertake the investigation of a fatal accident on board.* All the experts in these five cases will be assigned with the score of 0.3 individually. The score of 0.3 has been derived from the certainty factors in Table 5.7, from Chapter 5.

Analysis a3

Case 1. It was shown in Figure 7.3 that the Police 1(1) had attended the scene. In the context of this research, E1(1) is reliable information to the animator based on the fact that Police 1(1) had visited the collision vicinity to collect the evidence.

At 13:30 hours on ----, I attended the crash scene.

Figure 7.3: The text from E1(1) stating the presence of the police constable at the collision scene

Case 2. There were three experts at the scene to prepare E1(2) for Case 2. It has been extracted from E1(2) that all three experts had arrived at the collision scene at the following hours:

a. Police 1(2) arrived at 22:34,
b. Police 2(2) arrived at 22.49, and
c. Police 3(2) arrived at 22:34.

Case 3 and Case 6. For these two cases, it can be assured that the expert had obtained the physical evidence directly from the collision scene.

Case 4. The CCTV images were obtained from the crime scene. All the experts will be assessed as *exactly*, which stated that *the experts had visited the scene and obtained physical evidence* and will be assigned a score of 0.8.

Analysis a4

Case 5. The data recovery expert may not be the same person who attended the crime scene. The physical evidence prior to the incident being lodged may be handed-in by police enforcement. Hence, Expert F will be assessed under the *similar* category, which states that *he/she had obtained the physical evidence from a third party.* Expert F will be assigned a score of 0.5. The score of 0.5 has been derived from the certainty factors in Table 5.7, from Chapter 5.

Analysis a5

Case 1. Police 1(1) will be assessed under the *exactly* category, which stated that he *had applied a scientific/specific rule based on experience, training and qualification on a very similar collision investigation; that he has the ability to endorse and validate what has been stated in E1(1) based on the standard literature applied.*

Analysis a6

The assumption is made that the police officers in Case 2, Case 3 and Case 4 had applied general rule based on standard literature to investigate collision/crime. This ranges from collecting physical evidence at the collision scene to conducting further investigations on the road markings and calculating estimated speed. The general category states that *the experts had applied specific rules and that they have the ability to endorse and validate based on general experience, training and qualification on a collision/crime investigation.*

Case 5, the assumption made for the expert is that, *the expert(s) has/have the ability to endorse and validate the specific rule (based on general training, qualification and experience) on data recovery investigation.*

Case 6. For this case, an assumption is made that the expert had applied specific rule in conducting the investigation. All the experts will be assessed under the *general* category. This category states that, *the experts had applied specific rule to the case under investigation based on general training, qualification and*

experience; and that the experts have the ability to endorse and validate the specific rule. Hence, the experts for Cases 5 and 6 will be assigned a score of 0.3.

Analysis a7

Case 1. E2(1) has been assessed in a similar manner to analysis a1 on E1(1).

Case 2. "Police 1(2) holds City & Guilds certificates in Accident Investigation, Motor Vehicle Testing and Techniques. He is also a Member of the Institute of Traffic Accident Investigators. Police 1(2) is a police officer in the Area Traffic unit attached to the Accident Investigation Unit. He has been a police officer for thirty-one years of which twenty-seven have been spent as a traffic officer". The facts extracted from E2(2), shows that the item of evidence can be assessed under the *exactly* category.

Analysis a8

Case 2. Based on E2(2) concerning Police 2(2), there is no direct statement stating his training and qualifications. On the assumption that Police 2(2) had *general training, qualification and experience pertaining to collision investigation*, he will be assessed under the *general* category.

Case 3. E2(3) is a coroner inquest's report. For the purpose of the K1a and K1b concept, Expert E has been assumed to have training and qualification pertaining to performing post-mortems. With regard to the concept of acquaintance, the expert has been assumed to have experience in doing such tasks. He/she will be assessed under the *general* category, which states that *he had general training, qualification and experience on a similar type of post-mortem.*

Police 2(2) in Case 2 and the Expert E in Case 3 will be assigned a score of 0.3.

Analysis a9

The group of experts from an independent consultant had experience in both imagery analysis and technology and are equipped with state-of-the-art processing and enhancement facilities. Based on this fact the experts will be assessed under *similar* category, which states that *the experts had previous experience on similar tasks undertaken in the investigation.* The expert will be assigned a score of 0.5.

Analysis a10

Analysis a10 will assess the items based on the K1c concept on correct information. For the context of this research, K1c refers to the fact that the expert had visited the collision vicinity or crime scene.

Case 1. Item E2(1) will be assessed in a similar manner to the analysis in a3. The score will be assigned as 0.8.

Case 2. Item E2(2) will be assessed based on the information extracted from E1(2). It has been stated that, *Police 4(2) had attended the scene at 2340 hours* and *Police 2(2) had attended the scene at 2234 hours.* In the context of this analysis, the score will be assigned as 0.8.

Case 3. Item E2(3) will be assessed in a similar manner to the analysis in a3. The score will be assigned as 0.8.

Case 4. The item will be assessed in a similar to the analysis in a3. The score will be assigned as 0.8.

Analysis a11

Case 1. Under this concept Police 1(1) will be assessed under the *exactly* category, similar to the analysis in a5 with a score of 0.8.

Case 2. Police 4(2) had carried out a number of tasks during his presence at the scene. The tasks included,

1. taking measurements from fixed points to record the salient features of the accident scene;
2. inspecting the car, motorbike and the motorcyclist's helmet; and
3. carrying out a visual inspection and test-drive of the car involved in the collision.

Police 4(2) examined the car and noted that there was a slight dent to the lower part of the rear nearside wing just forward of the nearside wheel. Police 4(2) had also examined the motorcycle and in particular the lack of damage to the fairing area, the expert formed the opinion that the two vehicles had not collided.

In E2(2) the motorcycle has scraped along the road on its nearside and there was no discernible damage indicating any impact with the car. Police 4(2) went on stating that if the motorcycle tyre had struck the car with any significant force, the motorcycle would have deviated from its original line of travel. This fact can be assessed as the validation process by confirming that the momentum of the motorcycle took it along a straight line north along the north bound half of the road, as shown by the tyre and scrape marks (see Figure 7.4). Police 4(2) stated that in his opinion, the motorcyclist would have hit the car and because he became

separated from his machine he slowed down much more quickly (see Figure 7.5).

Figure 7.4: Photograph showing the tyre and scrape marks

Figure 7.5: Still from the animation demonstrating the motorcyclist became separated from the motorbike

Police 4(2) also indicates that, in his opinion the motorcycle did not make any contact with the car but simply slid straight along the road after dropping on to its nearside as a result of the rider losing control when he braked hard and locked the wheels.

Based on information from E1(2), Police 4(2) has attended many courses at the police driving school and qualified as an advanced accident investigator and an advanced vehicle examiner. He has been authorised by the Commissioner of the Metropolitan Police under sections 67 and 69 of the Road Traffic Act 1988 to examine motor vehicles and prohibit their use on the public road. Police 4(2) is also authorised under section 78 Road Traffic Act 1988 to weigh motor vehicles and trailers. Police 1(1) in Case 1 and Police 4(2) in Case 2 each will be assigned with a score of 0.8.

Analysis a12

Case 2. Police 2(2) had carried out a number of tasks during his presence at the scene. The tasks include,

1. administering a roadside breath test to the car driver and this proved to be negative;
2. testing the driver's eyesight: this was also satisfactory; and
3. examining the car (recorded a slight dent to the rear nearside wing in front of the wheel).

It is essential to note that the presence of Police 2 (2) at the scene was to assist Police 4(2) in the examination of vehicles and also in carrying out the skid tests. He did not perform any detailed mechanical examination of either vehicle and was not involved in further investigation. These facts have been extracted from E2(2) concerning Police 2(2). In E2(2), there is no information on his training, qualification and experience.

Case 3. Expert E had been assumed to apply specific or scientific rule and that he has the ability to endorse and validate the entire process of the post-mortem based on his general training and qualifications.

Case 4. Expert E had been assumed to apply specific or scientific rule and that he/she has the ability to endorse and validate the entire process of crime investigation based on his/her general training and qualifications.

Police 2(2) in Case 2 and the Expert E in Case 3 will be assessed for all three concepts (K2a, K2b and K2c) under the *general* category similar to a6 with a score of 0.3.

Analysis a13

The following facts were extracted from E3(2) pertaining to Expert A and Expert B for Case 2. In Case 2, a car was making a turn from Avenue C into the junction of Gardens D.

Expert A,

a. has passed City and Guilds exam in Vehicle Examination Techniques (Standard and Advanced levels), Air Brakes Technology and Level II Tachograph, which deals with the associated legislation; all these exams

have theory and practical components;

b. holds a Certificate of Professional Competence within the Road Haulage and Passenger Transport Industry;

c. has fourteen years experience, the last seven years spent in the Traffic Division;

d. is also a Police Vehicle Examiner under Section 67 Road Traffic Act 1988 at an advanced level; and

e. can issue prohibition notices to defective vehicles of all classes, and holds authorisation to weigh vehicles.

Expert B ,

a. possesses an Honours degree in Materials Science and Technology and is a full Member of the Institute of Traffic Accident Investigators;

b. has been employed by the Forensic Science service, specialising in the examination of components, which generally have been removed from vehicles involved in accidents; and

c. has been employed in this capacity for twenty-eight years.

The purpose of E3(3) is for vehicle examination (Expert A) and examination of motorbike rider's helmet (Expert B). Based on all the facts extracted from E3(2), Expert A and Expert B will be categorised under the *exactly* category similar to analysis in a1 with a score of 0.8 for each of them.

Analysis a14

Case 3. There is no information pertaining to the police officer producing E3(3) in Case 3. For the purpose of this research, only the list of items is available. On the assumption that the Police 2(3) prepared a set of accident reports at the collision scene has qualifications, training and experience based on *general* category similar to the analysis in a8 with a score of 0.3.

Analysis a15

Case 2. Expert A had visited the Motor Cycle Recovery Unit two days after the accident to examine the motorbike. Expert B had received one Arai helmet on the 9th August 1999 and was requested to assess the condition of the crash helmet, which was believed to be fourteen years old. Based on these facts, although Expert A and Expert B were not present at the accident scene, the motorbike and the helmet are the physical items of evidence obtained from the collision scene. Based on the nature of professional practice of both experts, they do not have to go to the collision scene to obtain the items of evidence, which in this instance are the vehicle and helmet. Both items of evidence were received from the police authority.

Case 3. Based on the fact that the reports were prepared at the collision scene, the Police 2(3) was present at the scene. The information furnished in the reports was gathered and obtained at the scene.

Both experts in Case 2 and Police 2(3) in Case 3 will be assessed under the *exactly* category similar to the analysis in a3 with a score of 0.8.

Analysis a16

Case 2. The following are facts extracted from E3(2) pertaining to Expert A and Expert B:

Expert A,

a. made a visual examination of the braking system;
b. found that the discs and pads were in good repair and showed that the brakes had been working correctly;
c. had also carried out the examination on the steering, warning instrument, and lights.
d. endorses his examination on the vehicle by explaining the damage details to the motorbike;
e. added that, as a result of this it had received deep scratches on all the lower fairing panels on that side and that there were scratch marks to the body panel below the nearside of the seat; and

Expert B,

a. had carried out a full examination of the helmet;
b. confirms that the helmet was about one-and-half years old (which was believed to be fourteen years old);
c. also stated that the only damage being slight fraying of the strap although that had not caused the strap to fail;
d. is not in a position to know how well the helmet fitted the wearer and whether the helmet was satisfactorily fastened at the time of the accident;
e. found that the helmet appears to have been in a satisfactory condition prior to the accident; and

f. found that it is clear from the examination of the helmet that it has received a violent blow to the right of the shell in the accident causing cracking of the shell but little crushing of the liner.

Both experts will be assessed under the *exactly* category similar to the analysis in a5 with a score of 0.8. This assessment has been based on the fact that the Vehicle Examination Report and Forensic Scientists Report have been prepared using appropriate rules and specific rule.

Analysis a17

Case 2. E3(3) from Case 3: K2a-b. The expert(s) will also be assessed under the *general* category similar to the analysis in a6 with a score of 0.3. The similarity in this regard refers to the lack of details pertaining to the expert(s) or police officer(s) preparing the items of evidence.

Analysis a18

Case 2. In Case 2, Expert A and Expert B are experts in accident reconstruction. The facts for analyses *a18-a22* are extracted from the two separate reconstruction reports.

Expert A had undertaken a post-doctoral research in materials science and metallurgy. The information on his training and qualifications does not mention much about accident reconstruction in particular. Expert A will be assessed under the *general* category, which states that *the expert had training and qualification on a general reconstruction process.* He will be assigned a score of 0.3.

Analysis a19

Expert C is a Senior Associate in a firm investigating accidents, engineering failures and personal injuries. He has fifteen years experience in this capacity. Expert C will be assessed under the *similar* category, which states that *the expert had experience on a similar type of reconstruction process.* He will be assigned a score of 0.5.

Analysis a20

Expert D

a. holds the degrees of Bachelor of Science in Mechanical Engineering, a Master of Science in research relating to car occupant injury mechanism, and a PhD relating to pedestrian accidents;
b. is a graduate member of the Institution of Mechanical Engineers;
c. is also a member of the Society of Automotive Engineers and a member of the Association for the Advancement of Automotive Medicine; and
d. has acted as an advisor and expert witness, in matters relating to accident investigation and reconstruction, to a number of police forces.

Based on these facts, Expert D is a forensic scientist specialising in the investigation and reconstruction of road accident. Expert D had training and qualification very similar to the accident being reconstructed. He will be assessed under the *exactly* category similar to the analysis in a1 with a score of 0.8.

Analysis a21

Case 2. Apart from obtaining items of evidence from the solicitors, both Expert C and Expert D had visited the scene of the accident on the 8 January 2000 and on 19 September 2000 respectively for the purpose of reconstruction of the collision. Both experts will be assessed under the *exactly* category for reasons similar to the analysis in a3 with a score of 0.8 for each of them.

Analysis a22

Concept K2 refers to the standard literature of investigating collision between vehicles. The piece of information to illustrate this circumstance has been stated in the background of Case 2 in the previous section. Both experts will be assessed under the *exactly* category similar to the analysis in a3 with a score of 0.8 for each of them.

Based on the analysis a1 to a22, Table 7.2 summarises the results from all the scores for items of evidence classified under the written evidence.

Analysis Reference	*Analysis Summary and Scores*
a1	E1(1): Case 1; K1a, K1b = 0.8
a2	E1(2), E1(3), E1(4), E1(5), E1(6): Case 2, Case 3, Case 4, Case 5 and Case 6; K1a, K1b = 0.8
a3	E1(1), E1(2), E1(3), E1(4), E1(6): Case 1, Case 2, Case 3, Case 4 and Case 6; K1c = 0.8
a4	E1(5): Case 5; K1c = 0.5
a5	E1(1): Case 1; K2a, K2b, K2c = 0.8
a6	E1(2), E1(3), E1(4), E1(5), E1(6): Case 2, Case 3, Case 4, Case 5 and Case 6; K2a, K2b, K2c = 0.3
a7	E2(1), E1(2): Case 1, Case 2 (Police 1); K1a, K1b = 0.8
a8	E2(2), E1(3): Case 2 (Police 2), Case 3; K1a, K1b = 0.3
a9	E2(4): Case 4; K1a, K1b = 0.5
a10	E2(1), E1(2), E1(3), E1(4): Case 1, Case 2, Case 3 and Case 4; K1c = 0.8
a11	E2(1), E1(2): Case 1 and Case 2; K2a, K2b, K2c = 0.8
a12	E2(2), E2(3), E1(4): Case 2, Case 3 and Case 4; K2a, K2b, K2c = 0.3
a13	E3(2): Case 2; K1a, K1b = 0.8
a14	E3(3): Case 3; K1a, K1b = 0.3
a15	E3(2), E3(3): Case 2 and Case 3; K1c = 0.8
a16	E3(2): Case 2; K2a, K2b, K2c = 0.8
a17	E3(3): Case 3; K2a, K2b, K2c = 0.3
a18	E5(2): Case 2 ; K1a = 0.3 (Expert C)
a19	E5(2): Case 2 ; K1b = 0.5 (Expert D)
a20	E5(2): Case 2 ; K1a, K1b = 0.8 (Expert D)
a21	E5(2): Case 2; K1c = 0.8 (Experts C and D)
a22	E5(2): Case 2 ; K2a, K2b, K2c = 0.8 (Experts C and D)

Table 7.2: Scores for items of evidence classified under the written evidence

Note: K1a: competence; K1b: acquaintance; K1c: correct information;
K2a: truth; K2b: acceptance; K2c: justification. (See Table 5.4)
E1 has been produced from each case studies. E1(1): Crash Investigation Report (Case 1), E1(2) Book of Accident (Case 2), E1(3) Police Statement (Case 3), E1(4) Report from police authority consultant (Case 4), E1(5) Data Recovery Report (Case 5), E1(6) Report on investigation (Case 6) (See Table 5.2)
E2(1) and E2(2):Police Statement (Cases 1 and 2), E2(3) Coroner's Inquest Report (Case 3), E2(4) Report by an independent consultant (Case 4).
E3(2): Vehicle Examination Report and Forensic Scientist Report (Case 2), E3(3) Police Reports prepared at the collision vicinity (Case 3).
E5(2): Two Reconstruction Reports (Case 2)

7.3 Quasi-experiment for Spatial Evidence

Items of evidence classified under spatial evidence in this Section have been previously described in Chapter 5. The spatial evidence has been extracted from four out of six cases as follows:

Case 1	Case 3	Case 4	Case 6
E3(1)	E5(3) E6(3)	E3(4)	E2(6)

Table 7.3: Items of evidence for spatial evidence

Note:
E3(1): Plan (Road Layout), E5(3) and E6(3): Two Overhead Plans, , E3(4): Plan (Environment) E2(6): Drawing and Sketches

Analysis b1

Case 1. This is a survey plan (E3(3)) of the road layout prepared by Police 1(1). Based on the evaluation for E1(1) and E2(1) on K1a and K1b, Police 1(1) will be assessed under the *exactly* category in a similar manner to the analysis in a1 with a score of 0.8.

Analysis b2

Case 3. An assumption is made that the expert(s) in E5(3)and E6(3) *had general training and experience relating to the collision under investigation.*

Case 4. An assumption is made that the expert(s) in E3(4) *had general training and experience relating to the collision under investigation.*

Case 6. An assumption is made that the expert(s) in E2(6) *had general training, qualification and experience to undertake the investigation of a fatal accident on board.*

Hence, all the expert(s) from these three cases for these particular types of evidence will be assessed under the *general* category in a similar manner to the analysis in a2 with a score of 0.3. The *general* category has been assigned based on the fact that there is a lack of details pertaining the experts(s) or police officer(s) preparing the items.

Analysis b3

Case 1. Police 1(1) states that he had prepared the E3(1) by himself as shown in the piece of information in Figure 7.6.

> *....Reference Number 30232.). copies of 1:520 and 1:200 scale plans of the road layout at the collision scene prepared by myself (Exhibit Reference Nos. AA1 & AA2), a....*

Figure 7.6: Extract from E1 concerning the preparation of plans of road layout

Case 3. In this case, the collision involves two motorcars. The assumption is made that, the expert(s) had visited the collision scene for the purpose of preparing E5(3) and E6(3).

Case 4. An assumption is made that, the expert(s) had visited the crime scene for the purpose of preparing E3(4).

Case 6. An assumption is made that, the expert(s) had visited the specified location of the fatal accident on board for the purpose of preparing E2(6).

All the expert(s) will be assessed under the *exactly* category in a similar manner to the analysis in a3 with a score of 0.8.

Analysis b4

For Case 1 and Case 3, an assumption is made that Police 1(1), Police 3(3) and Police 4(3) had applied the scientific or specific method in standard literature for collision investigation. All the police officers will be assessed under the *exactly* category similar to the analysis in a5 with a score of 0.8.

Analysis b5

Case 4. In this context, the K2 concept refers to the specific or scientific rule that is applied in the process of capturing images and taking photographs as described in the earlier section concerning standard literature provided by the Home Office.

Case 6. The K2 concept refers to the specific or scientific rule that has been applied in the process of drawing objects for preparation for loading as described in the Chapter 6 with reference to Figures 6.13-6.15, extracted from the MAIB report.

All the experts for both cases will be assessed under the *general* category for reasons similar to those given in the a2 a score of 0.3.

Based on the analysis b1 to b5, Table 7.4 summarises the results from all the scores for items of evidence classified under the spatial evidence.

Analysis Reference	*Analysis Summary and Scores*
b1	E3(1): Case 1; K1a, K1b = 0.8
b2	E5(3),E6(3): Case 3, E3(4): Case 4, E2: Case 6; K1a, K1b = 0.3
b3	E3(1): Case 1, E5(3), E6(3): Case 3, E3(4): Case 4, E2(6): Case 6; K1c = 0.8
b4	E3(1):Case 1, E5(3), E6(3): Case 3; K2a, K2b, K2c = 0.8
b5	E3(4): Case 4, E2(6): Case 6; K2a, K2b, K2c = 0.3

Table 7.4: Scores for items of evidence classified under the spatial evidence

Note: K1a: competence; K1b: acquaintance; K1c: correct information;
K2a: truth; K2b: acceptance; K2c: justification. (See Table 5.4)
E2(6): Drawings and Sketches (Case 6)
E3(1): Plan (Road Layout) (Case 1); E3(4): Plan (Environment) (Case 4)
E5(3), E6(3): Two Overheads Plans (Case 3)

7.4 Quasi-experiment for Visual Images

Items of evidence classified under visual images in this Section have been previously described in Chapter 5. The visual images have been extracted from two out of six cases as follows:

Case 3	**Case 6**
E7(3) E8(3)	E3(6)

Table 7.5: Items of evidence for visual images

Note:
E7(3) and E8(3): Paper copy of digital images and photographs, E3(6): Photographs

Analysis c1

Case 3 and Case 6. An assumption is made that the experts had training and qualifications in a similar type of investigation. In Case 3, the concept K2a-c for

E7(3) and E8(3) refers to the training and qualifications relating to the collision investigation. On the other hand, the concept K2a-c for E3(6) from Case 6 refers to training and qualifications relating to the capturing of images for such investigation by MAIB. The experts will be assessed under *similar* category for similar reasons as in the a19 analysis with a score of 0.3.

Analysis c2

Based on analysis a3, the expert(s) in Case 3 had visited the collision scene and the expert(s) in Case 6 had attended the location to capture the images. The expert(s) will be assessed under the *exactly* category with a score of 0.8.

Analysis c3

An assumption is made that the expert(s) in Case 3 had undertook the steps and rules in capturing images as described in the reference by the Home Office. A similar assumption has been made that the expert(s) in Case 6 had undertaken the steps and rules in capturing images as described in the note by the Home Office. Based on the analysis c1 to c3, Table 7.6 summarises the results from all the scores for items of evidence classified as spatial evidence.

Analysis Reference	*Analysis Summary and Scores*
c1	E7(3), E8(3): Case 3, E3(6): Case 6; K1a, K1b = 0.5
c2	E7(3), E8(3): Case 3, E3(6): Case 6; K1c = 0.8
c3	E7(3), E8(3): Case 3, E3(6): Case 6; K2a, K2b, K2c = 0.5

Table 7.6: Scores for items of evidence classified under the visual images

Note: K1a: competence; K1b: acquaintance; K1c: correct information;
K2a: truth; K2b: acceptance; K2c: justification. (See Table 5.7)
E3(6): Photographs (Case 6)
E7(3), E8(3): paper copy of digital images and photographs

7.5 Quasi-experiment for Eyewitnesses' Statements

The eyewitnesses' statements in this Section have been previously described in Chapters 5 and 6. The eyewitnesses' statements extracted from four out of six cases are as follows:

Case 1	Case 2	Case 3	Case 4
W1(1) W2(1) W3(1) W4(1)	W1(2) W2(2) W3(2)	(All) *	(All) **

Table 7.7: Summary of the eyewitnesses' statements

Note:
Due to the confidentiality, a copy of eyewitnesses' statements for Cases 3 and 4 are not available for the research, therefore,
* All ten statements from Case 3 will be referred to as all eyewitnesses' statements
** All three anonymised eyewitnesses' statements from Case 4 will be referred to as all eyewitnesses' statements

The quasi-experiment for the eyewitness statements will be described in this Section. There are a number of eyewitnesses in Case 1. However, four statements made by four different eyewitnesses, referenced as W1(1), W2(1), W3(1), and W4(1), will be assessed. The selection of these four eyewitnesses is based on the fact that one of them is the car driver involved in the collision. The other three eyewitnesses were at the closest distance when the collision occurred. Although there are also a number of eyewitnesses in Case 2, only three will be assessed based on similar grounds to Case 1. W1(2) in Case 2 was the car driver involved in the collision and the other two eyewitnesses referenced as W2(2) and W3(2), were closest to the area where the collision occurred. In Case 3, the fatal collision occurred between two motorcars. There were no statements available to the animator. However, the description of the collision was provided by the

police authority and ten eyewitnesses were named for reference by the authority. The assessment for all of the eyewitnesses in Case 3 will not be done individually. In Case 4, there were three anonymised eyewitnesses' statements. The actual copies of the statements are not available due to confidentiality and sub-judice. Hence, all statements in Cases 3 and 4 will be assessed all statements.

Analysis d1

The primary eyewitness in Case 1 is the car driver who was at the junction when the other two motorcycles approached the collision area. This eyewitness shall be referenced as W1(1).

Figures 7.7 and 7.8 show information extracted from an interview with the car driver (W1(1)). W1(1) stated that he has been driving since 1942 and that he is familiar with all the controls and operations of the vehicle. Based on the statement made by W1(1) and the concept interpretation for eyewitness (described in Table 5.8 from Chapter 5), W1(1) will be assessed under the *similar* category. These facts and this category are evaluated as:

a. the capabilities of the eyewitness in relation to how he was involved during the collision (K1a); and
b. the experience in relation to how he was involved during the collision (K1b).

W1(1) will be assigned the middle score of similar category that is 0.5.

Police :... *so that's fine. Can you tell me how long you've been driving*
W1: *Since about 1942*

Figure 7.7: W1(1) states that he has been driving since 1942

Police : *O.K. so you're familiar with all the controls and operations of the vehicle*
W1: *Yes, its very similar to the car I had before*

Figure 7.8: W1(1) states his familiarity with the vehicles

Analysis d2

In Figure 7.9, the police officer states that W1(1) has been called for the interview because he was involved in a serious road accident on the Road B. This information shows that W1(1) was at the vicinity of the accident or collision. W1(1) will be assessed under the *exactly* category with a middle score of 0.8.

Police 1(1): *O.K. Right you're here in interviews because you were involved in a serious road accident on the Road B at 11.35 on – the – of October 19 –*

Figure 7.9: The police constable clarifying the reason why the eyewitness was being interviewed

Analysis d3

Figures 7.10, 7.13 and 7.14 show the K2 concepts based on the five human senses, endorsement and the affirmation of the description. In Figure 7.10, W1(1) states that he pulled into the protected area. His awareness of the basic road traffic rule has been assessed as K2a. In Figure 7.13, W1(1) estimates the distance to the next vehicle before proceeding with the turn. This action has been

assessed as a form of endorsement to what has been depicted earlier in Figure 7.10. W1(1) further affirms that he was aware of the clicking noise of the indicator and the flashing light on the dashboard.

W1: *At the junction will – Road, I pulled into the protected area.*

Figure 7.10 : W1(1) states his position prior to the turning

Figure 7.11 below reflects what has been stated by W1 in Figure 7.10.

Figure 7.11: Still from the animation showing the position of the car before making the turn

Figure 7.11 shows the position of car driven by W1(1) from the opposite side of the road, from where the two motorcycles were travelling.

Figure 7.12: Still from the animation showing the position of the car before making the turn (view from the opposite direction)

W1(1): *And then having waited until the turning, was clear and the next vehicle I estimated to be about 80 or more yards away and then I proceeded to make my turn into Road A and as ...*

Figure 7.13 : W1(1) states his estimation on the distance of vehicles

Police: *So you have to stop, all the while your indicators on, it hasn't cancelled its self because of turning*
W1(1): *No the indicator's still working*
Police: *Has it got, like a clicking noise when the indicator --- inform you that its still on*
W1(1): *Yes*
Police: *and the flashing light on the dashboard as well*
W1(1): *Yes*

Figure 7.14: Series of conversations between W1(1) and the police constable regarding the controls and operation of the vehicle

Based on the explanation given by W1(1), these facts are reliable to some extent. This reliability has been assessed upon the K2 concept under the *similar* category with a middle score of 0.5.

7.5.1 Comparison with Other Eyewitnesses' Statements

The following animation stills demonstrate the position of vehicles travelling along Road B on the day the accident occurred. Each animation still describes the particular part in the eyewitness' statements.

Analysis d4

In Figure 7.15, W2(1) will be assessed in a similar capacity with W1(1) in analysis d1 with a score of 0.5. As seen from the facts, W2(1) heard the sound of the motorbike and her natural reaction was to slow down. These facts will be evaluated as inter-related with K1a (competence) and K1b (acquaintance) concept.

> W2: *As soon as I heard the sound of the motorbike my natural reaction was to slow down. I can recall glancing to my right and seeing the two motorbikes `overtake me`. The bikes were travelling one behind the other and came past me in very quick succession and at a fast speed. I remember thinking to myself as they drove past that they could have clipped my vehicle, or I could have hit them.*

Figure 7.15: W2(1)describing her reaction upon seeing the motorbikes

Analysis d5

Based on Figure 7.16, W2(1) will be assessed under the *exactly* category similar to W1(1) in d2 analysis with a score of 0.8. W2(1) was travelling on the Road B at time the collision occurred.

W2(1): *I drove from my home address and onto the Road B, and turned left towards --.*

Figure 7.16: W2(1) describing her position travelling in the vicinity

Figure 7.17: Still from the animation showing the first motorbike overtaking the car (View 1)

Figure 7.18: Still from the animation showing the first motorbike just finishes overtaking the car (View 2)

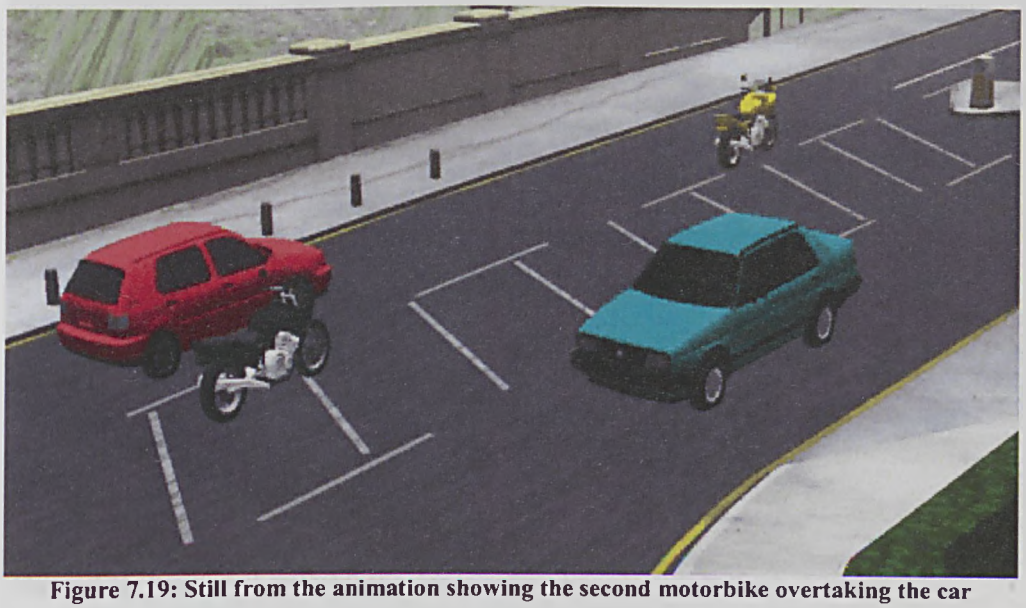


Figure 7.19: Still from the animation showing the second motorbike overtaking the car

Figure 7.20: Position of motorbikes prior to collision passing the bollards (View 1)

Figure 7.21: Position of motorbikes prior to collision passing the bollards (View 2)

Figures 7.17-7.21 are a series of stills captured from the animation to illustrate the description made by W2(1) in Figure 7.22.

Analysis d6

Figure 7.22 shows the K2 concepts based on the five human senses, endorsement and the affirmation of the description similar to the d3 analysis. W2(1) will be assigned a score 0.5. In Figure 7.22, W2(1) states that she heard a loud bang. She also saw the rider of the first bike being flung from the left side of the road. She further stated that she saw the second motorbike crash into the red car, and the rider ended up beneath the red vehicle near to the exhaust.

W2(1): *Suddenly I heard a loud bang. I saw the rider of the first bike being flung from the left to the right side of the road. I did not see the impact of the first bike. Almost immediately after the first bang I saw the second motorbike crash into the red car towards the front. The rider of the second bike ended up beneath the red vehicle near to the exhaust.*

Figure 7.22: W2(1) describing the chronology of collision

Figure 7.23: Still from the animation showing the motorbikes collision with the car

Analysis d7

Figure 7.24 has been extracted from the statement made by W3(1). W3(1) was driving a Renault Clio. On the assumption that W3(1) has the capability and experience in relation to the description he made, W3(1) will be assessed similar to the capacity of W1(1) in d1 with a score of 0.5.

W3: *I was driving my Renault Clio, registered number, M101 FOJ. I drove to the junction with Road B and turned right from C Road into B Road.*

Figure 7.24: W3(1) describing his vehicle

Analysis d8

Figure 7.24 also confirms the fact that W3(1) was travelling within the vicinity of the collision. W3(1) will be assessed under the *exactly* category similar to W1(1) in the d2 analysis with a score of 0.8.

Analysis d9

In Figure 7.25, W3(1) stated that he was aware of the two large motorcycles travelling down the centre of the carriageway.

W3(1): ... *when I was aware of two large motorcycles travelling along the centre of the carriageway almost immediately beside me.*

Figure 7.25: W3(1) describing the position of two large motorcycles

Further in Figure 7.26, W3(1) describes the initial position of both motorcycles. The description was based on five human senses. In expanding the preliminary description, the facts stated by W3(1) have been evaluated as K2 concepts. He will be assessed under the *similar* category as in d3 analysis with a score of 0.5.

W3(1): *As the two bikes went past me, I looked in my driver's wing mirror to see if I could see what the bikes were. Almost instantly I saw the first bike hit a red car that appeared to be in the middle of their lane turning right into Road A. The first bike hit the car somewhere between the front passenger side wheel and the front passenger door.*

Figure 7.26: W3(1) describes the initial position of both motorcycles

Analysis d10

For the K1a and K1b concepts, Figure 7.27 shows that W4(1) has held a full driving licence for ten years. She was driving a green coloured Rover Metro, which she had owned for three years. W4(1) will be assessed in a similar capacity with W1(1) in d1 analysis with a score of 0.5.

> W4: *I have held a full driving licence for ten years. I am the owner of green coloured Rover Metro with registration number ZY102 ABC. I have owned the vehicle for 3 years.*

Figure 7.27: W4(1) describing her vehicle

Analysis d11

In Figure 7.28, W4(1) describes that she was travelling within the vicinity of the collision. W4(1) will be assessed under the *exactly* category as in d2 analysis with a score of 0.8.

> W4: *I drive out of Drive D into Road E and then turn right onto A Road. It was my intention to turn right onto the Road B towards* -----

Figure 7.28: W4(1) describing her journey within the vicinity of the collision

Analysis d12

In this particular statement (Figure 7.29), the witness stated that the car driven by W1(1) was moving at a slow speed and at no time did it stop. This can be compared with the fact stated by W1(1) that the car was stationary (Figure 7.10).

W4(1): *As I approached the junction of Road A at Road B I could see a red car on the Road B in the process of turning right into A Road. The red car was moving at a slow speed and at no time did it stop.*

Figure 7.29: W4(1) describing the red car at the junction

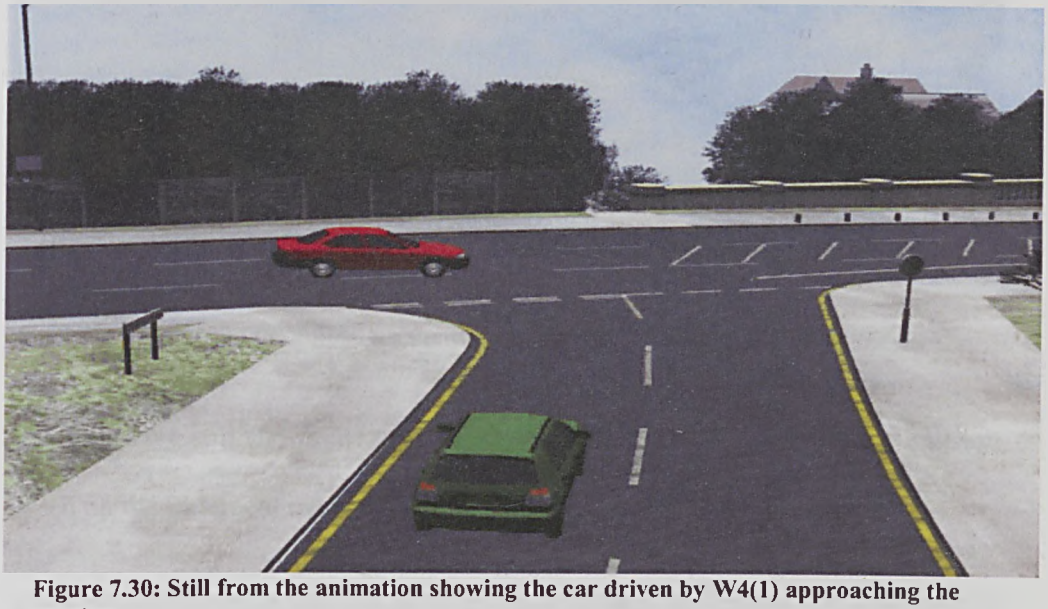


Figure 7.30: Still from the animation showing the car driven by W4(1) approaching the junction

Figures 7.30 and 7.31 shows the sequence described by W4(1) at the point of turning made by W1(1). This description may be useful for the animator to generate the animation from a different perspective. Other items of evidence such as the Crash Investigation Report (E1(1)) and the Police Statement (E2(1)) may substantiate the statement made by W4(1) in contrast to the statement made by W1(1).

Figure 7.31: Still from the animation showing the red car from Road B making the turn

The following still shows the position of the first motorbike prior to the collision based on the statement made by W4(1).

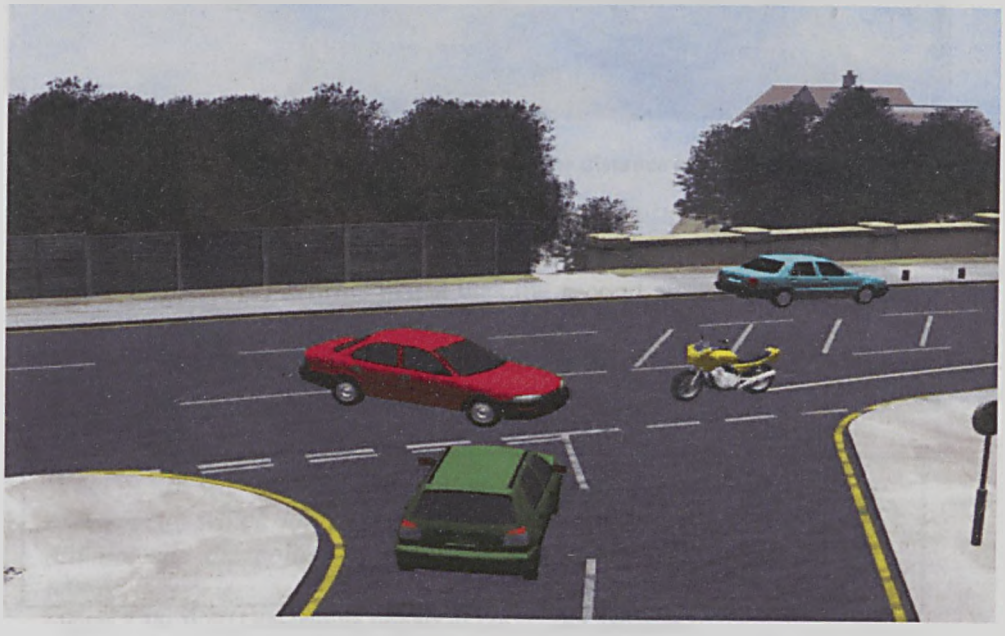


Figure 7.32: Still from the animation showing the first bike approaching the collision area

In Figure 7.33, W4(1) stated that she heard a loud bang and saw a body followed by a motorcycle fly through the air over the top of the red vehicle.

> W4(1): *I suddenly heard a loud bang. I then saw a body followed by a motorcycle fly through the air over the top of the red vehicle. Almost instantly after the first bang there was another loud bang. I was about 2.3 yards away from the giveaway lines and immediately stopped my vehicle.*

Figure 7.33: W4(1) describing what she heard and saw at the collision point

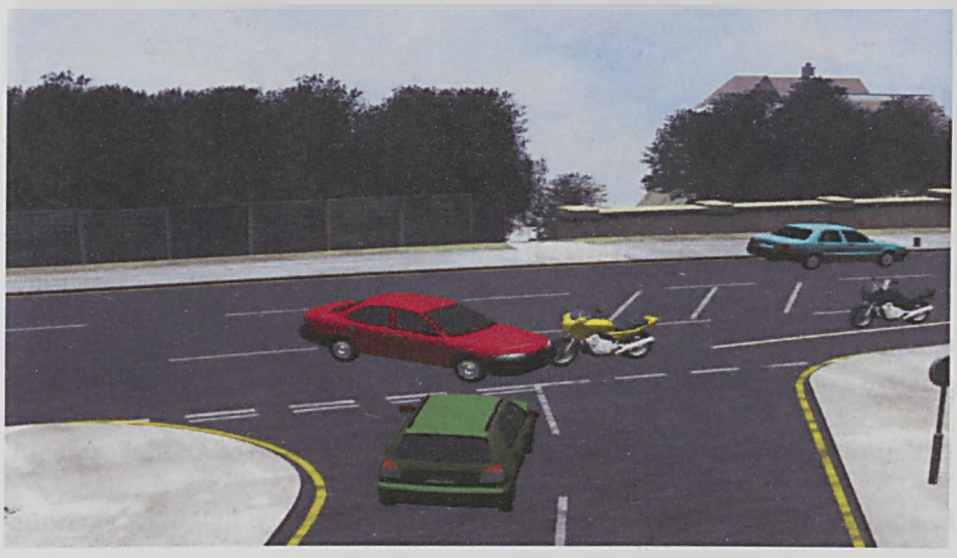


Figure 7.34: Still from the animation showing the distance between the first and second motorbike prior to the collision

In Figure 7.35, W4(1) affirms that it was the second collision. W4(1) stated that she believes that the second collision forced the red vehicle to collide with her car.

> W4(1): *It was the second collision, which I now know was a motorcycle, which forced the red vehicle to collide with my car. I did not see the collisions of either motorcycles I only heard the bangs.*

Figure 7.35: W4(1) describing impact of the second collision

Figure 7.36: Still from the animation showing the second motorbike collide with the motorcar

W4(1) was describing based on her human senses. The information extracted in Figures 7.29, 7.33 and 7.35 are facts that have been evaluated from the K2 concepts. She will be assessed under the *similar* category as in d3 analysis with a score of 0.5.

7.5.2 Case 2

Although there are several eyewitnesses, for the purpose of this research, only three will be assessed based on the fact that there is more information on the collision from these three eyewitnesses. The car driver will be referred to as W1(2) and the other two will be referred to as W2(2) and W3(2) respectively. The eyewitnesses' statements (E4(2)) will be assessed as item of evidence that has been referred to by the animator to assist in the positioning of the vehicles in the CGA environment relating to the collision.

Analysis d13

> W1(2): *I indicated right to turn into Gardens C and slowed the car so that it was practically stationary. I observed traffic coming up Avenue D there was plenty of time to turn.*

Figure 7.37: W1(2) describing his journey before he made the turn

Based on the statement (Figure 7.37) made by W1(2), he will be assessed under the *similar* category as in d1 with a score of 0.5. W1(2) has been evaluated as having the capabilities and experience for what he was involved induring the collision.

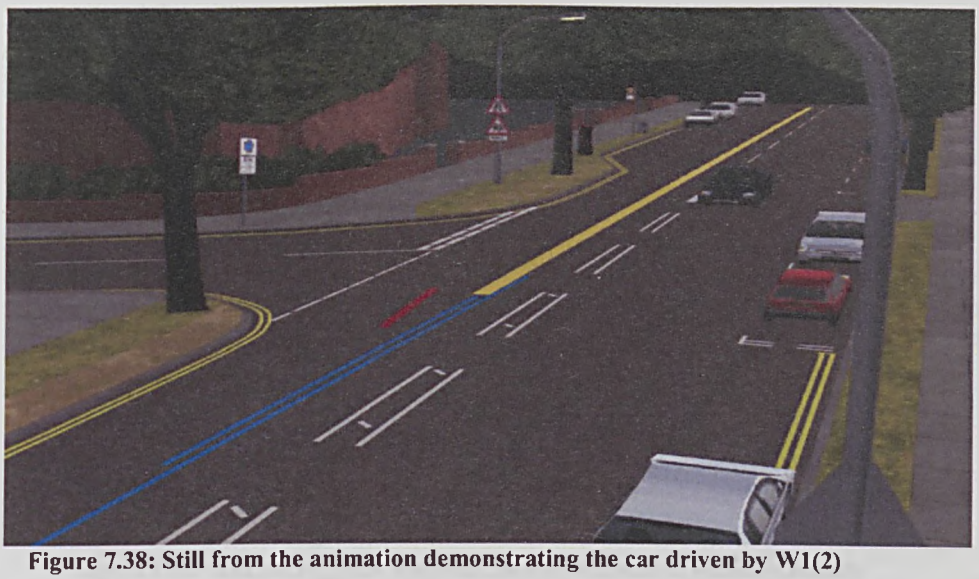


Figure 7.38: Still from the animation demonstrating the car driven by W1(2)

Analysis d14

Based on the statement above, W1(2) has stated that he was observing traffic from Avenue D. This statement shows that he was at the collision vicinity (Figure 7.39). W1(2) will be assessed under the *exactly* category similar to W1(1) in d2 analysis with a score of 0.8.

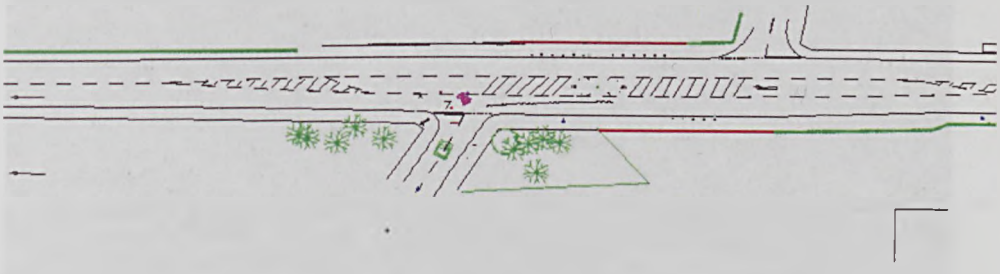


Figure 7.39: The survey plan showing the environment of collision vicinity

Analysis d15

> **W1(2):** *It was not a hurried manoeuvre. The road was not busy at that time of night. There appeared to be plenty of time to make the turn and his vehicle was already rolling forwards.*

Figure 7.40: W1(2) describing the traffic at the point he was about to make the turn

Based on this part of the statement (Figure 7.40), W1(2) had used his judgment relying on his human senses that he believed that there was plenty of time to make the turn. This fact will be evaluated as K2 concepts. Figure 7.41 is the still from the animation showing the turn was made with no "hurried manoeuvre".

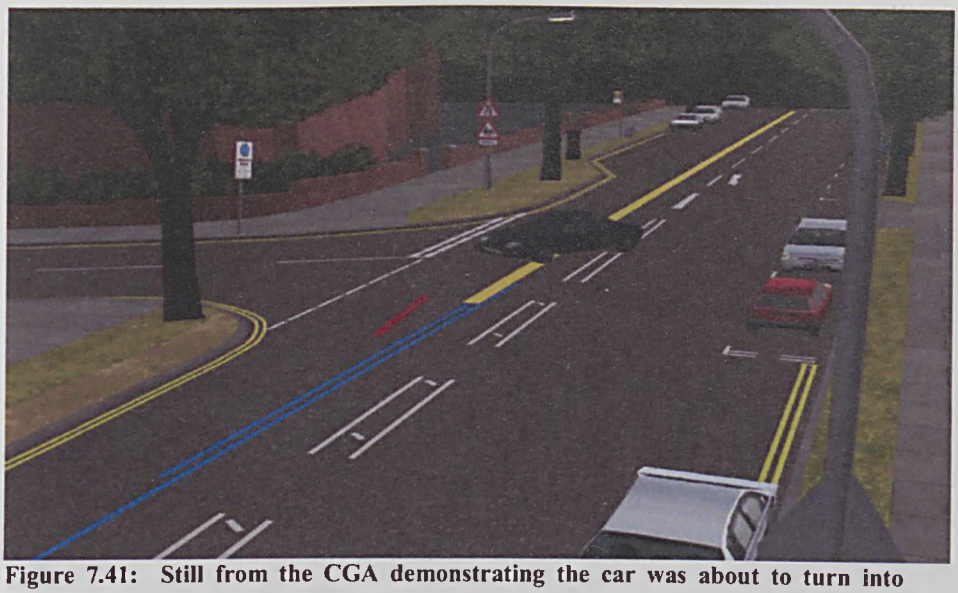


Figure 7.41: Still from the CGA demonstrating the car was about to turn into Gardens C

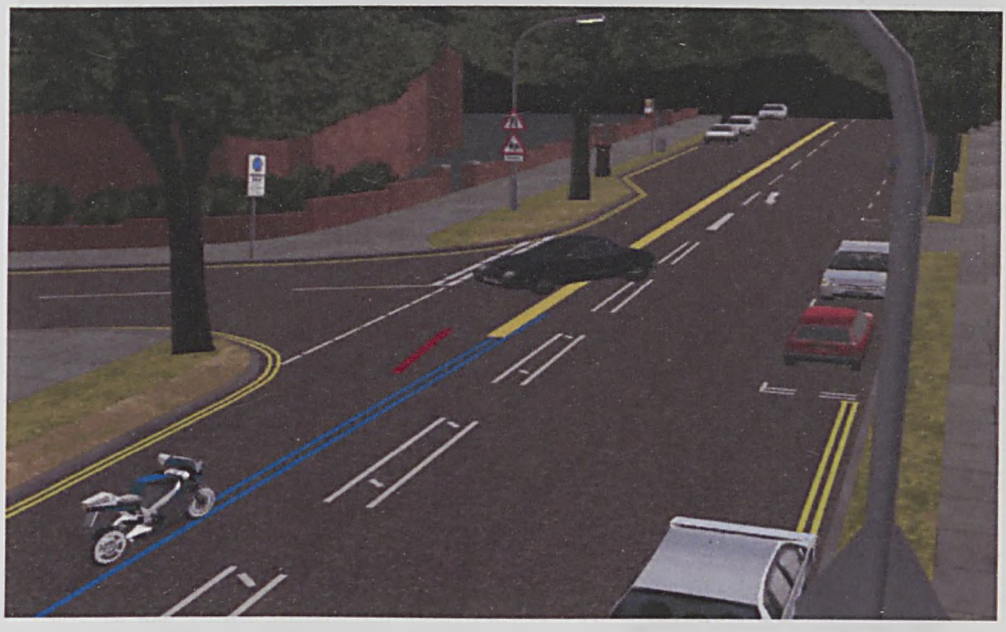


Figure 7.42: Still from the animation demonstrating the car was making the turn and the motorbike approaching the junction

Figure 7.43: Still from the CGA demonstrating the motorbike travelling on the straight line

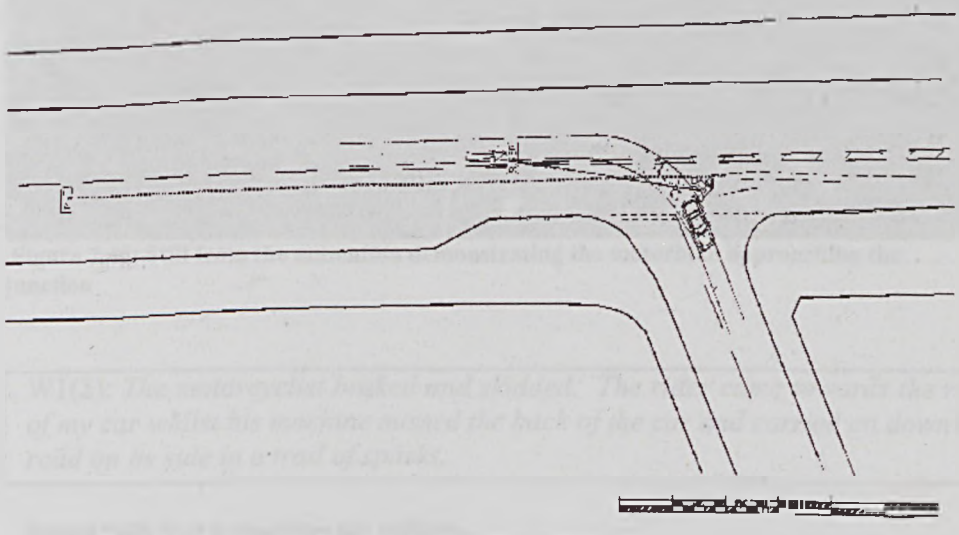


Figure 7.44: Sketch plan illustrating the vehicle path

W1(2): *I believe I first saw the motorcycle out of the nearside of the front windscreen. I believe that when I started my turn he would have been at least partially obscured behind the bollards.*

Figure 7.45: W1(2) describing his vision was partially obscured behind the bollards

Further stated in the above statement, W1(2) believes that he first saw the motorcycle out of the nearside of the front windscreen (Figure 7.42). This is a form of endorsement to the statement made earlier that he has plenty of time to make the turn. He did not see the motorcycle, at the time he believed there was plenty of time to make the turn. Figures 7.43, 7.44 and 7.46 are supplements to Figure 7.42 that illustrate the probable path of the vehicle.

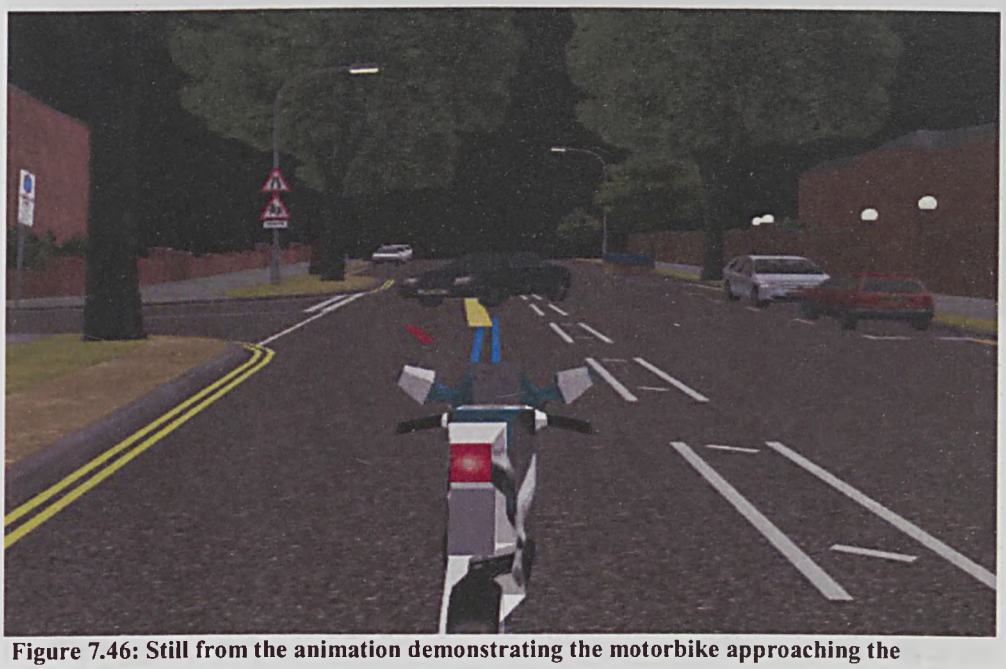


Figure 7.46: Still from the animation demonstrating the motorbike approaching the junction

W1(2): *The motorcyclist braked and skidded. The rider came towards the rear of my car whilst his machine missed the back of the car and carried on down the road on its side in a trail of sparks.*

Figure 7.47: W1(2) describes the collision

In this part of the statement (Figure 7.47), W1(2) described what he perceived from his sight. He claimed that the rider came towards the rear of his car (Figure 7.48). He added that the motorcycle missed the back of the car. This is a

form of affirmation that has been evaluated pertaining to K2 concept. W1(2) will be assessed under the *similar* category as in d3 analysis with a score of 0.5.

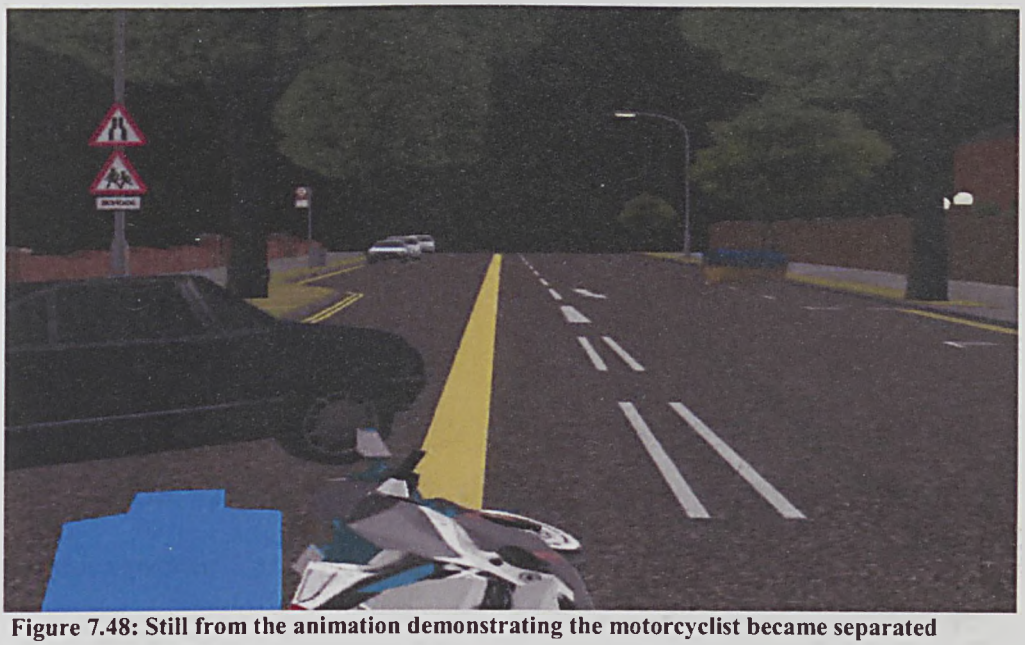


Figure 7.48: Still from the animation demonstrating the motorcyclist became separated from the motorbike

7.5.3 Comparison with other eyewitnesses' statements

Analysis d16

On the assumption that W2(2) has the capability and experience in relation to the description she made, W2(2) will be assessed similar to the capacity of W1(1) in d1 with a score of 0.5.

Analysis d17

W2(2) will be assessed under the *exactly* category similar to W1(1) in d2 analysis with a score of 0.8. W2(2) was travelling on the Avenue C at the time the collision occurred.

Analysis d18

W2(2): *... all I saw was the motorbikes break light.., not stopping in time and the driver falling off the motorbike and the bike skidding away.*

Figure 7.49: W2 (2) describes the collision

This statement (Figure 7.49) describes what was seen by W2(2). W2(2) will be assessed under the *similar* category as in d3 analysis with a score of 0.5.

Analysis d19

On the assumption that W3(2) has the capability and experience in relation to the description she made, W3(2) will be assessed similar to the capacity of W1(1) in d1 with a score of 0.5.

Analysis d20

W3(2) will be assessed under the *exactly* category similar to W1(1) in d2 analysis with a score of 0.8. W3(2) was travelling on the Avenue B at time the collision occurred.

Analysis d21

W3(2): *The motorcyclist was on the road surface in Avenue C, just beyond the junction. The machine was about 100 yards up the road.*

Figure 7.50: W3 (2) describes the collision

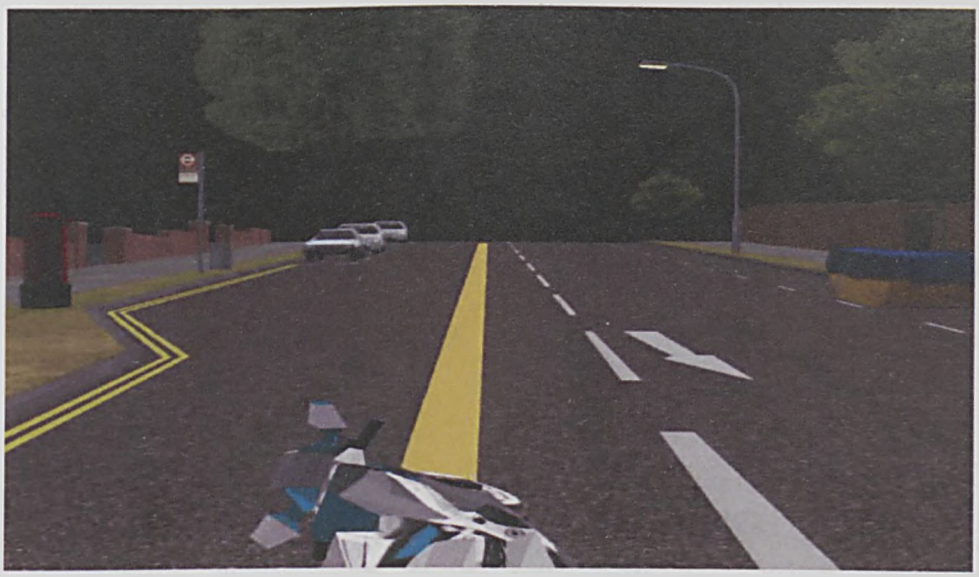


Figure 7.51: Still from the animation demonstrating the motorbike continues to slide along the road

This statement describes what was seen by W3(2). W3(2) will be assessed under the *similar* category as in d3 analysis with a score of 0.5.

7.5.4 Eyewitness statement: Case 3 and Case 4

The actual eyewitness' statements were not available for reference for this analysis. The evaluation on the eyewitness' statements for Case 3 and Case 4 will be based on assumptions.

Analysis d22

On the assumption that the eyewitnesses in Case 3 and Case 4 have the capability and experience in relation to the descriptions made in the statements, all the eyewitnesses will be assessed similar to the capacity of W1(1) in d1 with a score of 0.5.

Analysis d23

All the eyewitnesses in Case 3 and Case 4 will be assessed under the *exactly* category similar to W1(1) in d2 analysis with a score of 0.8. The eyewitnesses were at the collision or crime vicinity.

Analysis d24

For the purpose of the K2 concept, all the eyewitnesses have been assumed to perceive what had happened based on their human senses. The eyewitnesses have been assumed to endorse and affirm their descriptions pertaining to the collision or crime occurred. All the eyewitnesses will be assessed under the *similar* category as in d3 analysis with a score of 0.5.

Based on the analysis d1 to d24, Table 7.8 summarises the results from all the scores for items of evidence classified under the spatial evidence.

Analysis Reference	*Analysis Summary and Scores*
d1	E4(1): Case 1 (W1(1)); K1a, K1b = 0.5
d2	E4(1): Case 1 (W1(1)); K1c = 0.8
d3	E4(1): Case 1 (W1(1)); K2a, K2b, K2c = 0.5
d4	E4(1): Case 1 (W2(1)); K1a, K1b = 0.5
d5	E4(1): Case 1 (W2(1)); K1c = 0.8
d6	E4(1): Case 1 (W2(1)); K2a, K2b, K2c = 0.5
d7	E4(1): Case 1 (W3(1)); K1a, K1b = 0.5
d8	E4(1): Case 1 (W3(1)); K1c = 0.8
d9	E4(1): Case 1 (W3(1)); K2a, K2b, K2c = 0.5
d10	E4(1): Case 1 (W4(1)); K1a, K1b = 0.5
d11	E4(1): Case 1 (W4(1)); K1c = 0.8
d12	E4(1): Case 1 (W4(1)); K2a, K2b, K2c = 0.5
d13	E4(1): Case 2 (W1(2)); K1a, K1b = 0.5
d14	E4(1): Case 2 (W1(2)); K1c = 0.8
d15	E4(1): Case 2 (W1(2)); K2a, K2b, K2c = 0.5
d16	E4(2): Case 2 (W2(2)); K1a, K1b = 0.5
d17	E4(2): Case 2 (W2(2)); K1c = 0.8
d18	E4(2): Case 2 (W2(2)); K2a, K2b, K2c = 0.5
d19	E4(2): Case 2 (W3(2)); K1a, K1b = 0.5
d20	E4(2): Case 2 (W3(2)); K1c = 0.8
d21	E4(2): Case 2 (W3(2)); K2a, K2b, K2c = 0.5
d22	E4(3), E4(4): Case 3 and Case 4 (all eyewitnesses); K1a, K1b = 0.5
d23	E4(3), E4(4): Case 3 and Case 4 (all eyewitnesses); K1c = 0.8
d24	E4(3), E4(4): Case 3 and Case 4 (all eyewitnesses); K2a, K2b, K2c = 0.5

Table 7.8: Scores for items of evidence classified under the eyewitnesses' statements

Note: K1a: competence; K1b: acquaintance; K1c: correct information;
K2a: truth; K2b: acceptance; K2c: justification. (See Table 5.4)
E4(1), E4(2), E4(3) and E4(4): Eyewitness' statements
W1(1): the car driver in Case 1; W2(1) and W3(1) are two eyewitnesses at the collision vicinity
W1(2): the car driver in Case 2; W2(2) and W3(2) are two eyewitnesses at the collision vicinity
For cases 3 and 4, the eyewitness will be referred to as "all eyewitnesses"

7.6 Conclusion

The items of evidence have been analysed individually based on four classes of evidence namely written, spatial, visual and eyewitnesses' statements. All the items have been assessed based on all the concepts K1 and K2. The types of knowledge (K1) and the conditions for knowledge (K2) have been described in Chapter 4 and in Chapter 5 as part of the main components of the research methodology. The involvement of K1 and K2 in this Chapter concentrates on the quasi-experimental stage of the research.

The summary of each analysis has been demonstrated in the next Chapter. The summary will be presented in two forms, tables of all scores assigned and histograms. The first part of the summary will demonstrate the scores based on the four classes of evidence. The second part of the summary will present the scores based on the six cases. Apart from the tables and histograms, the next Chapter will also outline the significance of findings from individual items of evidence. The main purpose of outlining the significance is to answer the question as to whether a particular item of evidence has become reliable information to the animator to generate the CGA. Hence, answering the question of how reliable and accurate is the CGA based on the information (evidence) furnished to the animator.

Chapter 8

Summary of Data Aggregation

8.1 Introduction

The scores assigned in the analyses in Chapter 7 has been summarised into four tables based on the four classifications of evidence from Chapter 5:

1. Table 8.1: Written Evidence
2. Table 8.2: Spatial Evidence
3. Table 8.3: Visual Images
4. Table 8.4: Eyewitnesses' Statements

Each of the tables will be displayed in histograms accordingly.

8.2 Written Evidence

Table 8.1 and Figure 8.1 summarise the analysis of the written evidence. In order to clarify the scoring and the concepts on the summary chart, Table 5.7, Chapter 5 shows how the evidence has been obtained, a score rating, (ranging from 0.1 to 1.0), attributed to the reliability of the evidence and how the results are then classified into categories as either *general*, *similar* or *exactly*.

Cases/ Items of Evidence	**Concepts/Score**					
Written Evidence	K1a	K1b	K1c	K2a	K2b	K2c
Case 1						
E1(1)	0.8	0.8	0.8	0.8	0.8	0.8
E2(1)	0.8	0.8	0.8	0.8	0.8	0.8
Case 2						
E1(2) Police 1(2), Police 2(2), Police 3(2)	0.3	0.3	0.8	0.3	0.3	0.3
E2(2) Police 4(2)	0.8	0.8	0.8	0.8	0.8	0.8
E2(2) Police 2(2)	0.3	0.3	0.8	0.3	0.3	0.3
E3(2)	0.8	0.8	0.8	0.8	0.8	0.8
E5(2) (Expert C)	0.3	0.5	0.8	0.8	0.8	0.8
E5(2) (Expert D)	0.8	0.8	0.8	0.8	0.8	0.8
Case 3						
E1(3)	0.3	0.3	0.8	0.3	0.3	0.3
E2(3)	0.3	0.3	0.8	0.3	0.3	0.3
E3(3)	0.3	0.3	0.8	0.3	0.3	0.3
Case 4						
E1(4)	0.3	0.3	0.8	0.3	0.3	0.3
E2(4)	0.5	0.5	0.8	0.3	0.3	0.3
Case 5						
E1(5)	0.3	0.3	0.5	0.3	0.3	0.3
Case 6						
E1(6)	0.3	0.3	0.8	0.3	0.3	0.3

Table 8.1: Written Evidence

Table 5.7 in Chapter 5 showed that for concept K1c, the expert(s) or police officer(s):

a. had obtained only a list of evidence to score 0.1-0.3 in the *general* category;
b. had obtained the physical evidence, from a third party (description/summary) to score 0.4-0.6 in the *similar* category; or
c. had visited the scene and obtained physical evidence to score 0.7-1.0 in the *exactly* category.

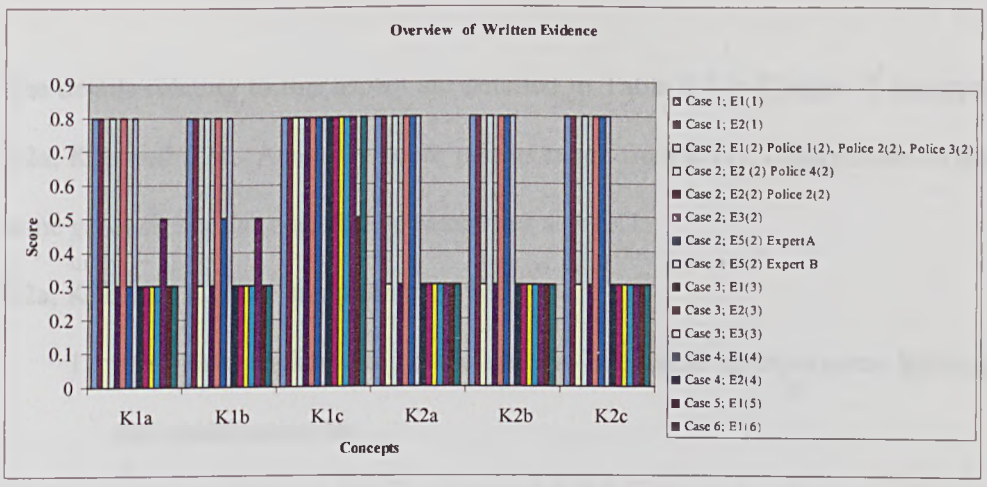


Figure 8.1: Written Evidence

Therefore, the first aspect derived from the histogram (Figure 8.1) is that the middle score of 0.8 in the *exactly* category indicates that the reliability of the evidence was greatest when the expert(s) or police officer(s) had attended the collision or crime scene to obtain information (evidence).

In the Data Recovery Report (E1(5)) for the Computer Forensics Investigation (Case 5), the expert has been assigned with a score of 0.5 (analysis a4 in Chapter 7). The score of 0.5 has been based on the fact that the expert was preparing a data recovery report for a computer forensic case, and that he or she received the item of evidence from the police authority. The expert in this particular case was not at the crime scene. Hence reinforcing that a score in the *similar* category is not as reliable as a score in the *exactly* category.

The second aspect derived from Table 8.1 and the histogram is that the expert or police officer has got to possess appropriate training, qualification and experience in related investigation.

The details relating to this aspect are detailed in Table 5.7 in Chapter 5 concepts K2a, K2b and K2c. Again the score ratings range from 0.1-1.0 and pertain to the same *general*, *similar* and *exactly* categories as in K1.

K2a, K2b, and K2c are summarised as follows:

1. K2a – had applied a scientific/specific rule based on experience, training and qualification for
    a. another type of case to score 0.1-0.3 in the *general* category;
    b. a similar type of case to score 0.4-0.6 in the *similar* category; or
    c. the case under investigation to score 0.7-1.0 in the *exactly* category.
2. K2b – had the ability to endorse the scientific/specific rule based on experience, training and qualification for
    a. another type of case to score 0.1-0.3 in the *general* category;
    b. a similar type of case to score 0.4-0.6 in the *similar* category; or
    c. the case under investigation to score 0.7-1.0 in the *exactly* category.
3. K2c – had the ability to validate the scientific/specific rule based on experience, training and qualification for
    a. another type of case to score 0.1-0.3 in the *general* category;
    b. a similar type of case to score 0.4-0.6 in the *similar* category; or
    c. the case under investigation to score 0.7-1.0 in the *exactly* category.

The third aspect concerns the pattern of scores for the concepts K2a, K2b and K2c. The score in K1a and K1b has influenced the score pattern for these three concepts.

K1a and K1b can be summarised as follows:

1. K1a – had qualification and training on
   a. general investigation process to score 01.-0.3 in the *general* category;
   b. pertaining to a similar case to score 0.4-0.6 in the *similar* category; or
   c. exactly the same type of case under investigation to score 0.7-1.0 in the *exactly* category.

2. K1b – had previous experience on
   a. general investigation process to score 01.-0.3 in the *general* category;
   b. pertaining to a similar case to score 0.4-0.6 in the *similar* category; or
   c. exactly the same type of case under investigation to score 0.7-1.0 in the *exactly* category.

The justification for these values or categories is that, if the expert(s) or police officer(s) had appropriate training, qualifications and experience, he/she is more likely to apply an accurate method of investigation. In addition to this, he/she will

have strong grounds to endorse and validate the whole investigation process due to the application of the accurate method of investigation.

8.2 Spatial Evidence

Table 8.2 and Figure 8.2 summarise the analysis for the spatial evidence.

Cases/ Items of Evidence	**Concepts/Score**					
Spatial Evidence	K1a	K1b	K1c	K2a	K2b	K2c
Case 1						
E3(1)	0.8	0.8	0.8	0.8	0.8	0.8
Case 3						
E5(3)	0.3	0.3	0.8	0.8	0.8	0.8
E6(3)	0.3	0.3	0.8	0.8	0.8	0.8
Case 4						
E3(4)	0.3	0.3	0.8	0.3	0.3	0.3
Case 6						
E2(6)	0.3	0.3	0.8	0.3	0.3	0.3

Table 8.2: Spatial Evidence

The items in the spatial evidence offered in the trial cases are detailed as follows:

1. A plan of the road layout, (E3(1)) in Case 1, the road traffic collision between two motorcars and two motorbikes.
2. Two survey maps, (E5(3)) and two overhead plans of debris (E6(3)) offered in Case 3, the road traffic collision between two motorcars.
3. A plan of the road layout, (E3(4)) offered in Case 4, a murder investigation.
4. Drawings and sketches, (E2(6)) offered in Case 6, the marine accident.

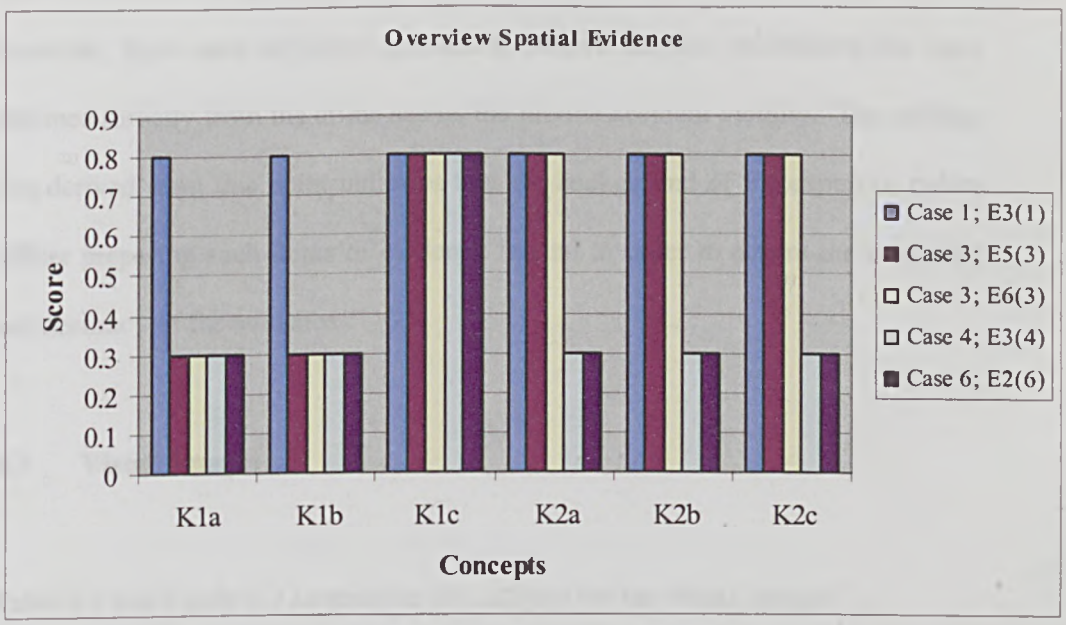


Figure 8.2: Spatial Evidence

The score of 0.8 assigned to E3(1) in Case 1 indicates that this is the most reliable item compared with other items within this class. The police officer preparing written evidence in the same case had prepared the road layout. It is essential to note that E3(1) is corroborated with the Crash Investigation Report (E1(1)) and the Police Statement (E2(1)).

The scores for K1a and K1b under E5(3) and E6(3) in Case 3 were based on the fact that there were no details pertaining to the police officer preparing both items (this information is restricted to the research). However, the scores for K2a, K2b and K2c were derived from *exactly* category based on the plans furnished to the animator.

In both E3(4) for Case 4 and E2(6) in Case 6, there were no details about the expert and method of investigation (the information is restricted to this research). However, there were sufficient grounds to believe that the information has been obtained directly from the crime scene, the marine accident vicinity. The striking fact derived from this point indicates that the background of the expert or police officer preparing such items of evidence is vital in order to ensure the reliability and accuracy of the evidence.

8.3 Visual Images

Table 8.3 and Figure 8.3 summarise the analysis for the visual images.

Cases/ Items of Evidence	**Concepts/Score**					
Visual Images	K1a	K1b	K1c	K2a	K2b	K2c
Case 3						
E7(3)	0.5	0.5	0.8	0.5	0.5	0.5
E8(3)	0.5	0.5	0.8	0.5	0.5	0.5
Case 6						
E3(6)	0.5	0.5	0.8	0.5	0.5	0.5

Table 8.3: Visual Images

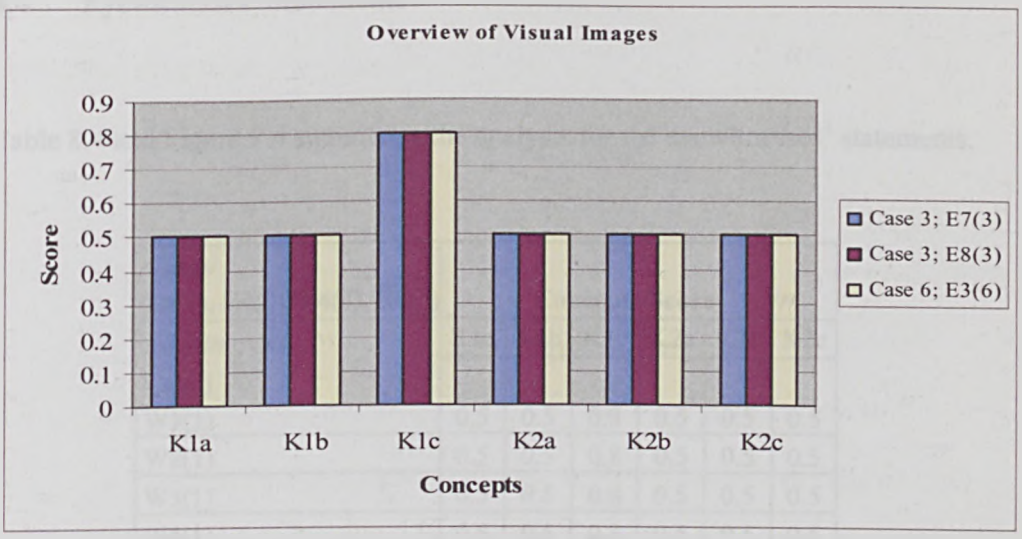


Figure 8.3: Visual Images

Similar to the reasons given for written evidence, in order to ensure the quality of the visual images and evidence, the expert(s) or police officer(s) must visit the collision/crime scene. Comparable to spatial evidence, visual images must be corroborated with the written evidence.

8.4 Eyewitnesses' Statements

Table 8.4 and Figure 8.4 summarise the analysis for the eyewitnesses' statements.

Cases/ E4(1), E4(2), E4(3), E4(4)	**Concepts/Score**					
Eyewitnesses	K1a	K1b	K1c	K2a	K2b	K2c
Case 1						
W1(1)	0.5	0.5	0.8	0.5	0.5	0.5
W2(1)	0.5	0.5	0.8	0.5	0.5	0.5
W3(1)	0.5	0.5	0.8	0.5	0.5	0.5
W4(1)	0.5	0.5	0.8	0.5	0.5	0.5
Case 2						
W1(2)	0.5	0.5	0.8	0.5	0.5	0.5
W2(2)						
W3(2)	0.5	0.5	0.8	0.5	0.5	0.5
Case 3 and Case 4						
Eyewitnesses	0.5	0.5	0.8	0.5	0.5	0.5

Table 8.4: Eyewitnesses' Statements

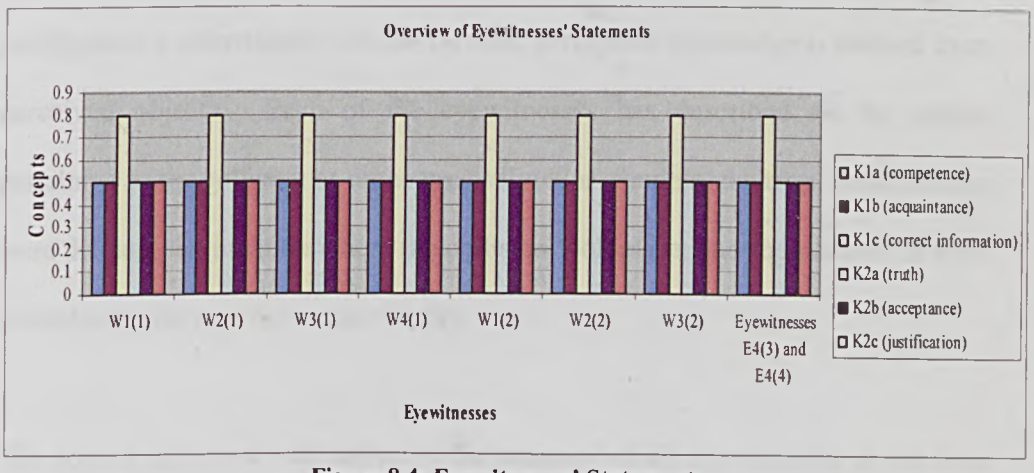


Figure 8.4: Eyewitnesses' Statements

All the eyewitnesses were assigned a score of 0.5 for K1a, K1b, K2a, K2b, and K2c. The middle score derived from the similar category has been based on the assumption that all the eyewitnesses:

a. have the capability in what he/she was involved during the collision/crime;
b. have the experience in relation to what he/she was involved during the collision/crime;
c. describe what had happened based on the five human senses;
d. support their description based on their intellectual capabilities; and
e. verify what he/she has described.

These grounds have been justified by taking into account the theory proposed by Goldman (1967) on causal knowledge, this was described in Chapter 4. All the eyewitnesses have been assumed to use their human senses in their statements describing what had happened at the collision or crime scene. This part of the justification is interrelated with the fact that perceptual knowledge is derived from perceived objects. Each of the eyewitnesses has described all the details pertaining to the collision or crime precisely. For example, the time, vehicles they were driving, the junction where the collision took place, and the position of their parked vehicles near the crime vicinity.

The second and most vital aspect is the presence of all eyewitnesses at the time the collision or crime occurred. This aspect refers to K1c with sufficient grounds from each of the statements that prove the eyewitnesses were at the collision or crime vicinity.

In this next section, scores for all the items from all six cases will be presented in a form of histogram. There are three histograms for each case except for Case 5. One histogram presents the overview of all items from each case. Two more histograms will present the average and standard deviation values for items of evidence and concepts (K1, K2 a-c) independently.

8.5 Case 1: Description

Table 8.5 and Figures 8.5, 8.6, 8.7 summarise the analysis of items of legal evidence for Case 1.

Case 1	Eyewitnesses	Concepts						Mean	Standard Deviation
		K1a	K1b	K1c	K2a	K2b	K2c		
E1(1)	-	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0
E2(1)	-	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0
E3(1)	-	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0
E4(1)	W1(1)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1
	W2(1)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1
	W3(1)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1
	W4(1)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1
	Mean	0.6	0.6	0.8	0.6	0.6	0.6		
	Standard Deviation	0.2	0.2	0.0	0.2	0.2	0.2		

Table 8.5: Items E1(1)-E4(1) in Case 1

This table summarises the scores for the individual items of evidence from Case 1. The mean and standard deviation values have been inserted in two columns on the right and in two rows below the table.

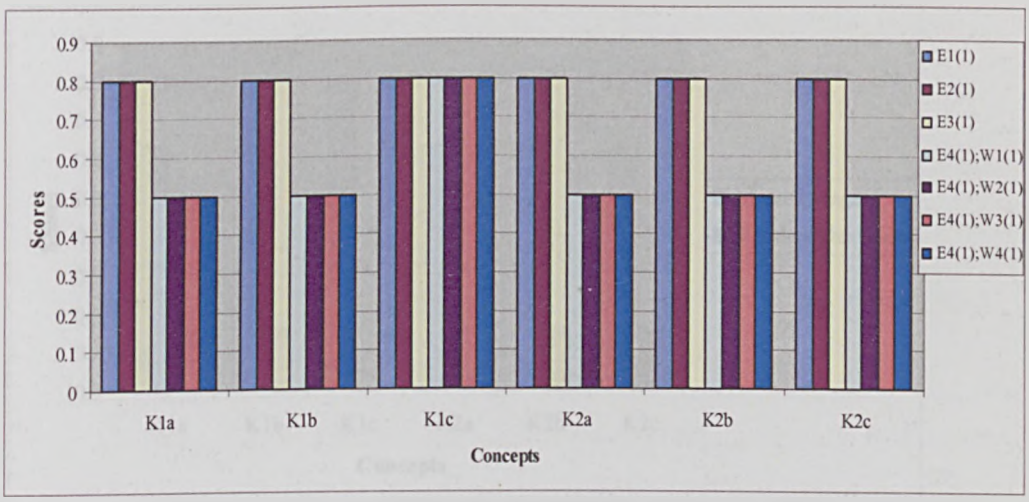


Figure 8.5: Items E1(1)-E4(1) in Case 1

The histogram in Figure 8.5 shows the frequency of scores for each of the items in Case 1.

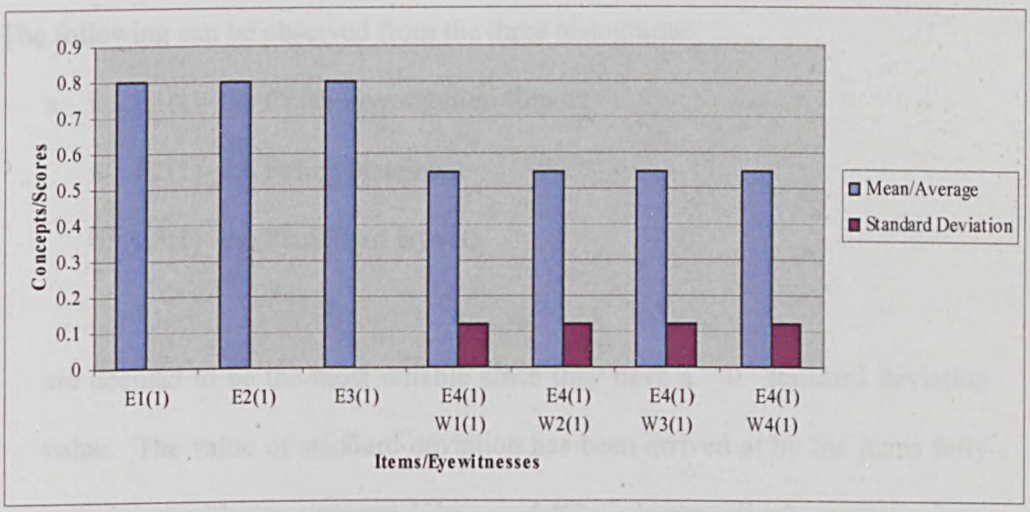


Figure 8.6: Mean and standard deviation value for items/eyewitnesses

The histogram in Figure 8.6 shows the pattern concerning average scores and standard deviation values for individual items of legal evidence in Case 1.

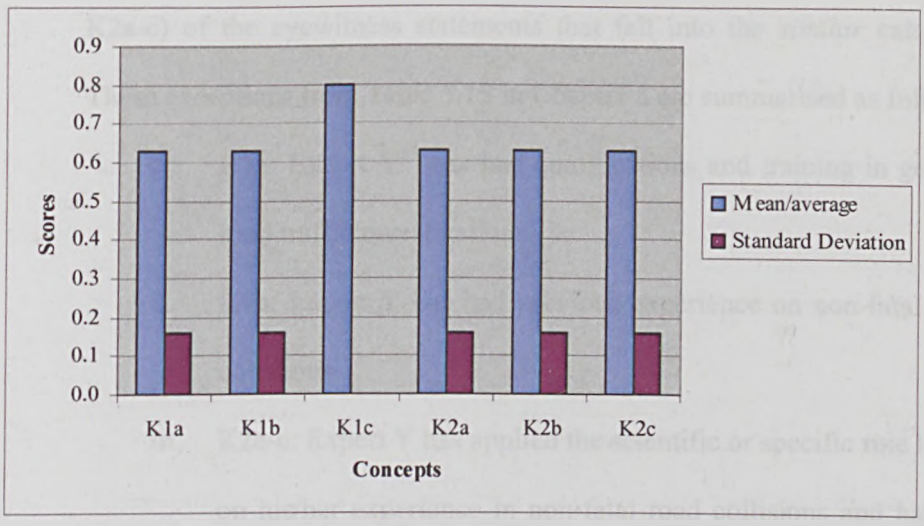


Figure 8.7: Mean and standard deviation values for concepts

Similar to Figure 8.6, the histogram in Figure 8.7 shows the pattern pertaining to average scores and standard deviation value for concepts (K1, K2) in Case 1.

The following can be observed from the three histograms:

a. i. E1(1)- the Crash Investigation Report

i. E2(1)- the Police Statement

ii. E3(1)- the Plan (road layout)

are deemed to be the most reliable since they have a "0" standard deviation value. The value of standard deviation has been arrived at by the items fully complying with the concepts K1a-c and K2a-c in the *exactly* category from Table 5.7, in Chapter 5, each item being scored as 0.8.

b. All the concepts are in the *exactly* category except for concepts (K1a, K1b, K2a-c) of the eyewitness statements that fall into the *similar* category. These exceptions from Table 5.15 in Chapter 5 are summarised as follows:

   i. K1a: Expert Y[33] has had qualifications and training in general road traffic investigations.

   ii. K1b: Expert Y has had previous experience on non-fatal road collisions.

   iii. K2a-c: Expert Y has applied the scientific or specific rule based on his/her experience in non-fatal road collisions and has the ability to endorse and validate the rule based on training, qualifications and experience investigating that type of road collision.

   The score allocated to these exceptions is between 0.4-0.6. The score would need to be 0.8 to achieve the *exactly* category.

c. that E1(1), E2(1), E3(1) are items prepared by Police 1(1), therefore, he/she has satisfied the requirements of the concepts.

Based on the summary and description in Case 1, items E1(1), E2(1) and E3(1) are most reliable for the animator to use as information to generate the CGA. The most vital qualities focusing on the first three concepts (K1a, K1b, and K1c) have been fulfilled by Police 1(1) for the preparation of E1(1), E2(1) and E3(1). The CGA pertaining to Case 1 will be assessed as reliable and accurate to this extent for based on the grounds that Police 1(1) has appropriate training, qualifications and experience pertaining to the fatal road traffic collision.

[33] "Expert Y" is only an example stated from Table 5.15 in Chapter 5

8.7 Case 2: Description

Table 8.6 and Figures 8.8, 8.9, 8.10 summarise the analysis of the items of legal evidence for Case 2.

Case 2	Police/ Experts Eyewitnesses	Concepts						Mean	Standard Deviation
		K1a	K1b	K1c	K2a	K2b	K2c		
E1(2)	Police 1(2)	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2
	Police 2(2)	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2
	Police 3(2)	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2
E2(2)	Police 4(2)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0
	Police 2(2)	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2
E3(2)	Expert A	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0
	Expert B	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0
E4(2)	W1(2)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1
	W2(2)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1
	W3(2)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1
E5(2)	Expert C	0.3	0.5	0.8	0.8	0.8	0.8	0.7	0.2
	Expert D	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0
	Mean	0.5	0.5	0.8	0.6	0.6	0.6		
	Std. Deviation	0.2	0.2	0.0	0.2	0.2	0.2		

Table 8.6: Items E1(2)-E5(2) in Case 2

The mean and standard deviation values have been inserted in two columns on the right and two rows below the table.

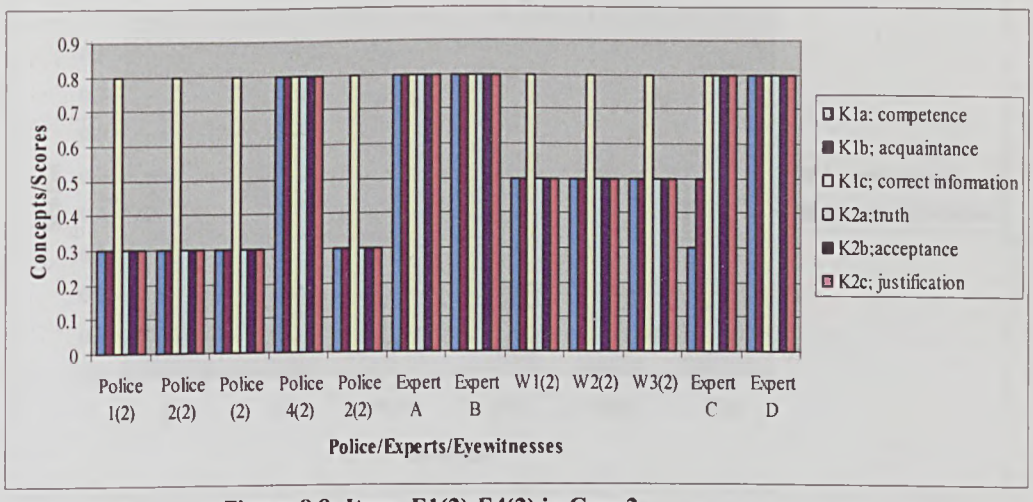


Figure 8.8: Items E1(2)-E4(2) in Case 2

The histogram in Figure 8.9 shows the frequency of scores for each of the items in Case 2.

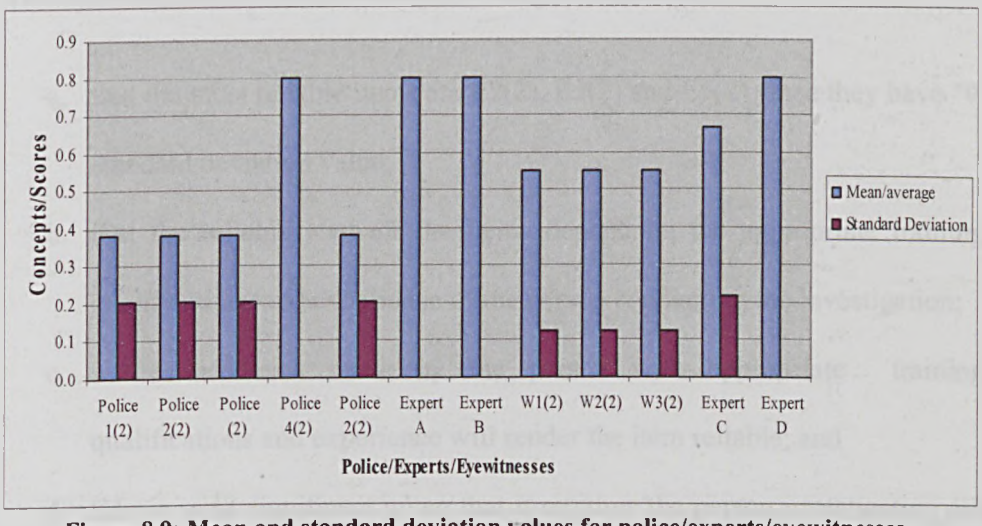


Figure 8.9: Mean and standard deviation values for police/experts/eyewitnesses

The histogram in Figure 8.10 shows the pattern concerning average scores and standard deviation values for individual items of legal evidence in Case 2.

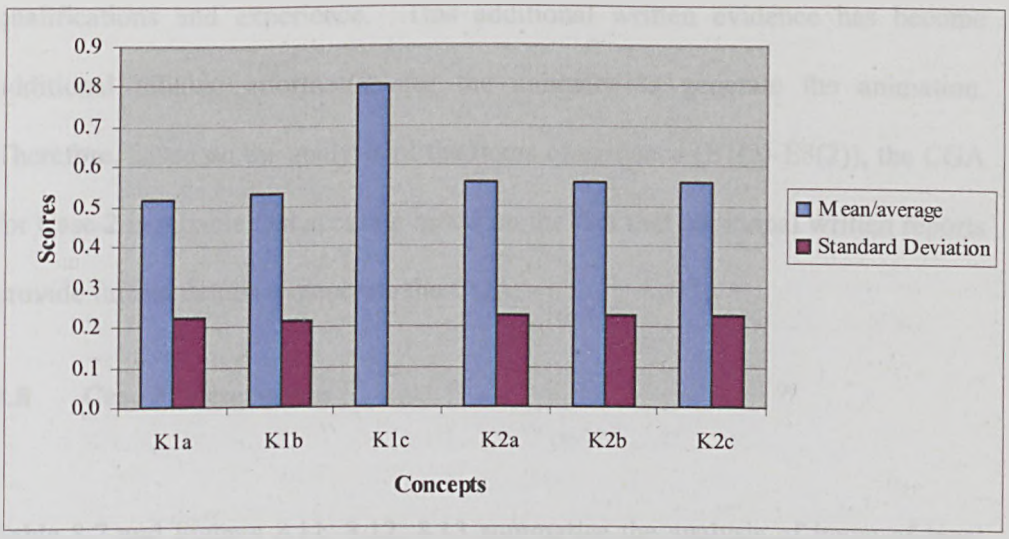


Figure 8.10: Mean and standard deviation values for concepts

Similar to Figure 8.9, the histogram in Figure 8.10 shows the pattern pertaining to average scores and standard deviation value for concepts (K1, K2) in Case 2.

The following can be observed from the three histograms:

a. that the most reliable items are E2(2), E3(2) and E5(2) since they have "0" standard deviation value;
b. that the reliability of all the items depend on the appropriate training, qualifications and experience of the person conducting the investigation;
c. written evidence made by the person with appropriate training, qualifications and experience will render the item reliable; and
d. K1c is most significant given that it requires the person investigating and the eyewitness to be present at the accident or crime.

In Case 2, there are additional written reports (E3(2) and E5(2)). There is sufficient evidential information showing that these written reports have been produced by Experts A, B, C and D based on their appropriate training,

qualifications and experience. This additional written evidence has become additional reliable information for the animator to generate the animation. Therefore, based on the analysis of the items of evidence (E1(2)-E8(2)), the CGA for Case 2 is reliable and accurate based on the fact that additional written reports provide further details to generate the CGA.

8.8 Case 3: Description

Table 8.7 and Figures 8.11, 8.12, 8.13 summarise the analysis of items of legal evidence for Case 3.

Case 3	Concepts							
	K1a	K1b	K1c	K2a	K2b	K2c	Mean	Standard Deviation
E1(3)	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2
E2(3)	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2
E3(3)	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2
E4(3)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1
E5(3)	0.3	0.3	0.8	0.8	0.8	0.8	0.6	0.3
E6(3)	0.3	0.3	0.8	0.8	0.8	0.8	0.6	0.3
E7(3)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1
E8(3)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1
Mean	0.4	0.4	0.8	0.5	0.5	0.5		
Standard Deviation	0.1	0.1	0.0	0.2	0.2	0.2		

Table 8.7: Items E1(3)-E8(3) in Case 3

Table 8.7 summarises the scores for the individual items of evidence from Case 3. The mean and standard deviation values have been inserted in two columns on the right and two rows below the table.

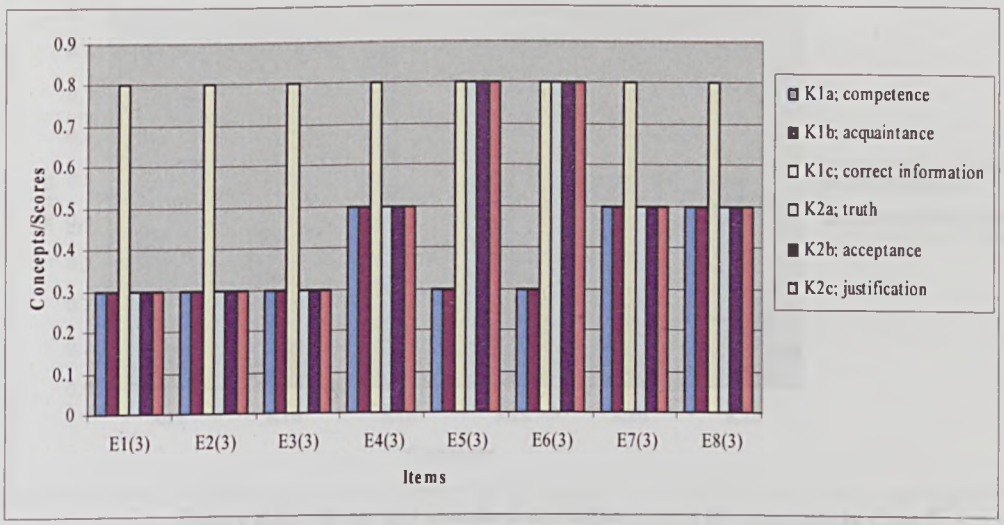


Figure 8.11: Items E1(3)-E8(3) in Case 3

The histogram in Figure 8.11 shows the frequency of scores for each of the items in Case 3.

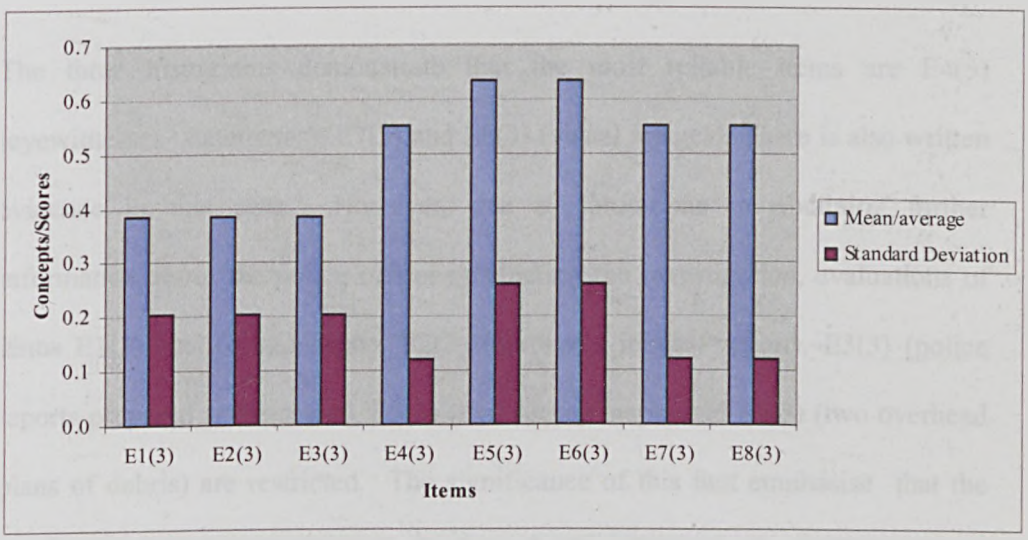


Figure 8.12: Mean and standard deviation values for items in Case 3

The histogram in Figure 8.12 shows the pattern concerning average scores and standard deviation values for individual items of legal evidence in Case 3.

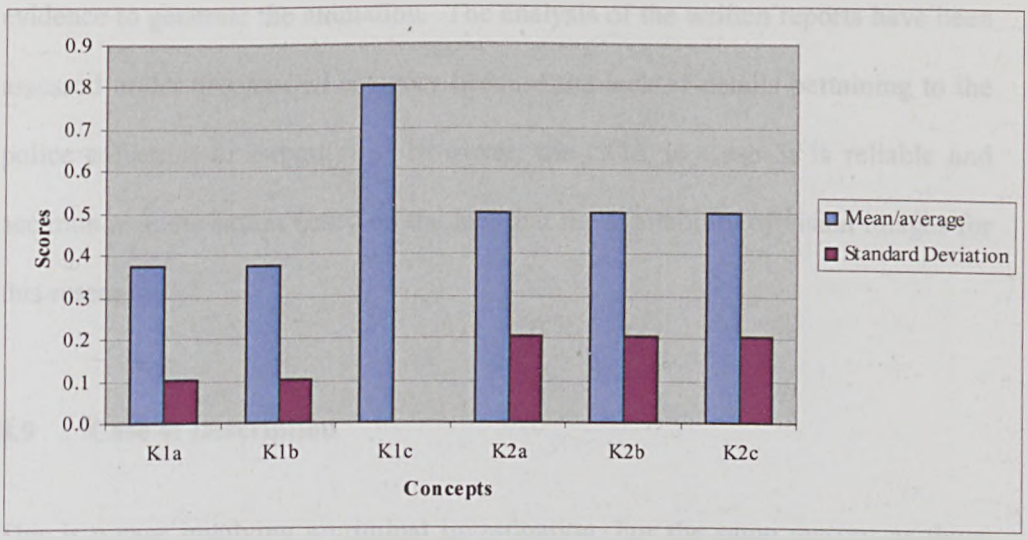


Figure 8.13: Mean and standard deviation values for concepts in Case 3

Similar to Figure 8.12, the histogram in Figure 8.13 shows the pattern pertaining to average scores and standard deviation values for concepts (K1, K2) in Case 3.

The three histograms demonstrate that the most reliable items are E4(3) (eyewitnesses' statements), E7(3) and E8(3) (visual images). There is also written evidence in this case. However, due to limitations in obtaining further information about the police officer conducting the investigation, evaluations of items E1(3) (police statement), E2(3) (coroner's inquest report), E3(3) (police reports prepared at the scene), E5(3) (two survey maps) and E6(3) (two overhead plans of debris) are restricted. The significance of this fact emphasise that the details of the person conducting the investigation should be available to assess whether or not the items have been prepared by a person with appropriate training, qualifications and experience pertaining to the case.

In Case 3, although the most reliable items are E4(3) (eyewitnesses' statements), E7(3) and E8(3) (visual images), the animator had also relied on the written

evidence to generate the animation. The analysis of the written reports have been assessed under the *general* category because the lack of details pertaining to the police officer(s) or expert(s). However, the CGA in Case 3, is reliable and accurate to some extent based on the fact that the availability of visual images for this research.

8.9 Case 4: Description

This is a case involving a criminal investigation. For the same reasons as those given in Case 3, the details of the person conducting the investigation are restricted. Therefore, the evaluation of this case is limited on K1a and K1b.

Case 4	Concepts						Mean	Standard Deviation
	K1a	K1b	K1c	K2a	K2b	K2c		
E1(4)	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2
E2(4)	0.5	0.5	0.8	0.3	0.3	0.3	0.5	0.2
E3(4)	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2
E4(4)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1
Mean	0.4	0.4	0.8	0.4	0.4	0.4		
Std. Deviation	0.1	0.1	0.0	0.1	0.1	0.1		

Table 8.8: Items E1(4)-E4(4) in Case 4

Table 8.8 summarises the scores for the individual items of evidence from Case 4. The mean and standard deviation values have been inserted in two columns on the right and two rows below the table.

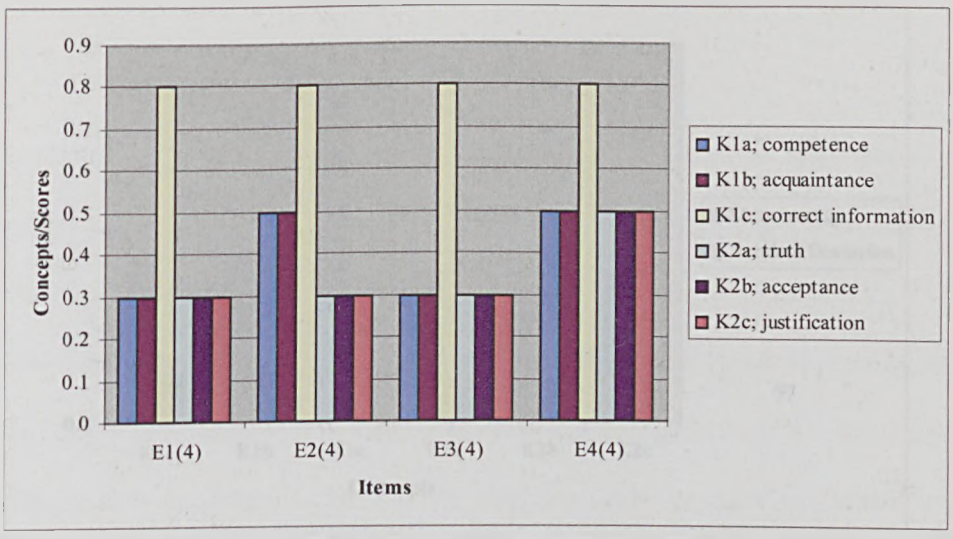


Figure 8.14: Items E1(4)-E4(4) in Case 4

The histogram in Figure 8.14 shows the frequency of scores for each of the items in Case 4.

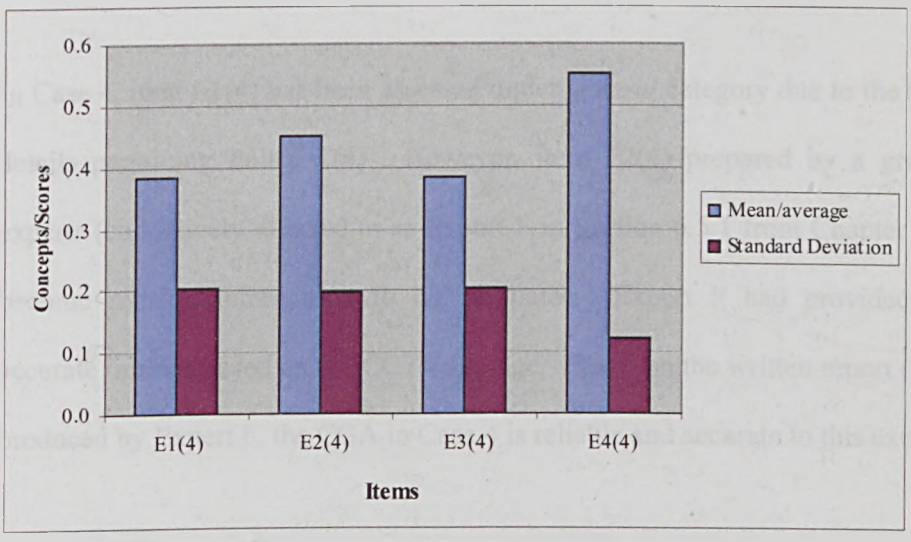


Figure 8.15: Mean and standard deviation values for items in Case 4

The histogram in Figure 8.15 shows the pattern concerning average scores and standard deviation value for individual items of legal evidence in Case 4.

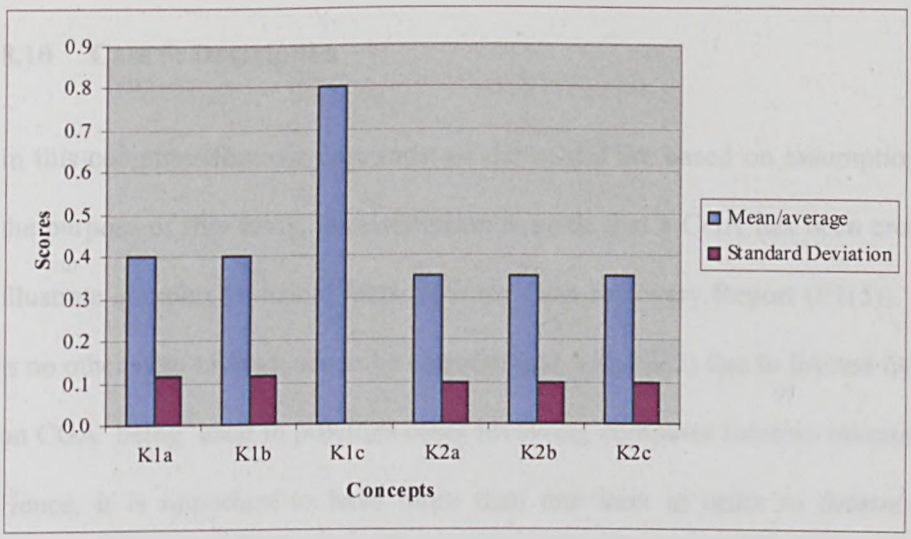


Figure 8.16: Mean and standard deviation values for concepts in Case 4

Similar to Figure 8.15, the histogram in Figure 8.16 shows the pattern pertaining to average scores and standard deviation values for concepts (K1, K2) in Case 4.

In Case 4, item E1(4) has been assessed under *general* category due to the lack of details pertaining Police 1(4). However, item E2(4) prepared by a group of experts (collectively referred to as Expert F in Section 6.5.1 from Chapter 6) has become reliable information to the animator. Expert F had provided more accurate timings based on the CCTV footage. Based on the written report (E2(4)) produced by Expert F, the CGA in Case 4 is reliable and accurate to this extent.

8.10 Case 5: Description

In this computer forensic case most of the values are based on assumption. For the purpose of this study, an assumption is made that a CGA has been created to illustrate complex technical facts from the Data Recovery Report (E1(5)). There is no other item of evidence to be corroborated with E1(5) due to limited literature on CGA being used in previous cases involving computer forensic investigation. Hence, it is important to have more than one item in order to determine the reliability and accuracy of an animation based on the information obtained from items of legal evidence.

Case 5	Concepts						Mean	Standard Deviation
	K1a	K1b	K1c	K2a	K2b	K2c		
E1(5)	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2
Mean	-	-	-	-	-	-		
Standard Deviation	-	-	-	-	-	-		

Table 8.9: Item E1(5) in Case 5

Table 8.9 shows the scores for E1(5) in Case 5. The mean and standard deviation value have been inserted in two columns on the right. There is no comparison with the item of evidence in this case.

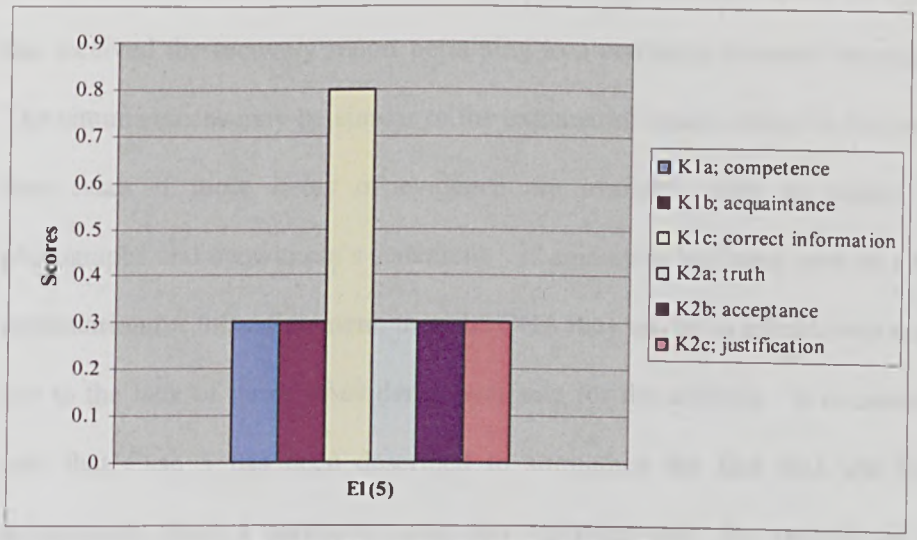


Figure 8.17: Scores for E1(5) in Case 5

The histogram in Figure 8.17 shows the scores for E1(5) for Case 5.

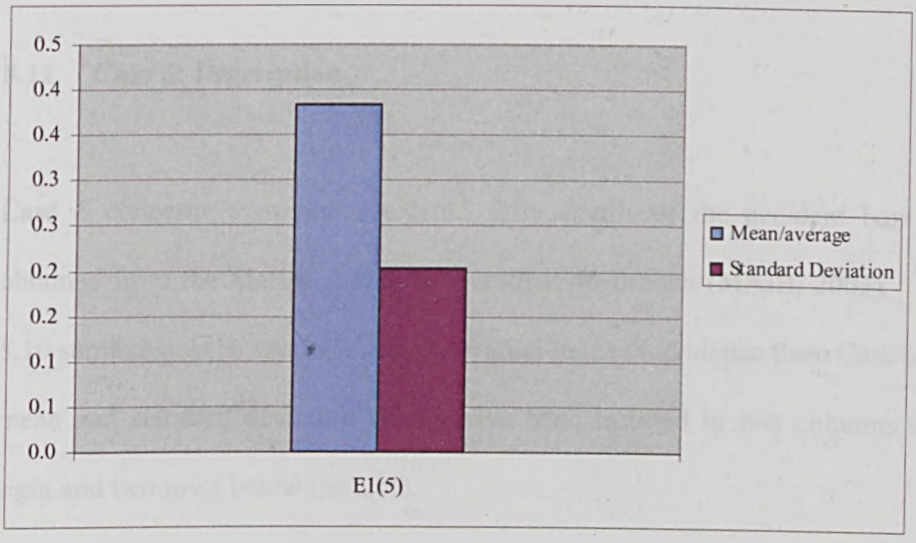


Figure 8.18: Mean and standard deviation value for E1(5)

The histogram in Figure 8.18 shows the average scores and standard deviation value for E1(5) in Case 5.

In this Case, only E1 has been assessed based on an assumption that the animator has received the recovery report pertaining to a computer forensic investigation. The circumstances may be similar to the explanation made earlier in the previous four cases if more items of evidence are available such as screen shots, photographs and eyewitness's statement. If animation has been used as a tool of presentation for this assessment, then the CGA may not be as reliable and accurate due to the lack of items of evidence available for the analysis. It is essential to note that Case 5 has been described to strengthen the fact that, the lack of information about a particular case may interfere with the analysis of as to whether the CGA is reliable and accurate.

8.11 Case 6: Description

Case 6 concerns a marine accident. The details of the accident have been obtained from the Marine Accident Investigation Branch (MAIB, 2003). Table 8.10 summarises the scores for the individual items of evidence from Case 6. The mean and standard deviation values have been inserted in two columns on the right and two rows below the table.

Case 6	Concepts						Mean	Standard Deviation
	K1a	K1b	K1c	K2a	K2b	K2c		
E1(6)	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2
E2(6)	0.5	0.5	0.8	0.3	0.3	0.3	0.5	0.2
E3(6)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1
Mean	0.4	0.4	0.8	0.4	0.4	0.4		
Std. Deviation	0.1	0.1	0.0	0.1	0.1	0.1		

Table 8.10: Items E1(6)-E3(6) in Case 6

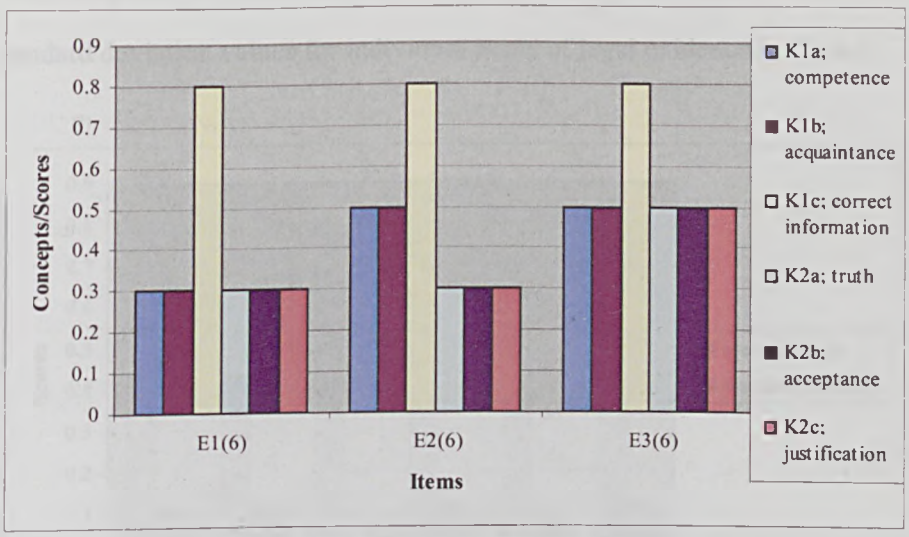


Figure 8.19: Items E1(6)-E3(6) in Case 6

The histogram in Figure 8.19 shows the frequency of scores for each of the items in Case 6.

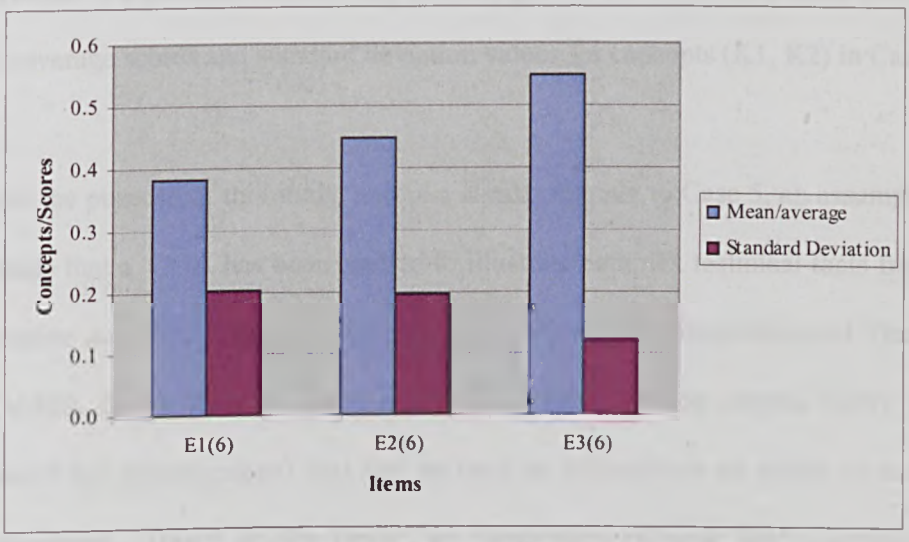


Figure 8.20: Mean and standard deviation values for items in Case 6

The histogram in Figure 8.20 shows the pattern concerning average scores and standard deviation values for individual items of legal evidence in Case 6.

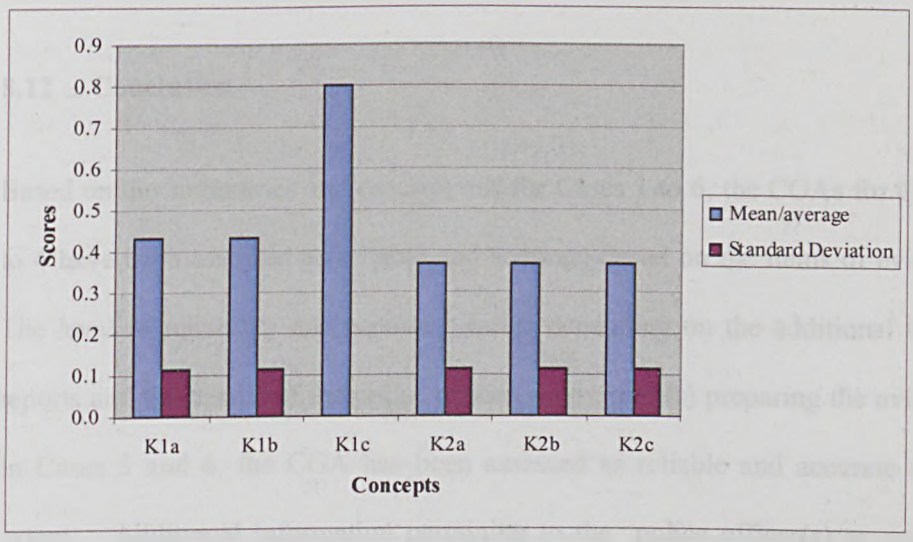


Figure 8.21: Mean and standard deviation values for concepts in Case 6

Similar to Figure 8.20, the histogram in Figure 8.21 shows the pattern pertaining to average scores and standard deviation values for concepts (K1, K2) in Case 6.

For the purpose of this study, and in a similar manner to Case 5, an assumption is made that a CGA has been created to illustrate complex technical facts from the marine accident. Based on the report produced by the Department of Transport (MAIB, 2003), there are three items: E1(5) (investigation report), E2(5) (plan), and E3(5) (photographs) that can be used as information on which to base the animation. Based on the report, an assumption is made that a person with appropriate training, qualification and experience pertaining to marine accident has undertaken the investigation. The striking fact demonstrated from the visual images of the photographs shows that the person capturing the images was at the marine accident scene, hence, concept K1c and falls within the exactly

category with a score of 0.8 and is therefore the most reliable source of evidence. Assuming that CGA has been used to animate the accident, the CGA is reliable and accurate based on E1(6) with details of other items (E2(2) and E3(2)).

8.12 Conclusion

Based on the summaries and descriptions for Cases 1 to 6, the CGAs for Cases 1 to 4 have been assessed as reliable and accurate based on the items of evidence. The level of reliability and accuracy varies depending on the additional written reports and the details of the police officer(s) or expert(s) preparing the evidence. In Cases 5 and 6, the CGA has been assessed as reliable and accurate to this extent. Additional information pertaining to the police officer(s) or expert(s) preparing the items may strengthened the level of reliability and accuracy of the CGA.

In relation to subsections 8.1 to 8.11, four segments have been formed to clarify the implications of the scores assigned in the quasi-experimental stage. These four segments are:

1. Analytic problems in knowledge.
2. Expert and the admissibility of expert evidence.
3. Method of investigation and bodies of evidence.
4. Knowledge without evidence.

These segments will be further discussed in Chapter 9 to highlight the implications of this analysis in determining the reliability and accuracy of computer-generated animation based on items of legal evidence. In summary, three important underlying findings can be derived from the data aggregation. Firstly, the expert or eyewitness must be present at the scene in order to deliver reliable information about a particular accident or crime. Secondly, the expert investigating the accident or crime must have an appropriate training, qualification and experience. Finally, based on the appropriate training, qualification and experience, the expert applies standard procedure of investigation in compliance with the details from each case.

Consequential to the three underlying findings, the implications can now be evaluated to propose the findings. The first finding that refers to the presence of the expert or eyewitness at the accident or crime scene may be associated with the *analytical problems in knowledge.* The second finding that refers to the expert investigating the accident or crime may be associated with the *expert and admissibility aspect.* In the analysis for the eyewitness statement, the second finding may be associated with the segment of *knowledge without evidence.* Finally, the third finding that refers to the procedure of investigation may be associated with the *method of investigation and bodies of evidence.* This explanation has been summarised in Table 8.11.

Findings	Implications
(1) Presence at the scene	(1) Analytical problem in knowledge
(2) Expert	(2) (a) Expert and admissibility (b) Knowledge without evidence
(3) Investigation procedure	(3) Method of investigation and bodies of evidence

Table 8.11: The connection between findings and implications

As each of these findings has an important impact on the reliability of the outcome, which in turn affects the accuracy of the CGA, it will be necessary to consider each one in detail and so will form the basis of the next chapter. The next Chapter will present the implications with sensitivity analysis. In this sensitivity analysis, the findings in Table 8.11 will be evaluated by assigning different scores compared to the results from Chapter 7.

Chapter 9

Pragmatic Stage: Sensitivity Analysis

9.1 Introduction

This Chapter demonstrates a sensitivity analysis based on the scores assigned to the individual items of evidence. As mentioned earlier in Chapter 5 Sub-section 5.3.1, the significance of the conversion reflects in this Chapter. The conversion discusses the interpretation of the concepts (K1 and K2) to the result (referenced as "R1-R6"). The purpose of the sensitivity analysis is to compensate the analysis in Chapter 7 by altering some of the values. For example in E1(1) in Case 2 has been prepared by Police 1(2), Police 2(2) and Police 3(2). There were no details about the three police officers pertaining to their training, qualifications and experience. In analysis a2, E1(2) has been assigned under *general* category. In the latter part of this Chapter, the scores of E1(2) will be altered to highlight the importance of details pertaining to the police officers.

The column on the left in Table 9.1 below shows the concepts formed from the type and conditions for knowledge. On the other hand, the column on the right shows the factors from the pragmatic stage. Table 9.1 refers to the items of legal evidence for written, spatial and visual classification.

Quasi-experimental stage	Pragmatic stage
o K1a (competence)	o R1 (expert)
o K1b (acquaintance)	o R2 (experience of the expert)
o K1c (correct information)	o R3 (visiting the scene)
o K2a (truth)	o R4 (scientific/specific rule)
o K2b (acceptance)	o R5 (endorsement)
o K2c (justification)	o R6 (validation)

Table 9.1: Conversion from concept to factors for written, spatial and visual evidence

The column on the left in Table 9.2 shows the concept formed from the type and conditions for knowledge. On the other hand, the column on the right shows the factors in the pragmatic stage. Table 9.2 below refers to the items of legal evidence from the eyewitness' statements.

Quasi-experimental stage	Pragmatic stage
o K1a (competence)	o R1 (capability)
o K1b (acquaintance)	o R2 (experience)
o K1c (correct information)	o R3 (vicinity)
o K2a (truth)	o R4 (senses)
o K2b (acceptance)	o R5 (endorsement)
o K2c (justification)	o R6 (affirmation)

Table 9.2: Conversion from concept to factors for eyewitness' statements

9.2 Sensitivity Analysis: Implications of findings

The implications of the findings have been divided into four segments:

1. Analytic problems in knowledge (Chapter 4).
2. Expert and the admissibility of expert evidence (Chapter 3).
3. Method of investigation and bodies of evidence (Chapter 3).
4. Knowledge without evidence (conclusions from Chapter 3).

9.2.1 Analytical problems of Knowledge

In this segment, the analysis emphasis utilises the factors (R1-R6 Table 5.6, Chapter 5) previously referred to as K1a-K2c (Table 5.2 in Chapter 5). Further to the facts described in the literature review (Chapter 4), the analysis of knowledge consists of five problems (Williams, 2001)[34]. The analytical problems of knowledge have been perceived as a strong aspect based on the fact that it correlates with the discussion in Chapter 4[35].

For that reason, the factors (R1-R6) will be the main elements in Table 9.2. The purpose of this section is to explain the significance of factors on items from all classes (written, spatial, visual and eyewitness). It is essential to note that not all items of evidence have been included in Table 9.3.

The range of items is based on the variety of scores ranging from 0.3-0.8. For spatial and written classes, there are two items each with the highest (0.8) and the lowest (0.3) scores to be compared. It is essential to note that two accident reconstruction experts have produced E5(2) in Case 2.

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[34] (1) The analytical problem (*analysis of the conditions of knowledge*)
(2) The problem of demarcation (*external vs. internal*)
(3) The problem of method (*how to obtain knowledge*)
(4) Sceptism (*is it possible to obtain knowledge at all?*)
(5) The problem of value (*if knowledge is worth having*)

[35] In the context of this research, legal evidence has a strong correlation to knowledge analysis in this problem due to the confidentiality, reliability and validity of source of information. The analytical problem of knowledge emphasises on the concept and conditions of knowledge. These conditions together with the types of knowledge will be applied in the research methodology in Chapter 5. In conditions for knowledge that discusses truth, acceptance and justification, the legal evidence requires evidence must be supported by hypotheses and that the evidence must be produced with credentials (expert).

Class	*Eyewitness*	*Visual*	*Spatial*	*Spatial*	*Written*	*Written*			
Case	*Case 1-4*	*Case 3*	*Case 1*	*Case 6*	*Case 2*	*Case 2*			
Items	*E4(1-4)*	*E7(3)*	*E3(1)*	*E2(6)*	*E5(2)*	*E5(2)*	*Mean*	*Standard Deviation*	
		E8(3)			*Expert C*	*Expert D*			
R1	0.5	0.5	0.8	0.3	0.3	0.8	0.5	0.2	A
R2	0.5	0.5	0.8	0.3	0.5	0.8	0.6	0.2	
R3	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	
R4	0.5	0.5	0.8	0.3	0.8	0.8	0.6	0.2	
R5	0.5	0.5	0.8	0.3	0.8	0.8	0.6	0.2	
R6	0.5	0.5	0.8	0.3	0.8	0.8	0.6	0.2	
Mean	06	0.6	0.8	0.4	0.7	0.8			B
Std. Deviation	0.1	0.1	0.0	0.2	0.2	0.0			

Table 9.3: All classes of evidence with factors

Table 9.3 proposes a comparison of all types of evidence classifications with the factors (R1-R6). Written (E5(2) by Expert D) and spatial (E3(1) prepared by the ' Police' 1(1)) evidence seem to be the most reliable items compared to the visual images and eyewitnesses' statements. The justification for this reliability is based on the fact that the items have been prepared by Expert D and the Police 1(1) who possesses appropriate training, qualifications and experience to conduct an accident reconstruction (Expert D) and fatal road collision investigation (Police 1(1)).

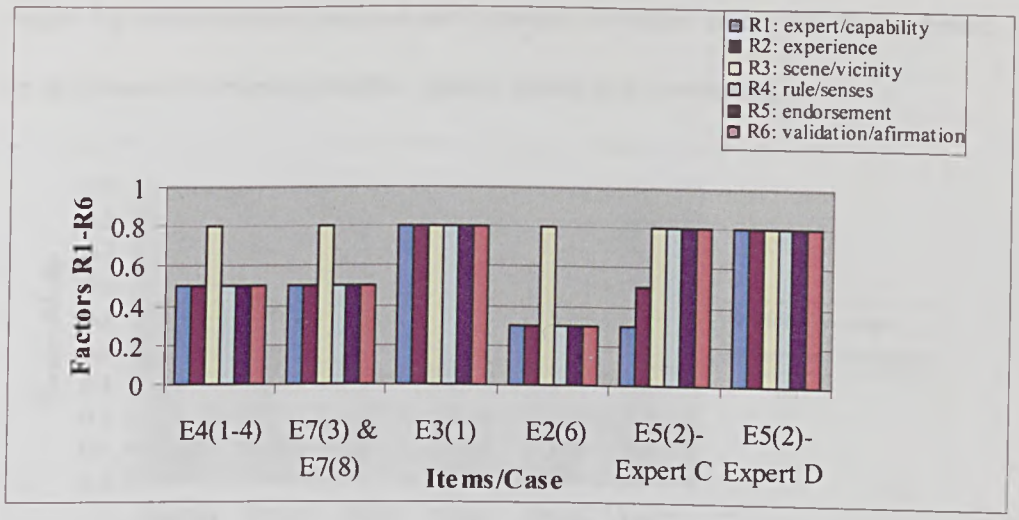

Figure 9.1: All classes of evidence with factors

Figure 9.1 shows that R3 is the most important factor for the items of evidence. E3(1) (spatial) in Case 1 and E5(2) (written) in Case 2 have the score of 0.8 for R3. E3(1), a road layout plan has been prepared by Police 1(1) with appropriate training, qualifications and training. E2(5) are two accident reconstruction reports which have been assessed under *exactly* category.

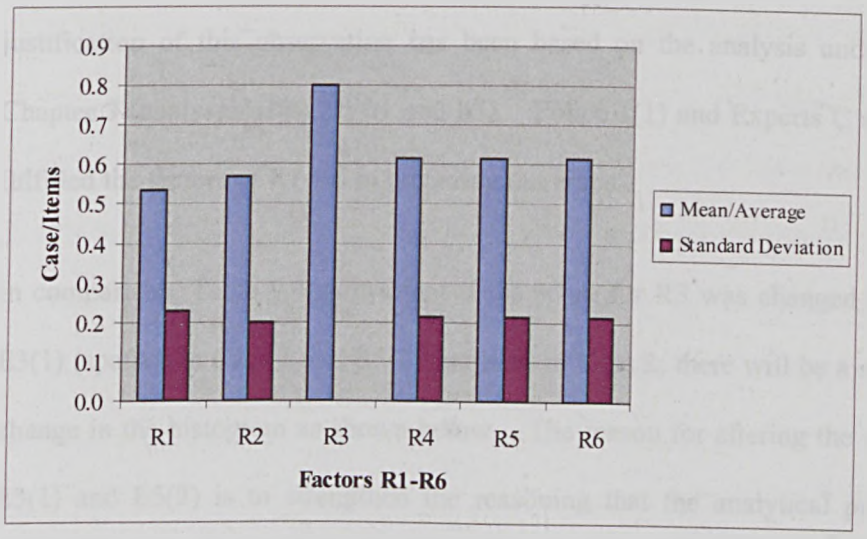

Figure 9.2: Mean and standard deviation values for factors

Figure 9.2 demonstrates the mean and standard deviation values for factors based on all classes of evidence (written, spatial, visual and eyewitness.

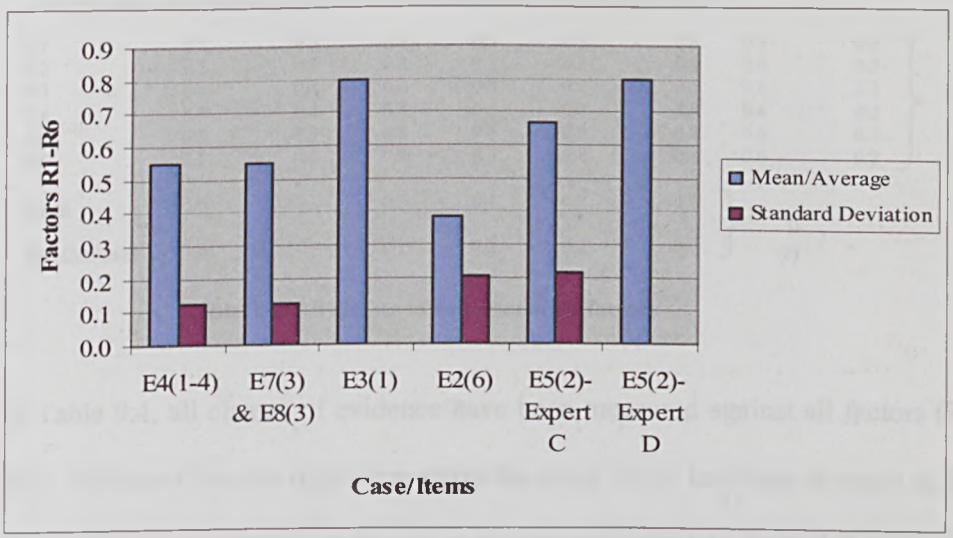

Figure 9.3: Mean and standard deviation values for items of evidence

Figure 9.3 shows that the written (E5(2); Case 2) and spatial (E3(1); Case 1) evidence are the most reliable items compared to the visual images (E7(3) and E8(3); Case 3) and eyewitnesses' statements (E4(1-4); Cases 1-4). The justification of this observation has been based on the analysis undertaken in Chapter 7 (analyses a18-a22; b1 and b3). Police 1(1) and Experts C and D had fulfilled the factors of R1-R6 in preparing the items.

In comparison, Table 9.4 shows that if the score for R3 was changed to 0.3 for E3(1) (spatial) in Case 1 and E5(2) (written) in Case 2, there will be a significant change in the histogram as shown below. The reason for altering the values for E3(1) and E5(2) is to strengthen the reasoning that the analytical problem of knowledge discusses the types of knowledge (factors R1-R3) and conditions for knowledge (factors R4-R6).

Class	*Eyewitness*	*Visual*	*Spatial*	*Spatial*	*Written*	*Written*			
Case	*Case 1-4*	*Case 3*	*Case 1*	*Case 6*	*Case 2*	*Case 2*			
Items	*E4*	*E7, E8*	*E3*	*E2*	*E5*	*E5*	*Mean*	*Standard Deviation*	
R1	0.5	0.5	0.8	0.3	0.3	0.8	0.5	0.2	C
R2	0.5	0.5	0.8	0.3	0.5	0.8	0.6	0.2	
R3	0.8	0.8	0.3	0.8	0.8	0.3	0.6	0.3	
R4	0.5	0.5	0.8	0.3	0.8	0.8	0.6	0.2	
R5	0.5	0.5	0.8	0.3	0.8	0.8	0.6	0.2	
R6	0.5	0.5	0.8	0.3	0.8	0.8	0.6	0.2	
Mean	0.6	0.6	0.7	0.4	0.7	0.7			D
Std. Deviation	0.1	0.1	0.2	0.2	0.2	0.2			

Table 9.4: All classes of evidence with factors

In Table 9.4, all classes of evidence have been measured against all factors (R1-R6). Column C on the right shows that the score of R3 has been changed to 0.3. These changes contribute an impact on the strength of R3 in Table 9.3 earlier. In this situation, the expert preparing spatial evidence did not visit the collision or crime scene to prepare the evidence. The plan (E3(1)) has been assigned with the score of 0.3 that indicates *the expert has obtained only the list of evidence about the collision or crime scene from a third party* (Table 5.7, Chapter 5). Hence, the fact that Police 1(1) and Expert D had visited the scene and obtained the evidence is vital, as the initial value in Table 9.3 indicated as 0.8. The alteration made in Table 9.4, has resulted to E3(1) and E5(2) becoming less reliable than the result shown in Table 9.3. The significance emphasis on the all the factors particularly R3 that the police officer(s) and expert(s) must obtain the evidence directly from the scene or the vicinity. The strength of R3 of correct information correlates with the literature of knowledge discussed earlier in Chapter 4.

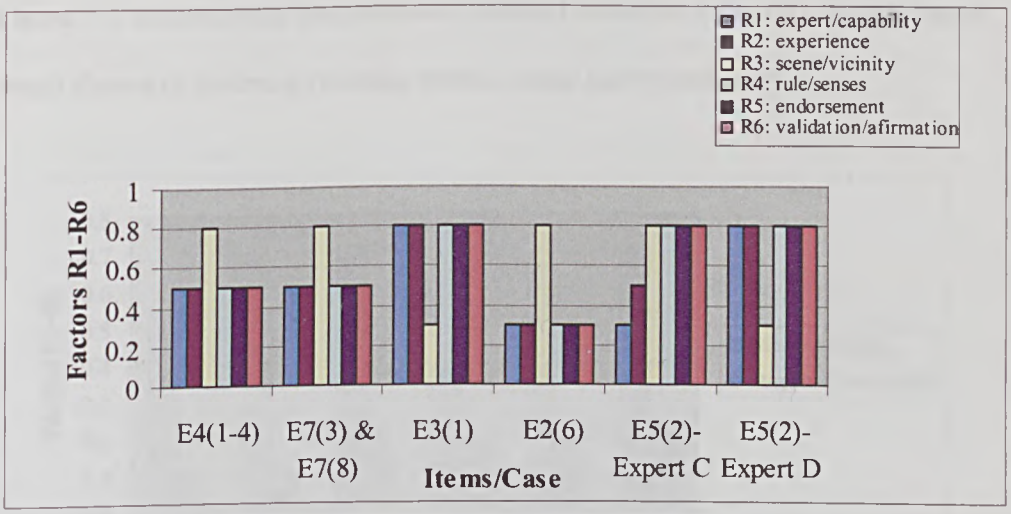

Figure 9.4: All classes of evidence with factors

Figure 9.4 shows that R3 has become the least important factor for the items of evidence. E3(1) prepared by Police 1(1) (spatial) in Case 1 and E5(2) prepared by Expert D (written) in Case 2 have the score of 0.3 for R3.

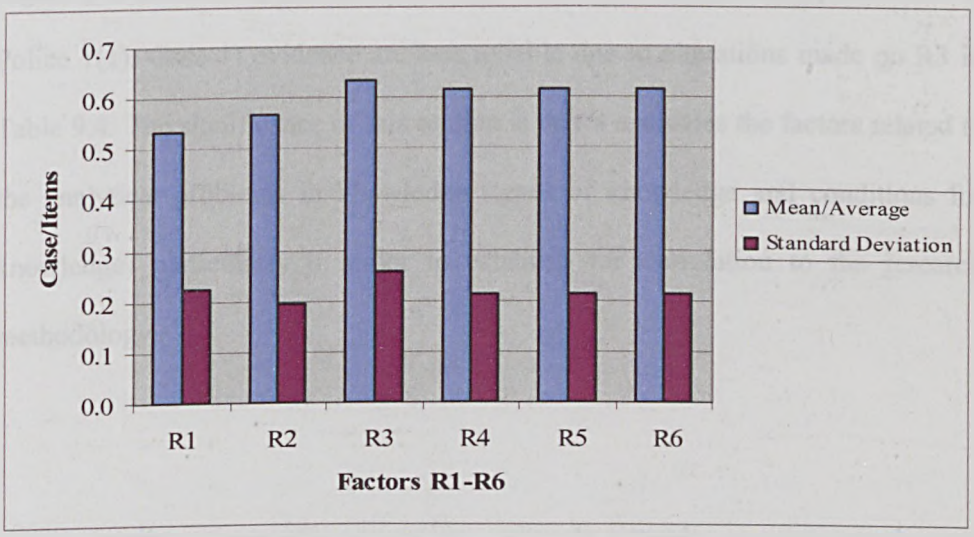

Figure 9.5: Mean and standard deviation values for factors

Figure 9.5 demonstrates the mean and standard deviation values for factors based on all classes of evidence (written, spatial, visual and eyewitness).

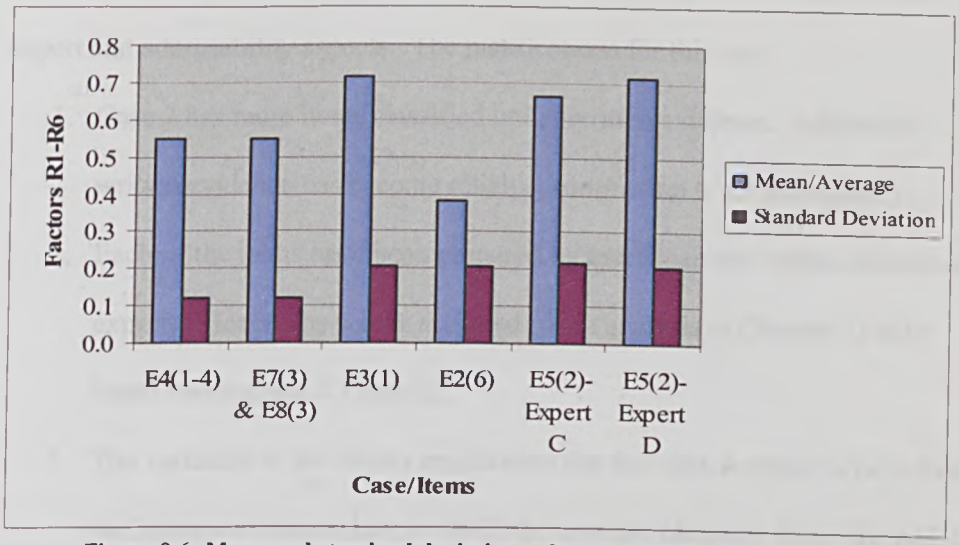

Figure 9.6: Mean and standard deviation values for items of evidence

Figure 9.6 shows that the written (E5(2)-Expert D; Case 2) and spatial (E3(1)-Police 1(1); Case 1) evidence are less reliable due to alterations made on R3 in Table 9.4. The significance of this section is that it evaluates the factors related to the analytical problems in knowledge (types of knowledge and conditions for knowledge) particularly in order to establish the correlation to the research methodology.

9.2.2 Expert and the Admissibility of Expert Evidence

In this section, Case 2 is pragmatically seen as the appropriate example under expert and admissibility aspects. The justifications for this are:

1. Case 2 has more items classified under written evidence. Additional written evidence has become reliable information to the animator.
2. Each of the items have been prepared by more than one police officers and experts. Hence, the scores assigned (from analysis in Chapter 7) vary based on concepts K1 and K2.
3. The variation in the scores emphasises the fact that in order to be reliable, the written evidence has to fulfil the *exactly* category from K1 and K2 (from analysis in Chapter 7).

Items of Evidence	**Factors** *R1*	*R2*	*R3*	*R4*	*R5*	*R6*	*Mean*	*Standard Deviation*	
E1(2) (Police 1-3(2))	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2	
E2(2) (Police 4(2))	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	
E2(2) (Police 2(2))	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2	A
E5(2) (Expert C)	0.3	0.5	0.8	0.8	0.8	0.8	0.7	0.2	
E5(2) (Expert D)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	
Mean	0.5	0.5	0.8	0.6	0.6	0.6			B
Std. Deviation	0.3	0.3	0.0	0.3	0.3	0.3			

Table 9.5: Written evidence prepared by two or more police officers and experts from Case 2

Table 9.5 provides a view of seven items in the written evidence category prepared by different police officers and experts.

This high score has been influenced by R1 and R2. These factors are related to the training, qualifications and experience of the person conducting the investigation. All the details of Police 4(2) and Expert D have been clearly stated in the items. However, E1(2) comprises of three separate books of accidents and were from Police 1-3(2). There were no detailed descriptions about Police 1(2), Police 2(2) and Police 3(2) pertaining to factors R1 and R2. This has influenced the lower scores obtained on R1, R2, R4, R5 and R6.

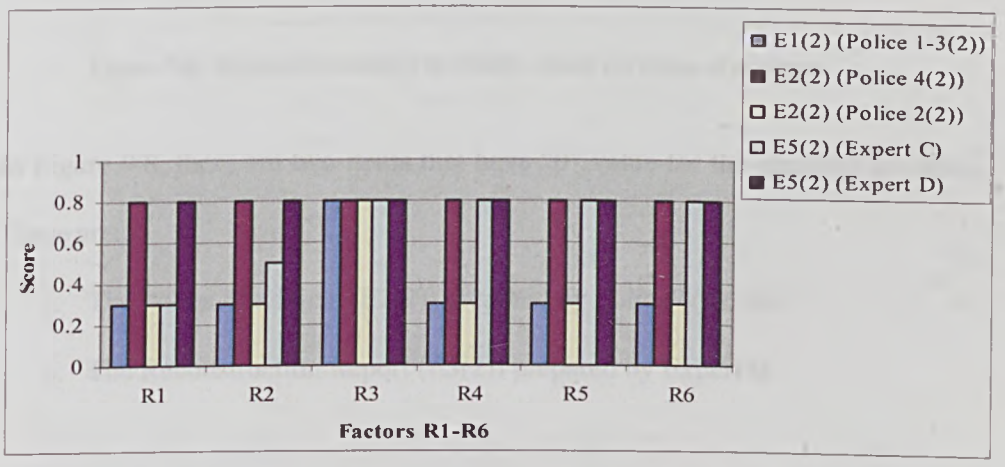

Figure 9.7: Written evidence prepared by two or more police officers and experts from Case 2

Figure 9.7 shows that items E1(2) prepared by Police 1-3(2) and E2(2) prepared by Police 2(2) in Case 2 are the least reliable due to the low score for the police constable investigating the collision. The low score has been assigned due to lack of details available to the researcher. The significance of this analysis is to demonstrate the importance of the background details of the police or expert in producing the evidence. The experiment continues in Table 9.5 whereby the scores for E1(2) prepared by Police 1-3(2) and E2(2) prepared by Police 2(2) will be changed.

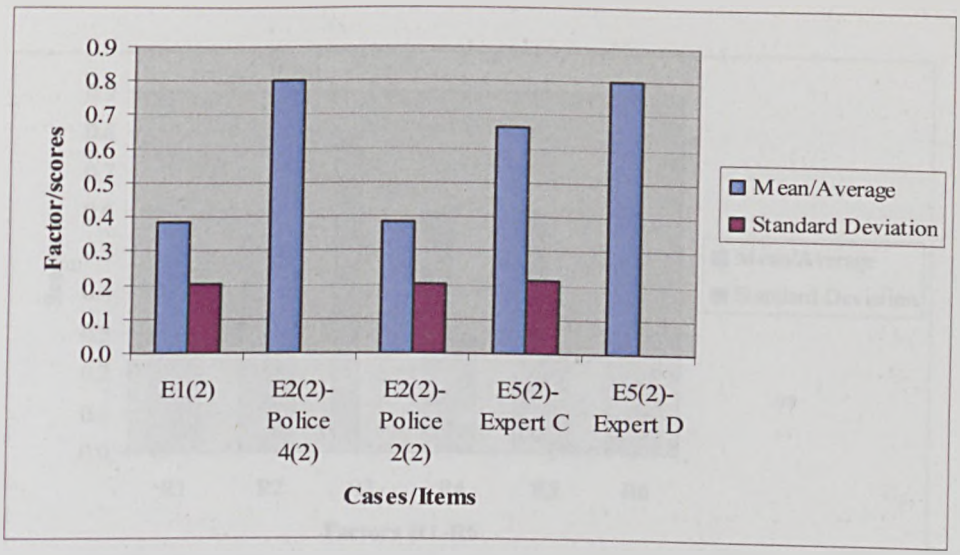

Figure 9.8: Mean and standard deviation values for items of evidence

In Figure 9.8, there are two items that have "0" value for the standard deviation. These are:

a. The Police Statement (E2(2)) prepared by Police 4(2); and

b. The Reconstruction Report (E5(2)) prepared by Expert B.

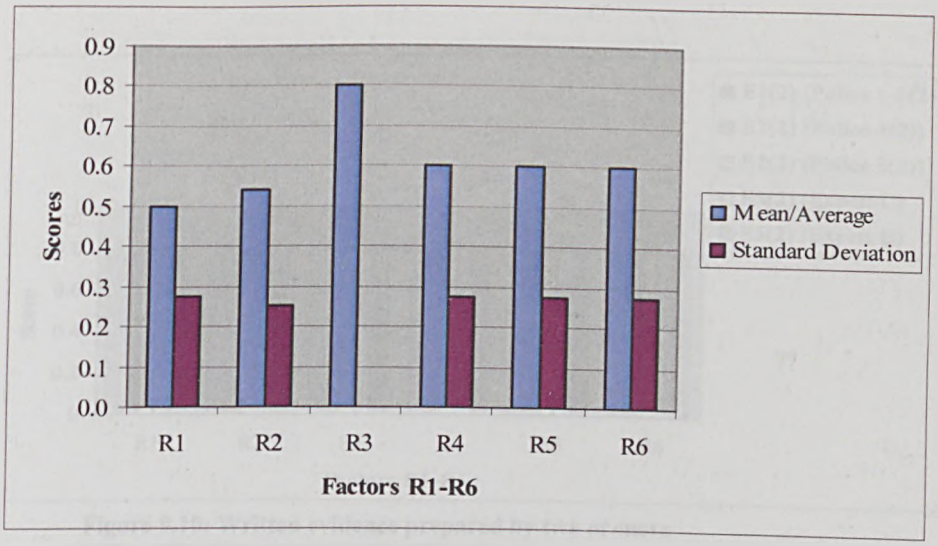

Figure 9.9: Mean and standard deviation values for factors

Figure 9.9 shows that R3 has the highest score in Case 2.

Items of Evidence	Factors R1	R2	R3	R4	R5	R6	Mean	Standard Deviation	
E1 (Police 1-3(2))	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	
E2 (Police 4(2))	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	
E2 (Police 2(2))	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	C
E5 (Expert C)	0.3	0.5	0.8	0.8	0.8	0.8	0.7	0.2	
E5 (Expert D)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	
Mean	0.7	0.7	0.8	0.8	0.8	0.8			D
Std. Deviation	0.2	0.1	0.0	0.0	0.0	0.0			

Table 9.6: Written evidence prepared by two or more police officers and experts from Case 2

In contrast, the score for factors R1, R2, R4, R5 and R6 pertaining to E1(2) and E2(2) have been altered to 0.8 compared with the score of 0.3 for all five factors in Table 9.6. The purpose of the alteration is to emphasise that the details of the police or expert preparing the items of evidence is important in order to estimate the value during the analysis in Chapter 7.

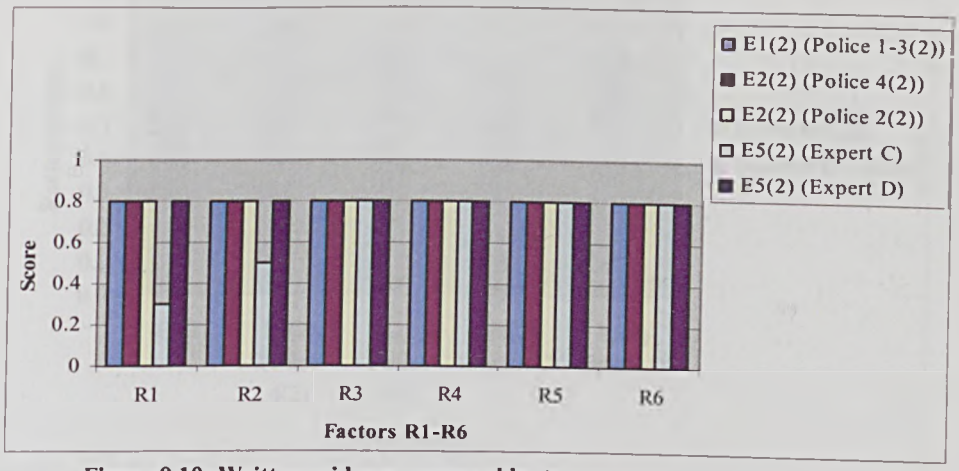

Figure 9.10: Written evidence prepared by two or more police officers and experts from Case 2

Figure 9.10 shows that E1(2) prepared by Police 1-3(2) and E2(2) prepared by Police 2(2) in Case 2 have become the most reliable items due to the changes made in factors R1, R2, R4, R5 and R6. This is based on the assumption that details of the police officers are available to be examined based on the two items produced from the investigation. Further details pertaining to the police officers in relation to their training, qualifications and experience (R1-R3) will influence the values/scores assigned in the analysis from Chapter 7.

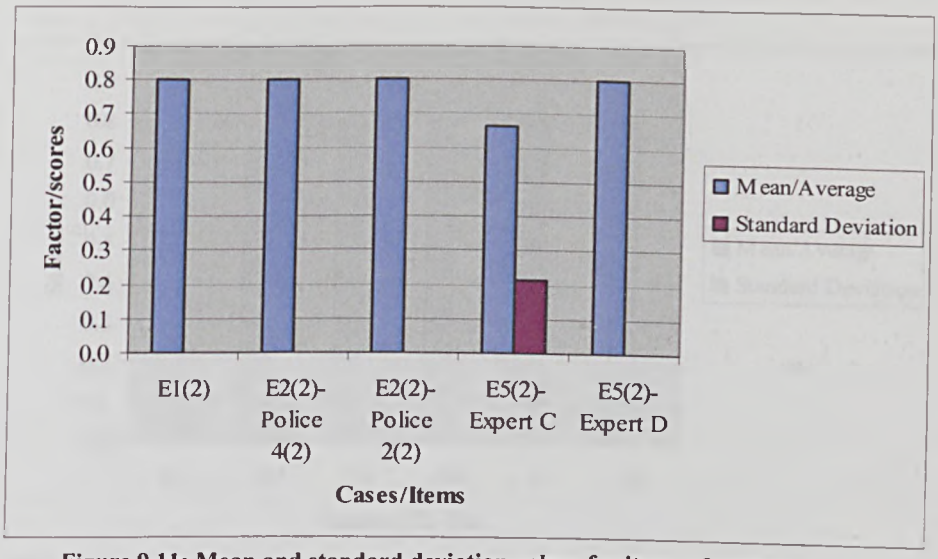

Figure 9.11: Mean and standard deviation values for items of evidence

In conforming to the histogram in Figure 9.10, two items in columns 1 and 3 of Figure 9.11 demonstrate "0" value for the standard deviation. Items E1(2) prepared by Police 1-3(2) and E2(2) prepared by Police 2(2) in Case 2 have become as reliable as other items (E2(2), E5(2)-Expert C and D) in Figure 9.11. In relation to the reliability and accuracy of the animation for Case 2, E1(2) may be reliable information to the animator if the details of police officers preparing the item are available for the analysis.

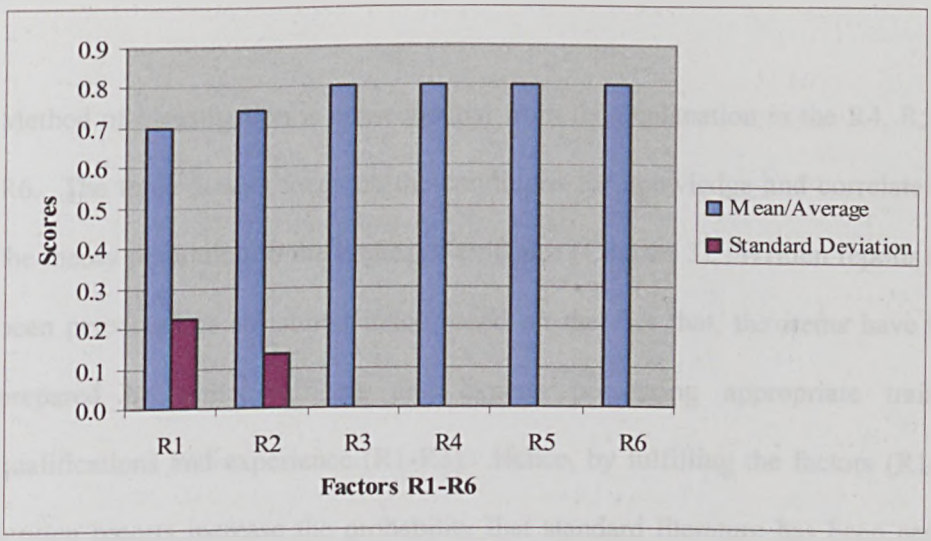

Figure 9.12: Mean and standard deviation values for factors

Figure 9.12 demonstrates the increased average value for each factor and the decreased value for the standard deviation on items E1(2) prepared by Police 1-3(2) and E2(2) prepared by Police 2(2) in Case 2.

The significance of this Section is to demonstrate the strength of written evidence. Items categorised as written evidence would usually have been produced by the expert possessing appropriate training, qualifications and experience. Therefore, by fulfilling these factors, the investigation is very likely to be conducted based on standard literature pertaining to a particular case. In summary, written evidence may be the most reliable information used by an animator to generate a forensic animation. Additional written evidence such as E5(2) in Case 2 may affect the reliability and accuracy of the CGA. The inference in Section 9.2.1 complements this Section with regard to the fact that other classes of evidence can be corroborated with written evidence from a particular case.

9.2.3 Method of Investigation and Bodies of Evidence

Method of investigation is consequential from the explanation in the R4, R5 and R6. The three factors focus on the conditions for knowledge and correlate with the theory pertaining to the bodies of evidence (Chapter 3). Written reports have been perceived as structured items based on the fact that, the items have been prepared by police officers and experts possessing appropriate training, qualifications and experience (R1-R3). Hence, by fulfilling the factors (R1-R3) written reports increase the probability that standard literature has been applied during the process of preparing the evidence. Table 9.7 summarises the scores for four items from Cases 1-4.

Case	Evidence	Factors R1	R2	R3	R4	R5	R6	*Mean*	*Standard Deviation*	
Case 1	E1(1)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	A
Case 2	E2(2)	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2	
Case 3	E2(3)	0.3	0.3	0.8	0.3	0.3	0.3	0.4	0.2	
Case 4	E2(4)	0.5	0.5	0.8	0.3	0.3	0.3	0.5	0.2	
Mean		0.5	0.5	0.8	0.4	0.4	0.4			B
Std. Deviation		0.2	0.2	0.0	0.3	0.3	0.3			

Table 9.7: Written reports from four cases

Figure 9.13: Written reports from four cases

Figure 9.13 shows Crash Investigation Report (E1(1)) in Case 1 has the highest scores for all the factors. Other written reports in Cases 2-4 demonstrate lower scores. Factors R4-R6 focuses on the method of investigation. It is essential to note that a score of 0.3 has been assigned to R4-R6 for the written reports in Cases 2-4. This is mainly due to the lack of background details pertaining to the police officers and experts preparing the written evidence. Figures 9.14 and 9.15 shall explain further the significance.

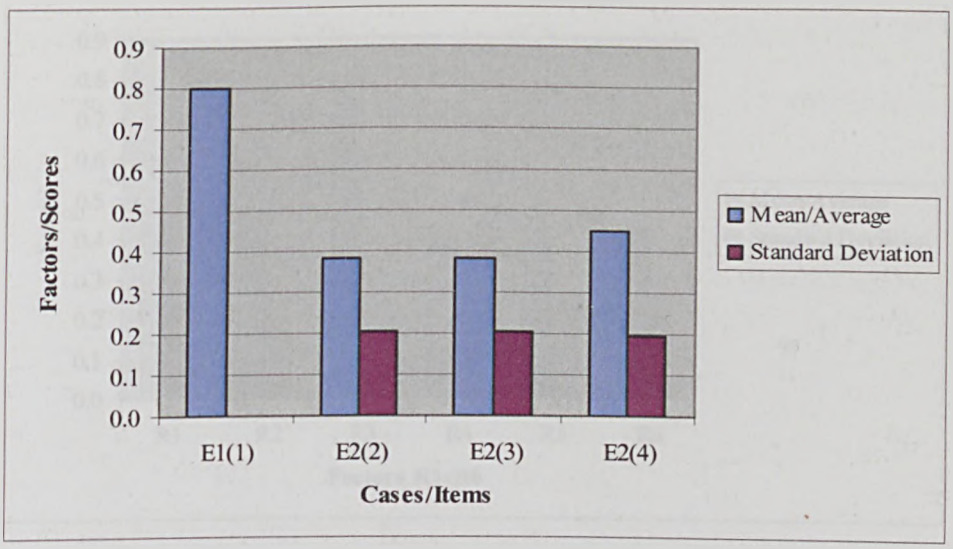

Figure 9.14: Mean and standard deviation value for cases and items

In Figure 9.14, the standard deviation value of "0" indicates that the Crash Investigation Report (E1(1)) in Case 1 is the most reliable item. The reliability of this item has been based on the fact that it has been prepared by Police 1(1) with appropriate training, qualifications and experience pertaining to the collision. In relation to the reliability and accuracy of CGA, E1(1) is the most reliable information for the animator based on the facts that:

1. E1(1) has been prepared by Police 1(1).
2. The background details of Police 1(1) are available from the item.

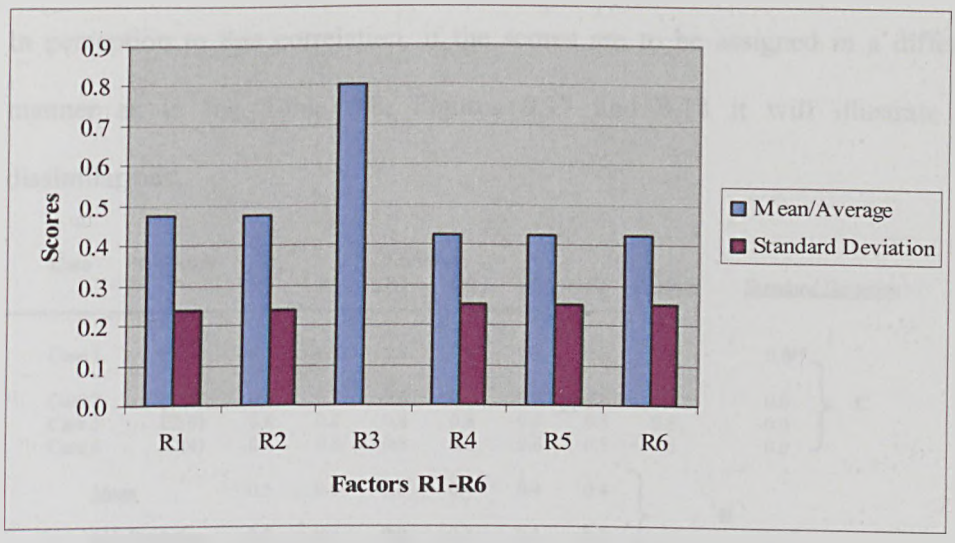

Figure 9.15: Mean and standard deviation values for factors

In Figure 9.15, the standard deviation value for R3 indicates the significance of the person investigating the collision or crime obtaining information directly from the scene or vicinity. Consequential to this discussion, the theory pertaining to the bodies of evidence refers to the fact that, *the method of investigation is the hypotheses to support the item and that the R1-R3 (expert, experience of the expert and visiting the scene) are the factors regarded as having creditable standing*. For example, if the item has been prepared by the police officer who had visited the collision vicinity, and had appropriately applied the method of investigation – the quality of item would be greater. Factors R1-R6 are aspects that correlate to the fundamental with bodies of evidence (pertaining to creditable standing).

In perception to this correlation, if the scores are to be assigned in a different manner as in the Table 9.8, Figures 9.17 and 9.18 it will illustrate the dissimilarities.

Case	Evidence	Factors R1	R2	R3	R4	R5	R6	*Mean*	*Standard Deviation*	
Case 1	E1(1)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	
Case 2	E2(2)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	C
Case 3	E2(3)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	
Case 4	E2(4)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	
Mean		0.5	0.5	0.8	0.4	0.4	0.4			D
Std. Deviation		0.2	0.2	0.0	0.3	0.3	0.3			

Table 9.8: Written reports from four cases

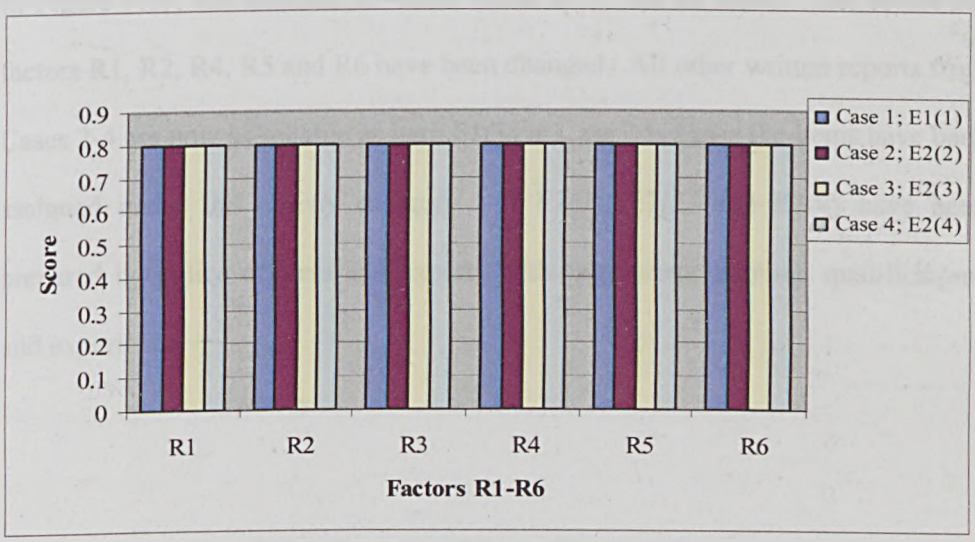

Figure 9.16: Written reports from four cases

Figure 9.16 shows written reports in Cases 2-4 and demonstrates increased scores. It is essential to note that a score of 0.8 has been assigned to R4-R6 for the written reports in Cases 2-4. Figures 9.17 and 9.18 shall further explain the significance.

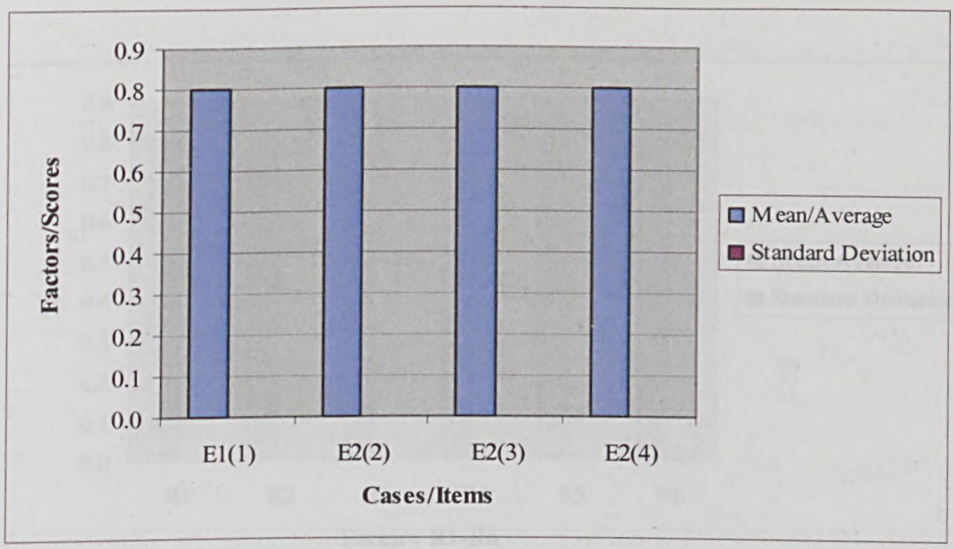

Figure 9.17: Mean and standard deviation values for cases and items

In Figure 9.17, the standard deviation value is "0" for all items. The scores for factors R1, R2, R4, R5 and R6 have been changed. All other written reports from Cases 2-4 are now as reliable as item E1(1) in Case 1 because the items have been assigned under the *exactly* category. If E2(2), E2(3) and E2(4) have been prepared by police officers and experts with appropriate training, qualifications and experience.

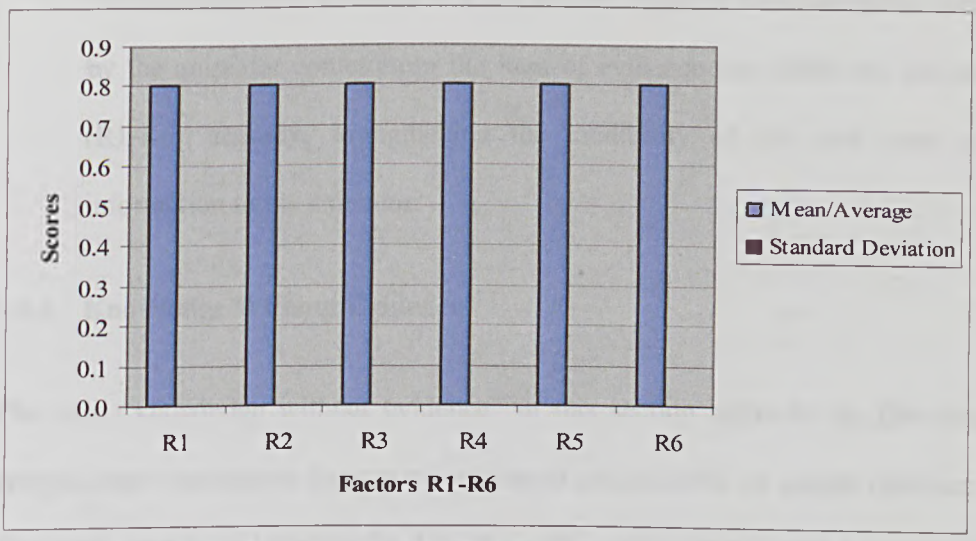

Figure 9.18: Mean and standard deviation values for factors

In Figure 9.18, changes for factors R1, R2, R4, R5 and R6 are shown. R3 remains the most vital factor pertaining being present at the scene.

The significance of this Section is the emphasis on the method of investigation and bodies of evidence. The method of investigation corresponds to the standard literature applied in producing the evidence. On the other hand, the bodies of evidence corresponds to the fact that "*evidence must support the hypotheses; evidence should be based on creditable standing*" (Chapter 3). This Section emphasises the fact that the method of investigation (creditable standing) contributes to the reliability of items. The relevance of this section is due to the following concerns:

1. The reliability and accuracy of CGA would be higher if the information used by the animator came from the item of evidence prepared with the appropriate method of investigation.

2. The reliability and accuracy of CGA will be higher if the information used by the animator comes from the item of evidence that fulfils the factors (R1-R6), thereby, strengthening the credibility of the item used as information to the animator.

9.2.4 Knowledge Without Evidence

The term "knowledge without evidence" in this section refers to the fact that eyewitnesses' statements have not been based on scientific or expert opinions. The statements have been obtained by the police authority to assist a particular investigation. The statements are mainly a description of "knowledge" from the eyewitnesses. Although in an actual scenario, an eyewitness' statement is evidence, the term "without evidence" refers to the earlier discussion in Section 9.2.3 pertaining to the method of investigation that correlates with creditable standing from factors R1-R6.

Cases/items	Factors								
	R1	R2	R3	R4	R5	R6	*Mean*	*Standard Deviation*	
Case 1									
W1(1)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
W2(1)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
W3(1)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
W4(1)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
Case 2									A
W1(2)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
W2(2)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
W3(2)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
Case 3 & Case 4									
Eyewitnesses	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
Mean	0.5	0.5	0.8	0.5	0.5	0.5			B
Std. Deviation	0.0	0.0	0.0	0.0	0.0	0.0			

Table 9.9: Eyewitnesses' statements

Further to the fact that an eyewitness' statement is not under the classification of expert testimony, the explanation in Chapter 3 shall be referred to for this segment. The score has been assigned based on general assumptions that all the eyewitnesses have fulfilled the requirement of factors R1, R2, R4, R5 and R6. All the eyewitnesses have been assigned a score of 0.5 under the similar category. However, for factor R3, all the eyewitnesses were assigned with the score of 0.8 based on the fact that they were at the collision/crime vicinity. This reasoning is due to adequate information from the statements showing that all the eyewitnesses were present at and near to the collision vicinity and crime scene. Based on the statements, there was also sufficient information to show that they were capable of describing what they have experienced based on the aspects pertaining to the human senses.

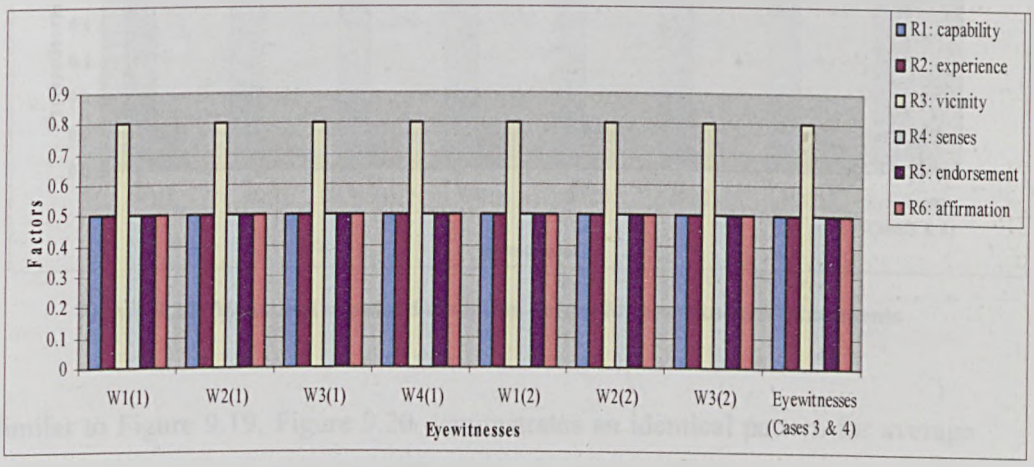

Figure 9.19: Eyewitnesses' statements

Figure 9.19 demonstrates an identical evaluation for eyewitness' statement (E4(1-4)) in Cases 1-4. The eyewitness' statement has been assessed based on different qualities from other classes of evidence (written, spatial and visual). The qualities have been explained in Table 5.8, Chapter 5. The difference is mainly due to

the fact that eyewitness statements are not expert opinion. Hence, the analysis in Chapter 7 (d1-d24) has been based on a different interpretation. In relation to CGA, the reliability and accuracy depends on the strength of written evidence from the case. For example, E4(1) pertaining to W1(1) may be useful to the animator. However, E4(1) pertaining to W1(1) is not reliable without corroborating it with E1(1) which has been prepared by Police 1(1). Item E1(1) has been assigned under *exactly* category. E1(1) has become reliable information to the animator, hence, E4(1) pertaining to W1(1) must be corroborated with E1(1).

Figure 9.20: Mean and standard deviation values for eyewitnesses' statements

Similar to Figure 9.19, Figure 9.20 demonstrates an identical pattern for average and standard deviation value for eyewitness statement (E4(1-4)) in Cases 1-4.

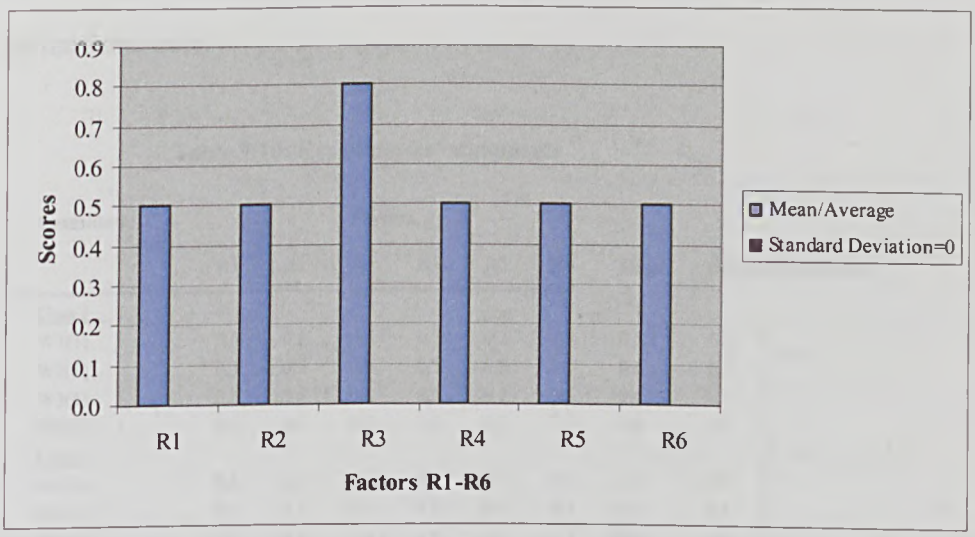

Figure 9.21: Mean and standard deviation values for factors

Figure 9.21 shows "0" standard deviation value for all factors (R1-R6) for eyewitness statement (E4) in Cases 1-4. The "0" standard deviation value corresponds with the identical scores that have been assigned to all eyewitnesses' statements.

In contrast to Figures 9.20 and 9.21, Figures 9.23 and 9.24 demonstrate a set of controlled factors. The scores have been changed to demonstrate perspective on controlled factors. The alteration will be made on W1(1), the driver of the car that collided with the two motorbikes in Case 1 (because W1(1) has the potential of aging aspects due to his age; eyewitnesses from Case 3 (because it was believed that the eyewitnesses were not at the collision vicinity, when the two motorcars collided; and eyewitnesses from Case 4 (because there were no details about the statements due to sub-judice and confidentiality). The alterations may not affect the reliability and accuracy of CGA.

However, it may help to compare the facts with other eyewitnesses' statements in the same case.

Table 9.10: Eyewitnesses' statements

Cases/items	Factors								
	R1	R2	R3	R4	R5	R6	*Mean*	*Standard Deviation*	
Case 1									
W1(1)	0.5	0.5	0.8	0.3	0.3	0.3	0.5	0.2	
W2(1)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
W3(1)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
W4(1)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
Case 2									C
W1(2)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
W2(2)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
W3(2)	0.5	0.5	0.8	0.5	0.5	0.5	0.6	0.1	
Case 3 & Case 4									
Eyewitnesses	0.5	0.5	0.8	0.3	0.3	0.3	0.5	0.2	
Mean	0.5	0.5	0.8	0.5	0.5	0.5			D
Std. Deviation	0.0	0.0	0.0	0.1	0.1	0.1			

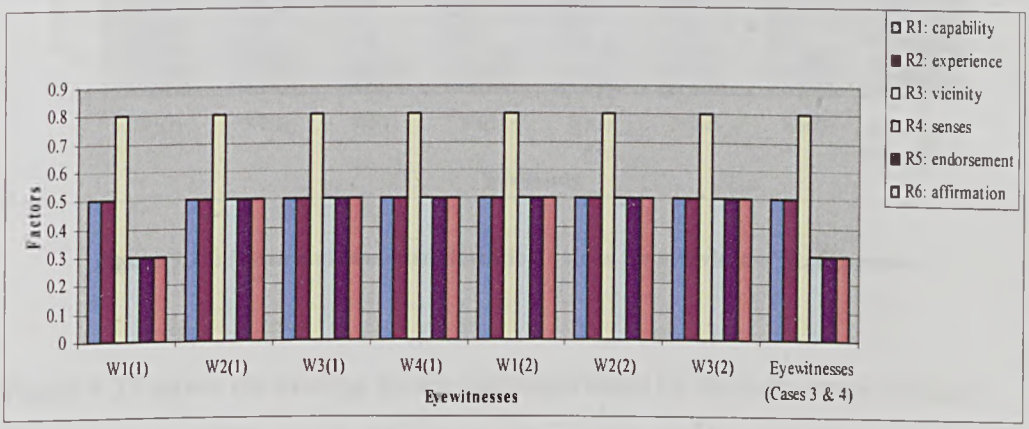

Figure 9.22: Eyewitnesses' statements

Figure 9.4(ii) shows that W1(1) in Case 1 and eyewitnesses in Cases 3 and 4 have been assigned a score of 0.3 for factors R4-R6 on the assumptions that:

1. The eyesight test report for W1(1) in Case 1 shows that he is not fit to drive due to his poor eyesight. Although W1 has been driving for several

years, his driving skills have been affected by his health condition. W1(1) with diabetes may experience hypoglycaemia (Chapter 5), which may be associated with irritability, anxiety and panic in the early stages.

2. W4(3) in Case 3 only arrived at the scene after collision occurred. The driver was fifteen minutes away at the time the two cars collided.
3. W4(4) in Case 4 was not in front of the premises when the shooting occurred. W4(4) heard the shooting from a block away, and rushed to the crime vicinity and saw two young girls whom he/she assumed to be dead.

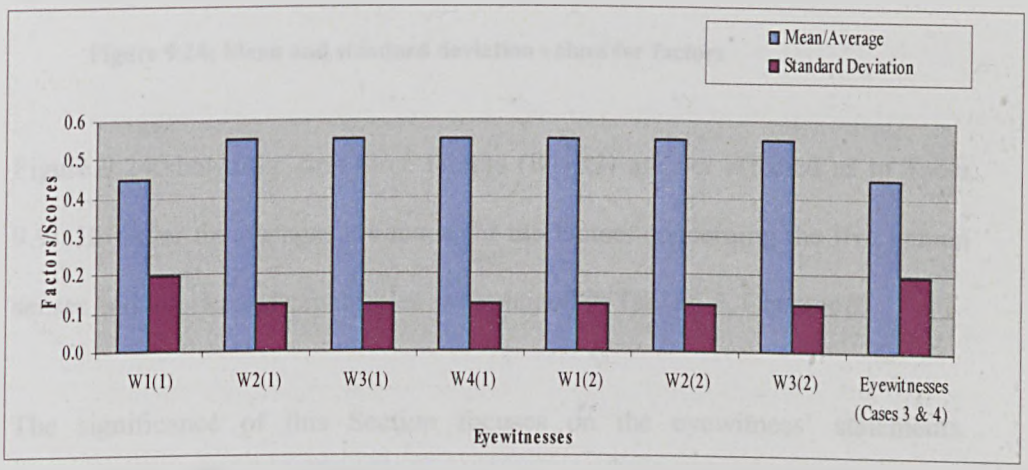

Figure 9.23: Mean and standard deviation values for eyewitness' statements

Figure 9.23 shows the average for the statement made by the eyewitness in Case 1 (W1) and eyewitnesses' in Cases 3 and 4 are lower than the other statements due to the changes made for factors R4-R6. Therefore, the standard deviation values in the first and eighth red column of Figure 9.23 are higher than the rest of the statements.

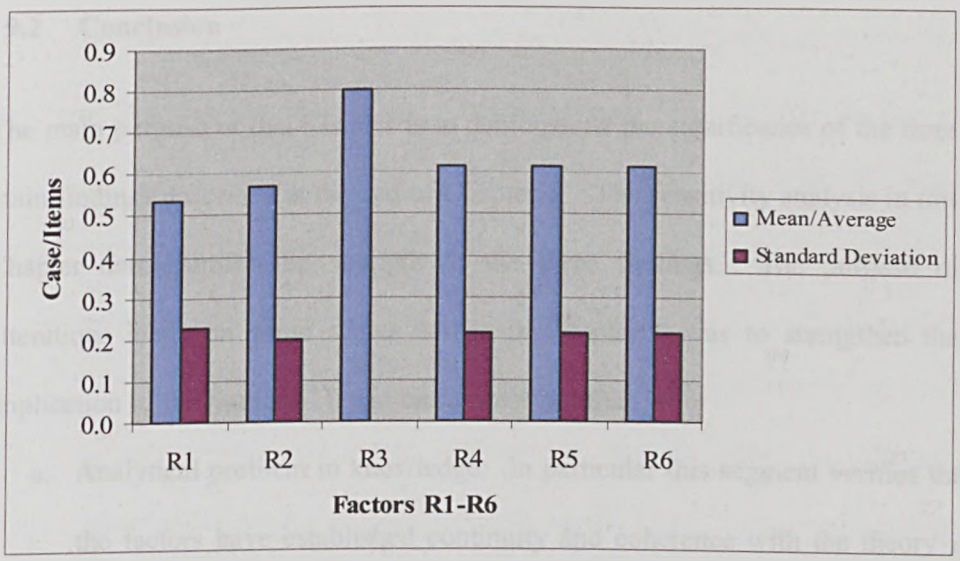

Figure 9.24: Mean and standard deviation values for factors

Figure 9.24 shows the first three factors (R1-R3) are not affected as in Table 9.9. However the changes are made for the factors concerning the five human senses and intellectual capabilities as explained in Table 5.8, Chapter 5.

The significance of this Section focuses on the eyewitness' statements. Although eyewitness statement may not be categorised as an expert opinion (Chapter 3), this item shall be essential to the animator to generate the animation. The evaluation of the reliability of a particular statement can be conducted as shown in Table 5.8, Chapter 5.

9.2 Conclusion

The main purpose of this Chapter is to demonstrate the significance of the three main findings described at the end of Chapter 8. The sensitivity analysis in this Chapter demonstrates the strength of the three findings. The purpose of alterations made on some scores earlier in Chapter 8 was to strengthen the implication of the findings. It can be summarised that:

a. Analytical problem in knowledge: In particular this segment verifies that the factors have established continuity and coherence with the theory in Chapter 4. Items of evidence that fulfil the factors R1-R6 (initially explained as concepts K1 and K2) are reliable to the animator as information. The CGA using this type of evidence (that fulfils the factors R1-R6) is reliable and accurate to this extent.

b. Expert and admissibility: The significance of this Section is to demonstrate the strength of written evidence. Written evidence is the most reliable information for the animator to generate the animation. The sensitivity analysis in Section 9.2.1 complements this Section with regard to the fact that other classes of evidence can be corroborated with written evidence from a particular case. For example, eyewitness's statement can be used as information to generate the CGA. However, the eyewitness' statement must be substantiated with the written evidence prepared by the police officer or the expert.

c. Method of investigation and bodies of evidence: This Section emphasises the fact that the method of investigation (creditable standing)

contributes to the reliability of items. Items with creditable factors R1-R6 are reliable information to the animator to generate the CGA. The CGA is reliable and accurate to a certain degree based on the fact that the item has been prepared with sound method of investigation and fulfils the factors (creditable standing) in the analysis.

d. Knowledge without evidence. The statement contains knowledge of the event. The eyewitness' statement can be validated by substantiating it with written, spatial and visual evidence. A case described in Chapter 3 whereby knowledge of how the crew would react to the conditions they found themselves in was another key ingredient (John, 2002). This case strengthens the importance of knowledge by the eyewitness as information for the animator.

All these four segments have been proposed as recommendations to the animator in deciding whether the information to be used is sufficiently reliable to generate the CGA. Hence, the reliability and accuracy of the CGA will be estimated based on both the quasi-experimental and sensitivity analysis.

The final chapter provides an overview of the study, re-stating the main research questions and justifying the interpretive methodology used. It summarises the main findings before discussing the significant issues and recommendations emerging from the study. Finally, limitations and directions for future research are presented.

Chapter 10

Conclusions and Implications

10.1 Introduction

The final Chapter seeks to bring together the results and conclusions from the previous chapters, examining them in the light of wider relevant literature. The strengths and weaknesses of this research are also discussed and some directions for future research and recommendations are presented.

This research has been built around three main themes: firstly, the accident reconstruction aspects (Chapter 2); secondly, the admissibility of CGA in the courtroom (Chapter 3); and thirdly, the application of the theory of knowledge from the analytical standpoint (Chapter 4). The nature of this research was to a large extent exploratory and multidisciplinary. As such, a combination of research design, both quasi-experimental and pragmatic, was employed for a fuller investigation of the research questions. In Section 10.3 of this Chapter, the contribution of this work to the wider perspective of CGA in the courtroom will be explained.

The main focus of this research, namely the reliability and accuracy of computer-generated animation in the courtroom, has been identified as crucial with regards to the technical and admissibility aspects. This work adopts a multi-literature approach aimed at addressing the variability and comprehending the aspects involved in generating the animation.

A number of research questions have been addressed in this work that relate to the broad context of admissibility of using computer-generated animation for litigation purposes. The implications are emphasised in four segments (Chapter 8):

a. analytic problem in knowledge;
b. expert and the admissibility of expert evidence;
c. method of investigation and bodies of evidence; and
d. knowledge without evidence.

10.2 The Rationale of This Research Revisited

The initial rationale consists of the following:

a. Formulating the research questions (Chapter 1) in light of acknowledging the need to determine the degree of reliability and accuracy of Computer-Generated Animation.
b. Investigating the background literature from three areas including reconstruction of an event, evidence and knowledge.
c. Incorporating the literature on knowledge as essential in developing a research methodology in Chapter 5.
d. Explaining the background of six case studies in Chapter 6.
e. Conducting analysis on the individual items of evidence in Chapter 7.

f. Presenting the summary in Chapter 8 of all the analysis from Chapter 7 into two parts:

(i) Classes of evidence (written, spatial, visual and eyewitness statement); and (ii) Cases (Cases 1-6).

g. Sensitivity analysis has been conducted in Chapter 9 to strengthen the findings in Chapter 9.

Chapter 1 explains the emergence and potential dangers of CGA. The Chapter also discusses previous studies pertaining to animation as an effective tool to be used in the courtroom. The research questions and objectives have been proposed in Chapter 1.

Chapters 2, 3 and 4 examine the background literature from three areas including reconstruction of an event, evidence and knowledge. The emerging issues have been identified. In summary, the evidence or information obtained from the scene is important in order to investigate and reconstruct a collision or crime. A CGA is normally created based on the items of evidence collected or obtained from the scene.

The Chapter proposing the research methodology is Chapter 5. In Chapter 5, the research design has been explained. Evidence has been classified into four classes. Theory of knowledge concerning types of knowledge and conditions for knowledge has been incorporated in the research methodology. Chapter 6 presents the background of all six cases.

The first question (Section 1.4, Chapter 1) asks how each item of evidence can be analysed to determine the reliability of the information pertaining to each individual case. This has been dealt with in Chapter 7. The analyses are undertaken in four classifications of evidence (written, spatial, visual and eyewitness). Scores have been assigned to each of the items. The score gives rise to categorisation. (*general*, *similar* and *exactly*). Based on this categorisation, each item can be determined as to whether it can be converted into useful information for the animator to generate the CGA. The level of reliability and accuracy can be further determined at this stage based on the three categories.

The second question (Section 1.4, Chapter 1) asks how the theory of knowledge can be applied to investigate whether the items of evidence fulfil the description in types, or knowledge and conditions for knowledge. This has been dealt with in Chapter 7. The types of knowledge and conditions for knowledge are referred to as K1(a-c) and K2(a-c) in Chapter 5. K1(a-c) and K2(a-c) are applied in all the analyses in Chapter 7. These concepts are reliable and justified by the literature mentioned in Chapter 4, and further strengthened when the concepts are incorporated in the research methodology stated in Chapter 5. The level of reliability and accuracy can be determined at this stage based on K1 and K2 in each analysis conducted in Chapter 7.

The final question (Section 1.4, Chapter 1) asks which method of analysis (Chapter 7), when applied to individual items of evidence, would generate a number of decisive factors that ensure the reliability and accuracy of the animation. This has been dealt with in Chapter 9. The sensitivity analysis emphasises that the three findings in Chapter 8 are vital. The scores for some factors (between R1-R6) have been changed in the sensitivity analysis in Chapter 9. For instance, comparison between classes of evidence and types of cases demonstrates that the vital decisive factors are eminent in determining the reliability of information furnished to the animator. The reliable facts of a particular case may determine the reliability and accuracy of the animation.

The last part of the structure embraces the content in Chapter 9 on the sensitivity analysis. Four types of analyses have been undertaken with the ultimate purpose of clarifying the deciding factors to determine the reliability and accuracy of CGA from the analysis in Chapter 7. The four types of analyses are:

a. Analysis of items of legal evidence on all classes of evidence against the factors (R1-R6).
b. Analysis of written evidence produced by two or more police officers and experts in Case 2.
c. Analysis of written reports from four cases.
d. Analysis of eyewitness' statements.

10.3 Implications for Theory

The significance of the reconstruction of an event (detailed in Chapter 2) has been reflected in one of the findings in Chapter 8. The "process" of generating the animation is the forensic animation. It has been further stated that the process depends on accuracy. All objects must conform to a set of facts that are determined by the forensic expert or the animator. These facts correspond with the findings of the investigation procedure based on the standard literature pertaining to a particular case.

The significance of evidence in Chapter 3 has been reflected in one of the findings in Chapter 8. When used to reconstruct an accident or crime, the animation is based upon information collected at the scene. This fact corresponds with the findings that the expert or eyewitness has to be at the accident or crime vicinity.

The significance of knowledge in Chapter 4 has been reflected in all the findings in Chapter 8. The types of knowledge referring to the competency, acquaintance, and correct information' and conditions for knowledge pertaining to truth, acceptance and justification, correspond with all the findings (presence of expert or eyewitness at the scene, and investigation procedures).

The novelty of this research can be demonstrated in two parts:

1. The body of literature covering reconstruction of an event, evidence, and knowledge (Chapters 2-4) are areas that create a proportionate scheme to generate the research questions in the earlier part of this thesis. Three main issues are identified in the research questions:
    a. the analysis of items of legal evidence;
    b. the fulfilment of types of knowledge and conditions for knowledge in the items; and
    c. the characteristics of the types of knowledge and conditions for knowledge that will correspond with the reliability and accuracy of computer-generated animation.

A multidisciplinary approach is used in formulating the research questions. The research questions aim to determine the reliability and accuracy of CGA. Previous acknowledged works with regards to visual presentation of evidence in the court room have been helpful in generating the research questions addressed in Section 1.4, Chapter 1.

2. The research methodology has been designed based on both quasi-experimental and pragmatic stages. This research design facilitates the analysis in determining the reliability and accuracy of CGA. The objectives are achieved at the end of Chapter 8 with three important findings in Table 8.11.

The objectives outlined in Chapter 1 aim to:

a. evaluate the individual items of evidence;

b. evaluate the reliability and accuracy of the information gathered at the scene of an accident or crime; and

c. provide guidance on the deciding factors of whether a particular animation is reliable and accurate based on the items of evidence.

The objectives are answered in Section 10.2 of this Chapter.

The area of research concentrates on the CGA as an effective tool to illustrate complex technical facts based on the investigation conducted by the police authority or expert for litigation purposes. Three critical aspects pertaining to the contribution based on the analysis are:

1. Theory of knowledge corresponds with the philosophical approach for evidence and therefore, forms an effective paradigm to evaluate the items of evidence.
2. The research design applied during the quasi-experimental and pragmatic stages proves to have facilitated a consistent pattern in the analysis.
3. The findings and implications of the research are reflected in all aspects pertaining to reliability and accuracy of CGA.

10.4 Strengths and Limitations of This Research

The present research has a number of strengths as well as limitations. One notable strength is the focus of this research on the reliability and accuracy of the information furnished to the animator.

Another major strength of this research is its multidisciplinary perspective that facilitates flexibility in the examination of the research questions. Two patterns of research designs (quasi-experimental and pragmatic) are employed to appropriately address the research questions. Finally, the examination of items of legal evidence within the context of analytical knowledge standpoint is also another strong point of this thesis.

Despite the above, this research does have its limitations. One limitation is that most of the items of evidence have been furnished by the animator for the purpose of this analysis. The researcher did not have the opportunity of a direct interaction with the expert (for example the police authority). Some of the items for the analysis in Chapter 7 are not available for instance, as in Case 3 (collision between two motorcars) and Case 4 (criminal investigation).

Another shortcoming is the limited number and types of cases available for the analysis. There are three cases on road traffic accidents and one on criminal investigation. These circumstances limit the discussion pertaining to evidence in other types of cases that have used the animation method to present the evidence.

Finally, as this thesis is largely exploratory in nature, it is not based on any specific theory that relates to the process of generating animation for litigation purposes. Consequently, this research represents an attempt to clarify the deciding factors in relation to the reliability and accuracy of CGA, hence it is most important to emphasise the emergent need for future research within this area of interest.

10.5 The Need for Future Research

The present research represents an attempt to evaluate items of legal evidence as information to the animator. The qualities of items of legal evidence and the diverse aspects relating to the generating of animation, call for a more scientific research method for these factors (Chapter 9, Tables 9.1 and 9.2). The quasi-experimental and pragmatic analysis approach applied in this work, is useful both for the purpose of generalisation and hypothesis investigation and of in-depth exploration of the questions investigated.

It would be essential and interesting for future research to assess and improve the analysis by establishing direct interactions with the appropriate authorities. The lack of background details of the police or expert producing such evidence may be solved by direct communication with the appropriate parties. The confidentiality issue may be dealt with by acquiring specific authorisation. This would require a regulatory approach addressing contemporary legal matters pertaining to the CGA in other countries.

10.6 Conclusion

This work aims to further contribute to the existing knowledge, of the use of CGA in the courtroom, such that it will facilitate further research. This thesis also proposes the structural guidelines in determining the reliability and accuracy of CGA as mentioned in Section 9.2, Chapter 9.

This research aims to reach a level of certainty in determining how reliable and accurate CGA is for each case based on the items of evidence. In the context of this research, the level of certainty is estimated based on the analysis of each item of legal evidence. The reliability and accuracy can be determined by deciding factors (R1-R6) in Chapter 9.

The main objective is to highlight the evidence as a crucial element in generating such an animation and that the items of legal evidence have been prepared by an authorised police officer or expert. For an instance where an eyewitness'

statement has been analysed as an item of legal evidence, the eyewitness must also be present at the collision or crime vicinity. The aspects related to the human senses involving statements made by the eyewitness are also crucial in determining the reliability of information given.

In addition to the main objective, each item of legal evidence can be used to substantiate the information for the animator. The process of generating a CGA will require more than one item of legal evidence as the source of information for the animator. The relationship between the two literature topics (evidence and knowledge) shows that:

a. evidence is knowledge to the animator;
b. the items of legal evidence (knowledge) have been investigated by an expert or a police officer with competency, acquaintance and correct information; and,
c. the evidence fulfils the conditions for knowledge to authenticate the credibility of (b).

In concluding this thesis, it is essential to note that the reliability and accuracy of the CGA as an effective tool of presentation in the courtroom, depends on reliable information used by the animator to generate the CGA. The analysis on each item of legal evidence conducted in this thesis strengthens the importance of reliable information obtained from the police officers, experts, and eyewitness' statements for the use of the animator in generating a reliable and accurate animation.

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APPENDIX: BASIC LITERATURE OF COMPUTER FORENSICS INVESTIGATION

Introduction

Computer forensic investigation begins when an incident is reported to the response team in a particular country. *Incidents* mean events that threaten security in computing systems and network. *Events* include any observable thing that happens in a computer and/or network. Events include connecting to another system via a network, accessing files, system shutdowns, etc. *Adverse events* include system crashes, packet flooding within a network, unauthorised use of another user's account, unauthorised use of system privileges, defacement of one or more web pages, and execution of malicious code that destroys data. Other adverse events include floods, fires, electrical outages, and excessive heat that causes system crashes.

The Data Recovery Report (potentially referred to by the animator to illustrate the investigation process)

Based on all these incidents, reports may be lodged with the team responsible to deal with the matter. The team usually referred to with various names such as "Emergency Response Team" and "Incident Response Team". Some of these incidents may be potentially liable for litigation. The computer forensic experts will present the evidence, for example, a recovery report.

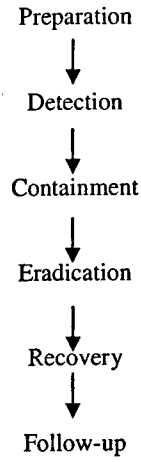
In the analysis, the recovery report will be referred to as E1(5) for the purpose of this assessment. Under this type of case, the types of knowledge (K1a-c) and conditions for knowledge (K2a-c) will be assessed on the assumption that CGA to illustrate the complex technical facts from the investigation of this computer forensic case.

The items of evidence for this type of case may be different from other types of case; in this report however, the category of evidence may be similar. For instance in the road traffic accident, the police crash investigation report (item of evidence) is the written report evidence by category. In a computer forensic case, the recovery report (item of evidence) is the written report evidence by category.

For the purpose of considering the conditions for knowledge (K2a-c), the methodology for incident response refers to the six-step methodology called PDFCERF (Schultz, 2002). It was presented at the Invitational Workshop on Incident Response at The Software Engineering Institute in Pittsburgh, Pennsylvania, in July of 1989 by approximately one dozen workshop participants. The acronym PDFCERF embodies the first letters of all six stages (*see Figure A*). This methodology has been adopted by many countries including Malaysia.[1]

[1] Malaysian Computer Emergency Response Team (MyCERT). *Available at www.niser.org.my (Date Last Accessed: 06/08/2004)*

Figure A: The PDCERF incident response methodology



The six-step methodology has detailed sub-steps for each stage. For the purpose of this analysis, a summary of each stage shall be described as follows:

1. *Preparation.* The first stage is preparation, which means being ready to respond before an incident actually occurs. The sub-steps under the preparation stage include:
   a. Setting up a reasonable set of defences/controls based on the threat that presents itself.
   b. Creating a set of procedures to deal with incidents as efficiently as possible.
   c. Obtaining the resources and personnel necessary to deal with the problem.
   d. Establishing the infrastructure to support incident response activity.
2. *Detection.* Detection means determining whether malicious code is present, files or directories have been altered, or other symptoms of an incident are present and, if they are, what are the problem as well as its magnitude is. Intrusion detection means determining whether unauthorised access to a system has transpired and whether misuse has occurred for example, a virus infection can be found using detection but not intrusion-detection software. Detection

embraces a potentially much wider range of incidents than does intrusion detection. From an operational standpoint, all actions that transpire as part of the incident response process depend on detection. Without detection, there is no meaningful incident response; detection triggers incident response. This elevates the relative importance of detection among the other five stages considerably.

3. *Containment.* The purpose of the third stage of incident handling, containment, is to limit the extent of an attack and thus the potential for damage or loss.
4. *Eradication.* The goal of eradication is to eliminate most viruses that infect small systems. At this stage, on the assumption that the experts have applied the methodology from preparation to eradication, he/she at this stage applied specific rule in the investigation process.
5. *Recovery.* The goal of recovery is to return any compromised system and network device completely back to its normal mission status. One reasonably safe method is to restore data from the most recent full backup. Another is to use fault tolerance system hardware such as Redundant Array of Independent Drives (RAID) to recover mirrored or stripped data that resides on the redundant hard drives.
6. *Follow-up.* The overall goal is to review and integrate information related to an incident that has occurred. The most important element of the follow-up stage is performing a post-mortem analysis on each significant incident. Exactly what happened and at what times? How well did the staff involved in dealing with the incident do? A follow-up report should also provide information that can be used for reference if other similar incidents occur.