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UNDERSTANDING ACCIDENT INVESTIGATORS: A STUDY OF THE REQUIRED SKILLS AND BEHAVIOURS FOR EFFECTIVE UK INSPECTORS OF ACCIDENTS

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Abstract

In the UK, accidents associated with maritime, aviation and rail transport are conducted by the Inspectors of Accidents at the Marine, Air and Rail Accident Investigation Branches.

A review of current academic literature provides little insight into the qualities and attributes essential for the role of accident investigator. A wealth of material exists about accidents themselves but as yet, a study into the profile of the accident investigator has not been conducted.

This research sought to determine the requisite skills and behaviours of an effective accident investigator based upon a three-phased, primarily qualitative, methodology. Content analysis was used to determine task and non-task specific themes from semistructured interviews conducted with accident investigators from the UK and the US, the findings of which are characterized by individualism and variability: the former having implications for effective teamwork and the latter indicating the paucity of structured analysis processes in use, which would lead to reproducible and transparent results.

Repertory Grid interviews elicited five competency themes and one hundred attendant behavioural indicators which were employed during the final phase of the research to determine their relative importance in terms of recruitment, training and the superior investigator.

The findings showed that it was believed essential to consider interpersonal and communication skills, cognitive abilities and personal attributes during recruitment and that technical skills were deemed to be most amenable to change through training interventions with personal abilities least likely. Further thematic analysis of highly rated behavioural indicators showed an emphasis on report writing and dealing with people. These findings have implications for recruitment with a need for non-technical competencies such as report writing and the ability to deal with people to be more prevalent in selection testing and decision-making.

No specific skills or behaviours were found to distinguish superior performance in investigation, instead requiring a balance of competencies. With no defining threshold, the researcher proposed that superior performance should be measured “relative to mission” and is more usefully thought of an added value continuum rather than a set of discrete skills and behaviours. Evidence was provided to demonstrate how the organizational structure and philosophy influenced the working styles of the Inspectorate and therefore the expected skills and behaviours.

The researcher advocates the combination of the competency framework and behavioural indicators derived with an extant Branch competence measure to strengthen the tools whilst responding to a call in the literature for a more blended approach to determining competences and competencies.

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Finally, I owe a significant debt of gratitude to my family and friends whose faith and encouragement have meant the world to me and whose relief that it's nearly over is palpable. The biggest thanks of all go to Jem and the boys to whom I dedicate my "very long story".

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Glossary

AAIB	Air Accidents Investigation Branch
AIBs	Accident Investigation Branches
ATSB	Australian Transport Safety Bureau
BEA	Bureau d'Enquêtes et d'Analyses
BPS	British Psychological Society
CIPD	Chartered Institute of Personnel and Development
C-JAM	Combination Job Analysis Method
DSB	Dutch Safety Board
EASA	European Aviation Safety Agency
EC	European Commission
EMSA	European Maritime Safety Agency
ERA	European Railway Agency
ETSC	European Transport Safety Council
EU	European Union
HMRI	Her Majesty's Railway Inspectorate
ICAO	International Civil Aviation Organization
IIC	Investigator-in-Charge
IMO	International Maritime Organization
ISASI	International Society of Air Safety Investigators
ITSA	International Transportation Safety Agency
KSAOs	Knowledge, skills, abilities and other characteristics
MAIB	Marine Accident Investigation Branch
MAIIF	Marine Accident International Investigators Forum
MCA	Maritime and Coastguard Agency
MCI	Management Charter Initiative
MCIA	Maritime Casualty Investigation Association
MOD	Ministry of Defence
NOS	National Occupational Standards
NSSB	National Skills Standards Board
NTSB	National Transportation Safety Board
PACTS	Parliamentary Advisory Council on Transport Safety
PI	Principal Inspector
RAIB	Rail Accident Investigation Branch
RAF	Royal Air Force
TSB	Transportation Safety Board of Canada
UK	United Kingdom
US	United States

1.0 Introduction

1.1 Background

In the UK, the responsibility for conducting investigations into the causes of accidents and serious incidents associated with marine, air and rail transport falls to three organizations, under the aegis of the Department for Transport. These are the Marine Accident Investigation Branch (MAIB), the Air Accidents Investigation Branch (AAIB) and the Rail Accident Investigation Branch (RAIB), respectively.

There has been a long-established relationship spanning three decades between Cranfield University, as a training provider, and the Air Accidents Investigation Branch. The University ran its first accident investigation course in 1977; initially conceived and developed in association with the Chief of Air Accidents due to the increasing strain placed upon the Branch by requests for assistance for training by foreign agencies (Tench, 1985). Principally designed for civil aircraft accident investigation, its syllabus and scope has widened to include military accidents and in recent years has been 'enhanced' through collaboration with the MAIB and RAIB to incorporate the investigation of accidents in other modes of transport.

The three Branches provide strategic guidance for the ongoing development of the accident investigation training, and the Cranfield Aviation Safety Centre as a whole, through close involvement as an industry advisory board.

As part of this relationship, the Branches agreed to support doctoral research with a view to better understanding the skills and attributes essential for effective performance of the role of accident investigator. Funding was made available from each of the Branches as well as from the Department of Air Transport at Cranfield University.

Accident investigation is a demanding role drawing upon not only technical expertise and experience but as importantly, ability and personal attributes. Establishing an appropriate mix of expertise, experience and specific skills through the recruitment and training process remains a challenge to the Branches. The recruitment and training costs associated with employing new investigators are high so it is imperative for the Branches that those selected at interview are appropriate for the role and will be retained.

1.2 Context

Statistically, travel by marine, air and rail transport is relatively safe within the UK. UK transport statistics published in 2008 by the Department for Transport show that in terms of number of fatalities, the three transport modes collectively

resulted in 48 deaths, in comparison with 2946 fatalities associated with road transport. These figures, however, belie the total number of serious incidents and accident reports published.

Each Accident Investigation Branch (AIB) operates as a separate autonomous entity reporting through to the Secretary of State for Transport, with varying cultures, history and operational procedures but sharing a common remit: the independent and impartial determination of the facts surrounding the causes of accidents and serious incidents, in order to make safety recommendations intended to prevent recurrence and preserve life. It is not, it is emphasized, to apportion blame or liability.

Employing collectively more than 150 people, the AIBs have a reputation for integrity, impartiality and credibility, not only in the UK but internationally. The accident investigators, or Inspectors of Accidents as they are called in the UK, are drawn from a specialist population. Such is the desireability of the role that it attracts the very best of the industry bringing with them a wealth of knowledge and experience.

The accident investigators at the AIBs are known collectively as the Inspectorate. The organizational structure is relatively flat with respect to hierarchy, the main grades being: Inspector/Senior Inspector (seniority title appears to be given after period of employment); Principal Inspector (responsible for the man-management of the Inspectors and the individual investigations); Deputy Chief Inspector and Chief Inspector responsible for day-to-day running of the Branch and political and strategic overview respectively.

The three Chief Inspectors form a Board of Transport Accident Investigators to pursue joint initiatives, identify opportunities to share best practice and the efficient use of shared resources. (MAIB, 2008a).

UK Inspectors are typically drawn from a professionally qualified and experienced cohort within their particular industry.

Marine Inspectors will be selected from nautical, engineering, naval architecture and fishing disciplines. Required qualifications and experience include: Class 1 Deck Officer Certificate of Competency, a degree or equivalent in a relevant subject, and considerable experience at sea including some as Master; Class 1 Engineer Officer Certificate of Competency, a degree in mechanical or marine engineering and experience of merchant vessel operation at a senior level at sea or ashore; degree in Naval Architecture, ideally with Chartered Engineer status, significant experience in a position of responsibility in an establishment involved in shipbuilding and survey, ship operations, ship repair, ship design or research (MAIB, 2008b).

Air accident investigators historically fell into one of two camps: flight operations or engineering. With the advent and development of flight data recorders, a third category of Inspector has emerged.

Operations Inspectors hold a current Airline Transport Pilots' Licence with a valid Class 1 medical certificate. They are typically able to offer extensive command experience on fixed wing aircraft or helicopters and will maintain currency by continuing to fly. Engineering Inspectors must hold an Engineering degree and/or be a Chartered Engineer with a minimum of five years' post qualifications experience. They are encouraged and supported to learn to fly.

The third and more recent category, the Flight Data Recorder Inspector will have attained first degree level in Electronics or Electrical Engineering or an Aeronautical Engineering related subject and/or will be a chartered member of a relevant engineering institute with at least eight years' experience since qualifying. (AAIB, 2008).

There are no comparable operator's qualifications for the newly formed RAIB to draw upon. Their recruitment requirements look for a degree in a relevant discipline or equivalent professional experience, with membership of a relevant professional institution. There is an expectation of a minimum of eight years' experience post qualifying. (RAIB, 2008).

1.3 Research objectives

A wealth of material exists about accidents and accident investigation; the majority of texts on the subject include a detailed breakdown and analysis of events with varying degrees of conjecture. These do not, however, cast much light on the skills and behaviours of those undertaking the task (Tench, 1985; Owen 1998).

Generalizations regarding the significance and complexity of the role are made and lists of adjectives provided (Taylor, 1996) but the researcher was unable to find previous academic work regarding the qualities and attributes specific to the role.

When constructing a model of an occupational role, there are a number of perspectives from which to approach the task. An individual can be described by the specific tasks that comprise the role, the behaviour exhibited whilst performing the task and the psychological constructs employed. These three differences in approach have formed the basic philosophy behind the numerous occupational analysis techniques available for use.

One of the approaches to understanding and measuring desired behaviours in the workplace is the use of a competency framework. Competencies are essentially the key characteristics or behavioural capabilities that the most successful performers have that make them successful (Kessler, 2006). At least half of the Fortune 500 and other major organizations in the US, Europe and internationally are said to be using competency-based systems for selection and appraisal (Kessler, 2006), with upward of 95% of the UK Civil

Service, to whom the Inspectorate belong, having adopted or in the process of adopting competency-based management (Horton, 2000b).

'Competency' should not, however, be confused with the term 'competence' for, as shall be discussed in more detail during the course of this thesis, they are in fact distinct in terms of their focus, purpose and what they purport to summarize (Wood and Payne, 1998).

Rowe (1995) defines it thus: "Competence [is] a skill and the standard of performance reached while competency refers to the behaviour by which it is achieved. In other words, one describes *what* people can do while the other focuses on *how* they do it." This is reiterated by Woodruffe (1990) who delineates between competence which defines the area of work at which a person is competent, and competency as the dimensions of behaviour underlying competent performance.

The confusion surrounding terminology in this area stems largely from the historical context of two seemingly divergent approaches in the US and UK. In essence, the US 'competency' model emphasizes the personal characteristics of superior performers, typically but not exclusively drawn from the management population whereas in contrast, the UK construct of 'competence' is task or output focused: it is the job that is deconstructed to its minima not the individual's attributes.

There is tendency to conflate the terms by the use of both 'competence' and 'competency' which, dependent upon the perspective, can either be used interchangeably or exist as completely separate entities with entirely different precursors and results (Woodruffe, 1990; Rowe, 1995; Rankin, 2001).

The sponsors expressed an interest in undertaking research into Inspectors' competency but the terms 'competence' and 'competency' were used in reference to differing activities by the three Branches. As the requirement to articulate the research objectives became more pressing, it became apparent that this was not simply a question of semantics; differing perspectives in terms of the focus and direction of the research began to be expressed.

Additionally, each of the three UK AIBs was individually involved with projects which had implications for the study and a consultancy had been employed to develop a competency framework although this was never concluded.

Given the amount of work already being undertaken in the area, there appeared to be diminishing room for unassisted innovative research. In order to produce work that was original, the researcher stepped outside of the original 'remit' of developing a competency framework for the Branches and chose to review the role of the accident investigator in a broader context.

There were also conflictions with regards to the understanding of what constituted doctoral research and how that differed from short term consultancy

work in terms of timescales and deliverables. The initial stages of the research were, therefore, characterized by a requirement to manage expectations and develop a mutually agreeable compromise.

The focus of this study is upon the three UK AIBs, although the researcher was keen to look at their work within the context of the global accident investigation industry. The findings of the research are limited to the Branches, but during the course of the study the researcher took the opportunity to talk with representatives from regulatory authorities, operators, manufacturers and other investigation agencies to gain an alternative perspective. Whilst this material does not form part of the research data per se, it provided insight into the interfaces between the AIBs and the organizations with whom they work.

The researcher wanted to explore whether the context in which the accident investigation took place had any bearing on the effectiveness of the outcome. This was sought within the history of the three Branches, legislation governing accident investigation and the wider European and international influences.

This research project, therefore, seeks to determine the requisite skills, qualities and behaviours in an ***effective*** accident investigator where effective is defined as producing the result that is intended: that is, a thorough, impartial, evidentially-based analysis of events with proportionate recommendations for change. This will be based upon analysis of the role of the investigator in terms of competencies required to perform generalized investigation tasks. The research will also look at how superior performance might be distinguished in investigation. Psychological constructs will be excluded from the study unless they can be directly inferred from behaviour.

1.4 Research methodology

This is not an evaluative study in as much as the organizations and the Inspectorate, in particular, involved in this research are not being ranked, rated or assessed as to competence.

The research study has been broken down into three individual but complementary phases; the results of the former phase informing the next.

The first stage, Phase 1, called for an exploratory study: "… to find out what is happening; to seek new insights; to ask questions; to assess phenomena in a new light and to generate ideas and hypotheses for future research" (Robson, 2002). This allowed the researcher to become more familiar with the subject and context, enabling a better understanding of the research question through the use of semistructured interviews, literature reviews, background research and observation.

Phase 2 utilized the findings from Phase 1 to conduct more in-depth interviews with Principal Inspectors to determine their perceptions regarding behavioural

indicators of effectiveness in accident investigation. Behavioural indicators are a description of either a positive or negative behaviour that illustrates the possession or not of a competency (Honey, 1982). This was achieved by employing the Repertory Grid technique to structure interviews and elicit responses.

Subsequent to this stage of the research, the RAIB felt unable to continue to support the research at a time when resources were more usefully employed in shaping the operation. Their withdrawal from the research was regrettable as their inclusion would have offered a valuable additional perspective as well as an opportunity to study how the shape and structure of a newly formed organization might influence the investigative process.

The final phase of the research, Phase 3, again employed the findings from the previous phase and sought to quantify the relative importance of these behavioural indicators for the role of accident investigator, in particular in terms of recruitment, training and the superior investigator.

The small sample meant that quantitative comparisons could only ever be suggestive (Freeman, 2003) and the researcher felt that a methodology that was predominantly qualitative in nature was more appropriate. Such an approach focuses upon interpretation rather than quantification, seeking to describe and understand as opposed to explain and predict. A flexible methodology was employed as it allowed for “progressive focusing” with concepts developing during research (Hall and Hall, 1996).

1.5 Structure of the thesis

This thesis is divided into eight chapters, the contents of each is outlined below.

Chapter 1: Introduction
This chapter introduces the thesis, setting out the research background, context and objectives including an overview of the methodology. It also informs as to the structure of the thesis.

Chapter 2: Literature review
The literature review further establishes the context in which the investigation of accidents takes place, both in the UK and internationally. It discusses the history and development of the UK Accident Investigation Branches within their industry, outlining the governing legislation that sets their purpose and shapes their output. The accident investigation process and the role of the investigator within that process are outlined and the chapter concludes with an overview of the terms competence, competency and job analysis as important concepts in determining and describing effectiveness in accident investigation.

Chapter 3: Methodology
This chapter sets out the three complementary phases of the research, each phase informing the next. Commencing with a discussion regarding the underpinning philosophical considerations and their influence on the methodology, the three phases of the research are then explained. Phase 1 involves the use of semistructured interviews with UK AIB Inspectors as well as US equivalent National Transportation Safety Board investigators to gather detailed information regarding the investigation process and the role of the accident investigator; Phase 2 uses in-depth Repertory Grid interviews to elicit polar constructs and resultant competency themes and behavioural indicators from the Principal Inspectors; and Phase 3 utilizes those indicators to determine their importance in terms of recruitment, training and the superior investigator by way of a questionnaire administered to the MAIB and AAIB Inspectors.

Chapter 4: Phase 1 Analysis
Each phase of the research is analysed and the results discussed in context. Phase 1 utilizes content analysis and coding to determine task and non-task specific themes which are illustrated by verbatim exemplars.

Chapter 5: Phase 2 Analysis
Phase 2 content analysis reveals constructs and behavioural indicators which are categorized by competency theme: interpersonal and communication skills; work activity management; personal attributes; cognitive abilities; and technical abilities.

Chapter 6: Phase 3 Analysis
The analysis of the Phase 3 questionnaire reveals further background information regarding the Inspectors as well as their ratings of the individual behavioural indicators in terms of recruitment, training and the superior investigator.

Chapter 7: Discussion
This chapter of the thesis seeks to synthesize the various elements of the research; to further consolidate the knowledge acquired during the course of the study and to determine what the implications are for this knowledge.

The chapter discusses how well the research design performed and summarizes the salient findings within the context of the AIBs. It concludes with consideration of the overall limitations of the present study as well as opportunities for further research.

Chapter 8: Conclusions
The final chapter provides a summation of the research, highlighting the most significant findings.

2.0 Literature Review

2.1 Why investigate accidents?

Accident investigation serves to satisfy one of the most fundamental perturbations of mankind: the fear of the unknown. Nietzsche (1908) described the "cause–creating drive" as the feeling of fear but "… to trace something unknown back to something known is alleviating, soothing, gratifying and gives moreover a feeling of power". Society's need to find a 'cause' stems from an overwhelming desire to control and show certainty: to regain the security and confidence of feeling derived from an advance in our body of knowledge. "First principle: any explanation is better than none." (Nietzsche, 1908).

The public's response to accidents "… often seems to require a stimulus that is immediate, close at hand and dramatic." (Haddon et al, 1964). Haddon et al continue that accidents remained the only source of morbidity viewed "… in essentially extra rational terms. 'Luck', 'chance' and 'acts of God' are all culturally acceptable explanations of accidents."

Less philanthropically, we are living in what has become known as an increasingly litigious society. Whether this litigious society is a reflection of a reluctance to admit fault coupled with an inability to accept that accidents may not be as a result of the actions or inactions of others is unclear. "Everywhere accountability is sought, it is usually the instinct for punishing and judging that seeks it." (Nietzsche, 1908).

There has, however, been a shift towards a compensation-oriented society, driving the desire "… to treat every death as chargeable to someone's account, every accident as caused by someone's criminal negligence" (Douglas, 1992). Douglas asserts that this is indicative of a "pervasive individualist culture" and that we are living through "adversarial times". This is supported by an ever-decreasing political and public tolerance for accidents (Kirchsteiger, 2004).

Approaching the question from a less philosophical stance, Kletz (1993) provides four reasons for investigating accidents: moral; pragmatic; economic; and image. Perhaps most importantly we have a moral duty to prevent future accidents and to preserve life. It is, also, practically effective to share data and information that can erode our 'infinite ignorance' (Popper, 1963). Accidents are expensive both financially and as a result of loss of image – the whole industry suffers when one company has a serious accident. Stoop (2003b), on the other hand, states that accident investigations serve generally as performance indicators for policy making and supply data for scientific research.

Harvey (1985) outlines five purposes of investigating accidents. Firstly, there are *legal* requirements which dictate which accidents must be investigated, particularly subsequent to the violation of prescribed codes. Secondly, it

enables the *description* of the events – the identification of a "… complete set of facts." The efficacy of this identification and the construction of an accident narrative is predicated upon an inference of objectivity by the accident investigator, with the knowledge and experience to recognize which 'facts' are relevant and pertinent, and which are not.

Prevention is perhaps the most often stated motivator behind accident investigation (ICAO, 2001; van Vollenhoven, 2002) where changes to a condition are proposed based on findings, satisfying the moral aspect proffered by Kletz (1993).

Harvey continues with *research* as a purpose for investigation but stresses the need for a complete and reliable data set for like-for-like comparison across different data sets – a task not without its difficulties.

Harvey finally alludes to the identification of *cause* but suggests that this is often subject to bias, conjecture and inference, serving little purpose other than to determine culpability - a view often cited (Johnson, 2003; Rimson, 2004).

The drivers for the investigation will impact the shape of the process and therefore the saliency of specific information and ultimately the outcome. The accident model adopted is thought to influence the data collected, acting as a filter or bias (Leveson, 2004).

In the UK, the three Accident Investigation Branches cite their fundamental purpose to be to determine or identify circumstances and causes. It is not their remit to determine criminal or civil culpability nor do they become involved with organizational disciplinary procedures. Their focus is singularly upon establishing what has occurred.

There are however, dissenting voices with regards to the pursuit of cause; the concept representing a fundamental difference in approach between international investigative agencies.

The National Transportation Safety Board in the US, for example, propose the establishment of "probable cause" as a deliverable from their accident investigations but, by contrast, as the Australian Transport Safety Bureau contest, the term "cause" – whether probable or not – can be confused with legal causality. They prefer to present their results in terms of findings and significant factors to avoid any inference of blame or liability. The recent ICAO Accident Investigation and Prevention Divisional Meeting in 2008 emphasized the polarity of opinion with regards to the definition of 'cause': a suggested compromise was to include the addition of contributory factors, but even that did not satisfy all parties. (ICAO, 2008).

"The idea of a single cause is the fixation of the media". (Miller quoted in Faith, 2001). Cause suggests the existence of an absolute truth which is impossible

to demonstrate for as Kletz (2006) states, “Accident reports are rather like Rorschach inkblots. Different people see different underlying causes.”

“Only litigants argue the merit of probable cause” (Benner, 2008). The establishment of cause with regards to accident investigations has unwittingly led to the inference of culpability and blame; there is an “… implicit normative notion of blame or liability” in the term (Stoop, 2003a). Nowhere is this more apparent than in the aviation industry. RAND (Sarsfield et al, 2000) in their lengthy study of how the NTSB operates concluded that “… the investigation process, as important as it is to the safety of the flying public, has unintentionally also become important to the establishment of legal fault and blame.” Indeed, NTSB accident reports were referred to as “… roadmaps to liability”.

Safety and human factors studies have shown that approaching an accident investigation with the objective of finding ‘culprits’ or those responsible in order to exact punishment is counterproductive to determining the facts surrounding an accident event.

Blame is described as “an aspect of everyday conduct evaluation that identifies behavior as morally wrong or socially opprobrious.” (Alicke, 2000). As a society we are quick to apportion blame, as it is emotionally satisfying particularly with outcome knowledge rather than a focus upon the actions and omissions that preceded the accident. Calming public outrage, blame and punishment have often been used to assuage corporate guilt, ensuring the problem goes away quickly.

It has been argued, however, that given that the majority of accidents are found to be attributable to human error where foresight and an intent to do harm are not present, that blame and punishment serve little purpose in accident prevention and move only to demoralize individuals involved, discouraging people from sharing information which could possibly prevent future accidents.

“Blaming those responsible for a crash is not really important to the cause of safety. Nor even, necessarily, is finding the definitive, or probable, cause of a crash. Much more important is to find out how the crash can be prevented in the future.” (Weir, 1999).

Rimson (1998) argues that attempting to balance the objectives of the pursuit of cause and the prevention of recurrence is “countervalent” or in opposition. “They are so fundamentally inconsistent that increasing concentration on one diminishes the worth of the other.”

RAND noted that the complexity of aviation accident litigation had evolved in synchrony with the evolution of the industry. Early aircraft were less complex and built to carry fewer passengers and the activity of flight was ascribed a certain degree of risk. Today’s modern jets can carry 400 or more passengers and what was once seen as an adventurous occupation has now become

commonplace; "… an everyday event, integral to commerce and leisure, that involves minimal risk." (Sarsfield et al, 2000). As a consequence, any accidents are more likely to be thought of as caused by negligence with its accompanying inference of blame, as opposed to technical aberrations (Kreindler, 1998).

Whether or not the outcry is justified (practically or philosophically), "… public concern is a strong weapon against those considered at fault in mishaps" (Ferry, 1988) and the power of public opinion should not be underestimated in its ability to shape the industry. As an example, the UK charter airline, Excalibur Airways, went into liquidation in 1996 due to a loss of consumer confidence caused by safety concerns about its aircraft.

What there does appear to be agreement upon is the need for accident investigation that is both independent and transparent. As Chairman of the International Transport Safety Agency, Pieter van Vollenhoven claimed that independent accident investigation is every citizen's right and society's duty (van Vollenhoven, 2002). Assuaging public concern and enabling victims and their families to come to terms with events is as important, he asserted, as ensuring lessons are learnt and future recurrences prevented.

This is echoed by former Chief Inspector of the AAIB, Ken Smart, "Perhaps the most important prerequisite for public and industry trust is independence." He continues, " An independent accident investigation body ensures that there can be no perception of conflict of interest which reduces the scope for 'cover-up' or conspiracy theories." (Smart, 2004)

Independent accident investigation, van Vollenhoven asserts, can only be guaranteed through law thereby making actions transparent. The difficulty arises with smaller countries experiencing few, if any, serious accidents or incidents where the justification for funding an independent body might not be acceptable. Where this is the case, there is often a requirement to fall back on existing government inspectors to perform the role, which can lead to questions regarding the impartiality and independence of the investigation.

Elliman et al (2007) state that independence in an investigative organization can be measured in terms of its structure, finances and functioning. Structural independence is gained through separation from "regulatory bodies, including the judiciary, and when the body and its investigators are granted a legal status." Investigative agencies should not be financially dependent upon commercial organizations and should have autonomy over its own finances. Functional independence occurs when "legislation governs the categories of accidents to be investigated but the body has the autonomy over the decision to investigate and the focus and scope of the investigation."

Transparency of practice, on the other hand, gains public trust. It enables the public to assess the quality of the investigations and the resulting data and is defined as "the full, accurate, and timely disclosure of information." (Elliman et al, 2007)

It is a question of debate as to whether a government investigation organization, however ostensibly independent it purports to be, can ever be truly transparent. The MAIB's first investigation report into the Marchioness accident in 1989 attracted criticism for conducting the investigation in 'private' (as opposed to through public inquiry). It was argued that this resulted in a lack of public scrutiny of evidence and an inability for the public to be able to challenge what evidence was considered and what was omitted.

As has been illustrated, the primary reasons for the establishment and continued operation of the UK Accident Investigation Branches is to determine the causes of accidents with the intention of preventing recurrence. The AIBs are precluded from implying blame or culpability although their reports will always have the potential for inference from its findings. As such, it mitigates the public desire for accountability by offering a detached interpretation of events that will, it is ventured, also offer advances in knowledge to the industry.

2.2 Development of the UK Accident Investigation Branches

"Each transport mode has its unique culture. The aviation, maritime and rail industries carry with them elements of their history and development that can be found in these industries today" (Smart, 2004).

The following section outlines the historical context in which each of the three UK Accident Investigation Branches developed as well as the international and European framework within which each operates.

2.2.1 Air

Of the three, the Air Accidents Investigation Branch has the longest history as a permanent independent organization. Despite its relatively recent history, aviation has been a tremendously dynamic and fast paced industry and yet, even though it has only been a century since the first powered flight, the desire to understand why accidents occur and to introduce ameliorating measures has driven the institution of accident investigation bodies across the globe. It is this international perspective, and not the reliance upon individual States or companies, which has been most influential in ensuring that accident investigation has such a high profile and exemplary reputation.

The first recorded aviation accident report was written as a result of the uncontrolled descent and crash landing of the aircraft Flyer 3 piloted by Orville Wright in 1908. US Army Cavalry Officer Lt. Thomas E Selfridge was on board the demonstration flight and whilst Wright survived, Selfridge did not.

In the UK, concern about significant numbers of early aircraft being lost led to Captain CB Cockburn, a leading aviation expert and the holder of pilot certificate number 5, being appointed to the independent post of Inspector of

Accidents in 1915 as part of the Accidents Investigation Unit of the Royal Flying Corps. As such, Cockburn was directly responsible to the Director General of Military Aeronautics at the War Office.

In the years immediately subsequent to the end of the First World War, the impetus for civil public transport increased and a Department of Civil Aviation of the Air Ministry was established. The Accidents Investigation Unit became part of this Department, changing its title to the Accidents Investigation Branch, and its function became substantiated in law through the Air Navigation Act of 1920 giving the Secretary of State for Air the power to make separate provision for the investigation of civil air accidents through the Air Navigation Order of 1922 and the Air Navigation (Investigation of Accidents) Regulations 1922.

Smart (2004) refers to three post-war UK government reviews of aircraft accident investigation which have "shaped" investigative practice, both nationally and internationally.

The Shelmerdine Committee was tasked with "considering whether the pre-war accident investigation arrangements were likely to be adequate for the post-war global expansion of the industry." (Smart, 2004). Never published, the Shelmerdine Report (1945) called for all accidents to culminate in a published report and that the UK should "take the lead in devising international arrangements for aircraft accident investigation."

Three years later, the Newton Committee sought to 'embed' the principles of accident investigation being espoused by the newly formed Provisional International Civil Aviation Organization, an interim precursor to the International Civil Aviation Organization (ICAO). The independent status of the accident investigation body was reinforced by the work of this committee.

Seen as "probably the most comprehensive" of the post-war inquiries into accident investigation (Smart, 2004), the Cairns Report, published in 1961 under the Chairmanship of the Honourable Mr Justice Cairns, widened the scope by examining accident procedures in the United States of America, Australia, France and Germany as well as across the transport modes: railway and maritime. Once again, the Cairns Report reiterated the requirement that accident investigation should remain independent and be seen as such by government, industry and society and that there should be more public accountability. The Report also called for the removal of the question that "is always put to the commissioner of a public inquiry", "Was the accident due to or contributed to by the wrongful act or default of any party?" (Flight International, 1962), thus strengthening the philosophy of non-judgement.

The Accidents Investigation Branch has remained resident within the Department of Transport in its various nomenclatures and in 1987 changed its name to the Air Accidents Investigation Branch as it remains known today.

From its early days as part of the Royal Flying Corps, the AAIB has maintained a close alliance with the UK military (in particular the RAF and MoD) and is still on hand to provide assistance to the military as requested.

Despite its colocation with the UK civil aviation regulatory body (the Civil Aviation Authority) in terms of government departmental oversight, the AAIB has assiduously maintained its function independent from that of the regulator. Within the UK aviation community, it would now be inapprehensible to combine accident investigation with regulatory oversight as the much lauded independence of the first would be seen to be compromised by the second.

Other industries, however, have not necessarily developed along similar tenets. For many years both the rail and the marine industries in the UK have had such functions inextricably linked and it is only in the last couple of decades that the benefits of separating the functions have been fully acknowledged.

2.2.2 Marine

Historically accident investigations were first found in the maritime industry in the second half of the 19th century in many of the seagoing trade nations (Stoop, 2003a). At this time investigations formed part of the judicial system, enabling disciplinary action for erring captains and officers in order to protect crew, passengers and cargo. Despite its long and illustrious history, objective and independent marine accident investigation was only recently established. Not unlike the rail industry, the driver was not international foresight but a reactive response to a high profile accident, at a time of decreased public forbearance.

Thus the judicial system prevailed until in his report on the Inquiry into the capsizing of the M/S Herald of Free Enterprise roll-on roll-off passenger car ferry in 1987, Lord Justice Sheen commented that “The responsibilities of the Department [of Transport] for matters of safety of life at sea are very wide. After a casualty has occurred there is natural instinct on the part of ship-owners to adopt the attitude that they had not taken certain precautions because the Department had not made Rules which required those precautions. From that defensive position there can easily develop what appears to the public, probably erroneously, to be a cover-up. In every Formal Investigation it is of great importance that members of the public should feel confident that a searching investigation has been held, that nothing has been swept under the carpet and that no punches have been pulled.” (Sheen, 1987)

The formation of a separate independent accident investigation branch was thought to go some way to assuaging the public’s fear and in July 1989, the UK marine industry saw the establishment of an independent Marine Accident Investigation Branch established under Section 33 of the Merchant Shipping Act 1988 and operated under The Merchant Shipping (Accident Investigation) Regulations 1989.

Prior to that the function of accident investigation formed part of the remit of the Marine Office Surveyors who came under the Surveyor General's Organisation, reporting through to the Secretary of State for Transport via the Marine Directorate. The Marine Directorate had previously moved under the Marine and Shipping section from the Department of Trade and Industry to the Department of Transport in 1983. The Surveyor General's Organisation went on to become the Marine Safety Agency and most recently, in 1998, joined with the Coastguard Agency to form the Maritime and Coastguard Agency, remaining responsible for the regulatory aspects of the marine industry and implementing the UK government's maritime safety policy.

The casualty investigation section of the Surveyor General's Organisation appears not to have had a direct remit to conduct investigations itself, but to ensure that casualties to UK registered ships anywhere in the world and casualties to any ship within UK territorial waters were properly investigated. The principal purpose of the section was to gather information pertaining to the accident, analyse the reports with respect to previous events and pass on suitable recommendations to another part of the Organisation.

Surveyors could undertake desk audits or would be appointed as an Inspector under the Merchant Shipping Act to conduct a preliminary investigation if the situation was felt to warrant it. Suitably qualified people, usually from the Marine Office, would be sought to carry out investigation. The primary purpose of the casualty investigation was "to learn lessons for the future and not to apportion blame. If, however, breaches of regulations or unacceptable conduct were uncovered then a parallel investigation would ensue with a view to court proceedings." (Scully, 2000)

Within weeks of establishment, the MAIB found their complement of five Inspectors fully occupied with the investigation into the collision of the Marchioness and the Bowbelle on the River Thames which claimed 51 lives. Their first investigation and report proved to be contentious: a public grown accustomed to formal inquiries were incensed to find that a 'private' investigation was being conducted with no opportunity to test the evidence by 'adversarial' means before the writing of the report. The MAIB were accused of being "an anomalous body" (Hughes, 1993) and "not awfully well regarded" (Spearing, 1993) and the report was criticized as being "shot through with opinions" (Christian, cited in Hartley, 2001).

There had been resistance to holding a public inquiry into the Marchioness accident as it was felt that it would undermine the credibility of the MAIB's investigation: after all, the MAIB had in part been set up to avoid the need for expensive and time consuming public inquiries. But such was the strength of public opinion, however, the government were obliged to reconsider their position and subsequently instigated a formal investigation under Lord Justice Clarke.

In the intervening years, a number of private inquiries had been held including the report into the Enquiry into River Safety, conducted by John Hayes in July 1992 and the Thames Safety Inquiry, a precursor to the Formal Investigation, under the guidance of Lord Justice Clarke.

During the first two years of operation, the MAIB relied quite heavily upon the expertise and experience of the Marine Office Surveyors. The Surveyors were used as Inspectors when necessary and Inspectors were encouraged to spend time on secondment with the Surveyor General's Organisation. The transition from oversight to independent investigation was, therefore, not immediate: the formal inquiry into the Marchioness and the Bowbelle in 2001 noted that, in its recommendations, the MAIB had advised against the prosecution of one of the individuals involved in the collision, indicating that it had considered disciplinary action to be part of its remit.

Eventually it was, however, acknowledged that the dual function of regulator and investigator was untenable. The Hayes Report recommended that care should be exercised with the use of members of the Surveyor General's Organisation to "… maintain public confidence and avoid any possible criticisms" (MAIB, 1992). This was reiterated by Lord Justice Clarke who was critical of the perceived "close relationship" between the Department of Transport and the MAIB. His report called for clear lines of demarcation to promote public confidence in the independence of the MAIB as an investigative body.

Since its formation, the MAIB has grown in reputation, budget and numbers. Recently there have been changes to the grading structure of MAIB Inspectors to give them parity with their counterparts in the Air and Rail Branches. It is now seen as being a highly regarded independent organization, with a rightful place on the international stage.

2.2.3 Rail

At the start of this research study, the Rail Accident Investigation Branch was at its inception. A Chief Inspector had been appointed and an interim project team was brought together to design and set up a new independent accident investigation unit. Whereas the other two Branches had evolved over time with industry changes and technological advances, the RAIB were establishing themselves in full view of not only industry but also politicians and the travelling public.

Prior to October 2005, the investigation of railway accidents was undertaken by Her Majesty's Railway Inspectorate (HMRI) which in 1990 had transferred from the Department of Transport to the Health and Safety Executive to become the operational division with responsibility for health and safety on the railways. At this time, HMRI's responsibilities were threefold: technical; legal (prosecutory) and advisory. In addition to the investigation of accidents, HMRI was also

responsible for safety regulation of the rail industry – approving railway safety cases, allowing train companies to operate as well as providing technical expertise to the industry. Not unlike the marine industry, the HMRI had a combined function of investigation and regulation within one corporate body and latterly, there was "… an increasing tendency of the railway inspectorate to seek prosecution following accidents" (Watson, 2004).

Two major accidents at Southall in 1997 and Ladbroke Grove two years later, highlighted the inadequacies of the system post privatization and combined with an overwhelming support from industry for separated investigation from regulation (Hall, 2001), proved a catalyst for the initiation of the RAIB.

At 13:15 on 19th September 1997, nine miles west of Paddington, a side-on collision occurred involving Great Western Trains 10:32 Swansea to Paddington High Speed Train and a freight train operated by English Welsh and Scottish Railways (EWS). Seven people died as a result of the collision and a further 139 were injured. It was the first major rail accident to occur in Britain since the start of privatization of the railways in 1994.

Professor John Uff QC was asked to Chair an enquiry into the accident. As a result of the lengthy study, prosecutions were brought against the Great Western Trains driver and also against the train operating company, Great Western Trains for corporate manslaughter. The driver was found to have passed signal SN254 at danger: an action known colloquially as a SPAD.

Uff's report pointed to a number of areas for improvement, one aspect of which, included in recommendation number 81, was consideration be given to whether an additional independent accident investigation body should be created, to take over the accident investigation functions of HMRI. The increasing tendency of the regulator to seek prosecutions was felt to have a negative effect on the industry's motivation for self reporting of issues and would more likely drive a blame culture, where each part of the fragmented structure denied culpability. This was exemplified by "… a general recourse to lawyers" (Uff, 2000).

Uff also commented upon the perceived "… duplication and protraction of the technical investigation": where multiple enquiries were found to be wasteful in terms of time and money; where important information may have been overlooked.

In his opinion, the instigation of a new accident body would ensure that "… a single, thorough and definitive technical investigation is carried out." (Uff, 2000).

Whereas the Uff report only intimated that an additional investigative body would be beneficial, Lord Cullen's report into the subsequent accident at Ladbroke Grove two years later made the point more vociferously. In total, 9 of his 74 recommendations made direct reference to an independent rail accident investigation organization.

At 08:09 on 5th October 1999, a head-on collision occurred between the 08:06 Paddington to Bedwyn Thames Train Turbo and the 06:03 Cheltenham to Paddington First Great Western High Speed Train at Ladbroke Grove junction. Thirty one people died as a result of the crash with a further 227 admitted to hospital as a result of sustained injuries.

A subsequent enquiry by Cullen highlighted several anomalies with regards to organizational and regulatory issues. His report was divided into two parts: the first concerning itself with the description of events at Ladbroke Grove; and the second, which took "… a much wider look at the industry post-privatization" (Watson, 2004).

Independent investigating of rail accidents formed the "… centerpiece of Lord Cullen's reforms of railway safety" (Haigh, 2001). The two objectives of independence and control were considered to be incompatible. Criticisms were raised regarding the arrangements with regards to the responsibility for accident investigation being discharged by the regulator. "It is inappropriate for the safety regulator to carry out the function of investigation since it might be necessary for the investigator to examine the decisions and activities of the safety regulator itself." (Cullen, 2001).

After a period of consultation with industry, the Rail Accident Investigation Branch was established by the Railways and Transport Safety Act 2003 which in turn empowered the Secretary of State for Transport to make detailed provisions in the Railways (Accident Investigation and Reporting) Regulations 2005. The RAIB became operational under these regulations and are now responsible for the investigation of accidents and incidents on the UK's national mainline railway networks, the Channel Tunnel (in cooperation with the Bureau d'Enquêtes et d'Analyses in France) and the London and Glasgow underground systems, Midland Metro and other metro systems as well as tramways, heritage railways and cable hauled systems of 1km or longer.

Formation of the RAIB "… strips from Her Majesty's Railway Inspectorate its 161 year tradition of accident investigation which, although not one of the roles for which it was created, was one it took on from the beginning" (Haigh, 2001).

Not everyone was as convinced of its benefits outweighing its costs. With major accidents being rare, Haigh (2001) expressed concern that the RAIB would not be able to maintain the skills required for the role and indeed Hall (2001) went further: "Noone who proposes a separate Accident Investigation Unit has yet suggested how it will fill its time between accidents sufficiently severe to warrant its attention. Even when there were plenty of accidents and a dozen public inquiries a year, a couple of Inspecting Officers and couple of clerks sufficed. The danger then is that they will dabble in minor accidents which ought properly to be left to the industry." He saw the remit of the RAIB focused solely upon the more serious accidents and proposed that there might not be a great deal for

them to do, with an allusion to the devil finding work for idle hands. This has proven to be far from reality.

2.3 Multimodal or Unimodal? – the variation in structure of accident investigation organizations

The three UK Accident Investigation Branches operate as separate entities, each responsible for the investigation of accidents within their distinct mode: air, marine and rail. Other nations have adopted a multimodal approach including the US National Transportation Safety Board, the Transport Safety Board of Canada, the Australian Transportation Safety Bureau, the Transport Accident Investigation Commission of New Zealand and the Statens Haverikommission of Sweden. These organizations cover a multiplicity of modes although typically, investigators will remain mode specific in their investigations – for example, those with aviation experience will find themselves investigating aviation accidents and so forth.

The exceptions to this are to be found at organizations such as the Dutch Safety Board (DSB). In 2005, the Dutch Transport Safety Board transformed itself from an organization responsible for five sectors or modes "… each working with their own investigators, with respective domain expertise" (Koning and Peters, 2006) to the Dutch Safety Board complete with expanded remit. The DSB now found itself responsible for the investigation of ten sectors (rail, shipping, aviation, road transport, industry, pipelines and energy net, construction and services, defence, healthcare, water (environment) and crisis control) and, constrained by funding and resource, utilized the skills of the existing investigators in unfamiliar domains supported by newly hired generalists (Koning and Peters, 2006). The Netherlands, along with Sweden and Finland, are the only independent accident investigation bodies to have legal authority outside the transportation sector (Stoop, 2004).

The main advantage cited for the multimodal approach is that the basic methodology used in an investigation can be the same across all modes. The European Transport Safety Council (2001) also posit that "… certain investigative tools can best be utilized across all modes", including data recording facilities, forensic studies and human factors specialization. They also cite practical advantages in "… sharing the administrative load, investigator training, public relations and legal issues." Stoop (2004) refers to this as "synergistic cooperation" which leads to "… harmonization of investigative methodologies" and it is his view that there will be a trend towards multimodal boards in the future.

Koning and Peters (2006) commend the use of a common methodology, strategy and goals as well as shared uses but advise that multimodal boards need clearly defined tasks and accountabilities, taking into account multiple EC directives and "supra-national established resolutions", for example those of the

International Civil Aviation Organization and International Maritime Organization. Stoop (2004) also warns against the potential loss of in-depth modal expertise and credibility.

In the UK, there have been appeals for the Government to give thought to establishing a multimodal board. In 1999, the Parliamentary Advisory Council on Transport Safety (PACTS) called for a new national safety body, responsible for all modes of public transport which would bring the existing accident investigation branches together along with commercial road operations. It was felt that the new organization would "… encourage the sharing of experience and best practice across the modes". It recognized, however, that "each of the modes is likely to argue that, while change might be beneficial, that that specific mode should be left alone." (PACTS, 1999).

2.4 The international perspective

The transport industry, by its very nature, is a global enterprise. And yet, it is only in the last two decades that independent accident investigation has begun to be considered on more than a national basis. The one exception has been aviation.

In 1944, 54 States accepted an invitation by the United States government to attend an International Civil Aviation Conference in Chicago. Research in the US and abroad had shown that the economic advantages offered by aviation could only be realized with the establishment of standards and regulations worldwide (Smart, 2004). It was no longer a national concern.

The conference in Chicago culminated in the signing of the Convention on International Civil Aviation (most often referred to as The Chicago Convention) and the establishment of the International Civil Aviation Organization (ICAO) with the aim of achieving the desired harmony of services and standards throughout the industry and across the world. Article 26 of the Convention spelt out the responsibilities of States in the event of an accident to an aircraft. The State of occurrence is required to "… institute an inquiry into the circumstances of the accident, in accordance, so far as its laws permit, with the procedure which may be recommended by the International Civil Aviation Organization" (ICAO, 1944). As annexes to the Convention, 18 Standards and Recommended Practices were laid down, of which Annex 13 set out the guidelines and responsibilities for aircraft accident and incident investigation. Subsequent iterations have refined the document but its original intent, to provide structure, standardization and international cooperation in air accident investigation remains. It was here that the Member States were required to investigate accidents with the "sole objective" being "the prevention of accidents and incidents", and not "to apportion blame or liability" (ICAO, 2001). These phrases have found their way into common usage and are contained in many of the regulations.

On the marine side, the International Maritime Organization was established by Convention in Geneva in 1948 to develop and maintain a comprehensive regulatory framework for shipping. The first maritime treaties date back to the 19th Century with the first international convention (SOLAS – safety of life at sea) being initiated by the Titanic disaster in 1912. A United Nations specialized agency, the IMO is responsible for improving maritime safety and preventing pollution from ships. Its objectives are summarized thus: "… safe, secure and efficient shipping on clean oceans" and its remit today includes safety, environmental concerns, legal matters, technical cooperation, maritime security and the efficiency of shipping (IMO, 2007).

As yet, no agency exists to overarch the railways on an international basis. This is most likely due to the historical development of the railways on a national basis, contained within boundaries. With greater cross-boundary function comes the need for greater international cooperation so it is not unlikely that the railway industry will eventually follow suit.

International legislation within each mode provides a framework to promote assurances of standardization in independent accident investigation at the highest level but given the rapidly changing transport environment (ETSC, 2001) global intermodal cooperation is required to build on the successes gained at a national or European level. Organizations such as the International Transportation Safety Agency (ITSA) have been founded to strengthen this resolve.

ITSA was created by the investigation boards of the United States, Canada, Sweden and the Netherlands in 1993 with the mission to "… improve transport safety in each member country by learning from the experiences of others". Its aim was to bring together independent investigations in all modes of transport from around the world. The organization has a multimodal focus but membership is not denied single modality agencies, with caveats. The UK's membership is based on the Board of Chief Inspectors which overarches the individual Accident Investigation Branches. Whilst the organization has no legal power, it is nonetheless a powerful association for mutual learning, suasion and support. (ITSA, 2007).

2.5 Europe

Within Europe there has been an increasing desire to unify and strengthen accident investigations across the modes, supported by the international framework as described above.

In 2001, the European Transport Safety Council, an international non-government organization which advises on transport safety matters to the European Commission and the European Parliament, published a document outlining the situation in Europe with regards to independent accident investigation in the transport industry.

The report highlighted that "… a key issue in any accident investigation is the status and impartiality of the body carrying out the inquiry. Any organization with an actual, or perceived, vested interest in the result is rarely able to act with total impartiality."

It spelled out the need for the European Union to mandate that organizations undertaking transport accident investigations are totally independent of the regulator. Such a situation had already been achieved in aviation under Council Directive (94/56/EC) which mainly reflected the rules set out in the international regulations of Annex 13 of ICAO's Chicago Convention on Civil Aviation.

Using the progress made within the aviation industry as a yardstick, the ETSC document called for similar measures to be put in place of the rail and marine industries in order that there might be comparable standards of accident investigation across the modes. The argument was taken up in the subsequent White Paper published in 2001 by the Office for Official Publications of the European Communities which set out intentions for a European transport policy for the next decade.

The paper highlighted once again the need for separation between investigation body and regulator. "The chief concern in investigations conducted by the authorities or by insurance companies is to compensate for any damage caused by the accident and to determine liability under the codes established by the legislator. However, such investigations are geared towards revealing the causes of accidents and ways of improving the law." Prior to the paper's publication, the case for independent investigations had been moved forward with the introduction of Council Directive (2004/49/EC) which requires Member States to establish independent rail accident investigation bodies. Similar obligations were in preparation for the marine industry under a proposal for a directive establishing the fundamental principles governing the investigation of accidents in the maritime transport sector and amending Directives 1999/35/EC and 2002/59/EC COM/2005/0590 final of 23/11/2005.

As a consequence of the Commission's White Paper, it was decided in June 2003 to create a "… group of Experts to advise the Commission on dealing with accidents in the transport sector" (Commission Decision EC/425/2003). In their final report (European Communities, 2006), the Group of Experts make specific recommendations for each mode (including road and pipeline) regarding continued and increased coordination within and between the modes on a European basis. Of great import for successful investigation of transport accidents and incidents, they propose, is a common European methodology for investigation, designed "… to produce a harmonized and consistent approach to safety investigation of transport accidents and incidents within the European Union" (European Communities, 2006).

Given "… increased concerns about transport safety", the EU has "… stepped up its determination to improve mobility safety" by the creation of a number of

independent EU agencies, set up under European law (European Communities, 2007).

The European Maritime Safety Agency was created in the aftermath of the Erika oil pollution disaster in 1999. It became operational in 2002 and aims to "… contribute to the enhancement of the overall maritime safety system in the European Community"; to reduce the risk of maritime accidents, marine pollution from ships and the loss of human lives at sea. A specialized expert body, EMSA is able to provide technical and scientific support to the Community and the Commission as well as working to improve cooperation within and between the Member States.

The aviation equivalent, the European Aviation Safety Agency, is "… the centerpiece of the European Union's strategy for aviation safety", aimed at promoting the "… highest common standards of safety". Working closely with ICAO and other aviation organizations across the world, EASA has developed common safety and environmental standards at the European level which it monitors through inspection. Its remit is growing as it draws back to a centralized function many of the activities that would have been carried out at a national regulatory level. (EASA, 2007).

The aviation industry in Europe is also working towards a European standard for accident reporting through the European Coordination Centre for Accident and Incident Reporting Systems (ECCAIRS), part of the European Commission Joint Research Centre. Their aim is for safety information from investigations to be collected, analysed and ultimately shared, in order to improved public transport safety. This work presupposes a common understanding of the underlying taxonomy, strongly reinforcing the need for standardized methodologies and investigation techniques.

2004 marked the inception of a new EU body responsible for improving the safety and interoperability of Europe's railway networks – the European Railway Agency. The ERA seeks to bring 'synergy' to the 25 Member States with what it perceives as disparate regulations and policies, contributing to "… creating an integrated railway that is competitive and guarantees a high level of safety." (ERA, 2007).

Whilst the ERA does not have regulatory powers, it submits opinions and recommendations to the European Commission which, in accordance with the Safety and Interoperability Directives, transforms them into decisions applicable to the Member States of the European Union.

There have been calls for European cooperation to be extended further with the establishment of a multinational single mode board, initially within the aviation community along the lines of the Air Transport Accident Investigation Committee which is a sub-committee of the Commonwealth of Independent States: comprising twelve member states of the former Soviet Union. Whilst the

intention is far sighted, it is thought unlikely that the individual states in Europe would accede autonomy.

2.6 Intramodal community

In addition to the agencies set up by statute on a national, European and international level, two further organizations exist to further support global accident investigation.

The International Society of Air Safety Investigators (ISASI) was established in 1964 to promote air safety by the exchange of ideas, experiences and information regarding aircraft accident investigations. Its objectives include: promoting technical advancement through professional education; the exchange of information for mutual development of improved investigations; to broaden professional relationships among members; and to maintain and increase the prestige, standing and influence of Air Safety Investigators in matters of air safety. (ISASI, 2007)

Similarly, within the marine industry, the Marine Accident Investigators International Forum (MAIIF) was established in 1992 and exists to foster, develop and sustain a cooperative relationship among national marine investigators for the purpose of improving and sharing the knowledge in an international forum; to improve maritime safety and the prevention of pollution through the dissemination of information gained in the investigative process; and to encourage through cooperation the development, recognition, implementation and improvement of related international instruments, where appropriate (MAIIF, 2007a).

An alternative association, the newly launched Maritime Casualty Investigation Association (MCIA), aims to “maintain, enhance and promote professionalism in maritime and offshore casualty investigation in the public and private sectors” as a means of enhancing safety and risk reduction.

Of particular interest to the researcher are the objectives of encouraging “the study of theoretical and practical aspects of investigation methodologies and practices” to develop “code-compliant templates and ontologies” referring to the IMO Casualty Code and the development and acceptance of “a unified matrix of desired competencies for maritime casualty investigation.”

As yet, there appears to be no unifying international professional group for the railway industry although conferences such as the International Rail Accident Investigation Conference hosted by the Institution of Mechanical Engineers in 2007 would suggest that collaboration is welcomed.

2.7 The accident investigation process

Within the UK, notification of an accident to one of the three Branches will result in a decision as to whether an investigation will ensue. This decision ultimately resides with the Chief Investigator although under the definition of what constitutes an accident, there will be an understanding of what is an investigatable occurrence.

The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996 define an accident in terms of fatalities and serious injuries, where the aircraft sustains significant damage or structural failure or where the aircraft is missing or completely inaccessible.

The Merchant Shipping (Accident Reporting and Investigation) Regulations 2005 similarly use the term accident to mean any occurrence on board a ship or involving a ship where there is loss of life or major injury, or significant damage to the ship, its equipment or the environment.

Lastly, The Railways (Accident Investigation and Reporting) Regulations 2005 define a serious accident as one that involves a derailment or collision of rolling stock which has an obvious impact on railway safety regulation or management of safety and results in the death of at least one person, serious injuries to five or more persons or extensive damage to rolling stock, the infrastructure or the environment.

The accident investigation process is essentially "the examination, study, searching, tracking, and gathering of factual information that answers questions or solves problems. It is more of an art than a science. Although the person engaged in investigation is a gatherer of facts, he or she must develop hypotheses and draw conclusions based on available information. The investigative process, that is to say, is a comprehensive activity involving information collection, the application of logic and the exercise of sound reasoning." (Sennewald and Tsukayama, 2006).

It is a logical means of answering Stoop's (2003b) five questions:

- What happened?
- How did it happen?
- Why did the accident occur?
- What can be done to prevent a recurrence?
- What can be done to minimize accident consequences?

To provide answers to the questions above, Stoop outlined five distinct phases to accident investigation:

1. Initiation phase – a decision is made as to whether action is warranted.
2. Fact finding phase – can be a reactive event investigation, a retrospective safety study or a proactive safety study.

3. Safety deficiency identification phase – determining systematic threats to transport safety through modelling or using operational experience or a combination of both.
4. Recommendation phase – recommendations should be economically and politically acceptable.
5. Feedback phase - systematic monitoring of recommendations.

Henderson et al (2001) expanded upon this by stating that a successful investigation process should contain the following basic requirements:

- A causal model that represents a system-based approach to accident and incident investigation
- The involvement of relevant individuals within the investigation
- Procedures or protocols to structure and support the investigation
- The identification of both immediate and underlying causes
- The development of recommendations that address both immediate and underlying causes
- The implementation of these recommendations and the updating of relevant risk assessments
- Follow-up to ensure that actions taken are successful in reducing the risk of further incidents
- Feedback to relevant parties to share immediate learning

Summarizing the accident investigators' tasks, Zotov (2002) suggests "… we first seek to describe the accident, and then answer the questions how and why it happened. Finally, we try to persuade others to take action to avert future accidents".

There appears to be little agreement in the literature as to what constitutes the "best" accident investigation methodology (Benner, 2000). Reinach and Viale (2006) comment that: "Accident/incident investigations must be consistent and thorough to be most effective. Yet they are, by most accounts, part science and part art. Thus, inevitably, some degree of variability exists across investigative methods and results. Variability depends on a number of factors, including the data collection methods and tools that are used (eg Woodcock et al, 2005), the knowledge and experience of the investigators, and the particular accident/incident causation philosophy of the investigator or company."

In his study of seventeen US Federal organizations, Benner (1985) determined 14 different models (the perceived nature of the accident phenomenon) and 17 different methodologies (the system of concepts, principles, and procedures for investigation accidents). Given the diversity of the models and the fact that, in some cases, intermodel conflict was observed, Benner concluded that not all models were valid. What became clear from Benner's study was that there was extensive variability in approach and little consistency in terms of quality of output: the accident report.

Literature regarding accident investigation techniques points to a wide variation of available overarching methodologies, in contrast to specific accident analysis

tools. McCormick and Papadakis (1998) outline seven techniques to aid in "… sorting out the clues".

The *Integrated Method* simultaneously gathers facts and sorts them both to exclude areas of nonconcern and to note areas of high probability.

The *Differential Method* is "… used almost exclusively in air crash disasters". The event is dissected into logical and definable segments, which are assigned to committees whose job it is to gather and document all pertinent facts pertaining to the assigned segment. The findings of each subgroup will be integrated later. This methodology very much allies with the "party process" adopted by the National Transportation Safety Board in the United States. One potential shortfall of this method is that some meaningful material may be discarded or overlooked and lost. This echoes Uff's comments (2000) post the Southall rail accident in 1997 when he alluded to multiple enquiries being duplication and wasteful in terms of time and money, calling instead for a "… single, thorough and definitive technical investigation."

The *Hypothetical Exclusion Method* lists all possible scenarios and these hypotheticals are created and limited by logic, experience and facts. The investigator then tries to exclude scenarios by looking at facts that reduce its likelihood. This method is described as being potentially flawed if assumptions are incorrect or incomplete.

In the *Time Line Method*, all factual data is documented and given a time stamp. The accident is then plotted and reconstructed. Whilst it can be cumbersome, by adding causation chains and discarding meaningless facts, the investigator is left with "… a very straightforward and complete picture of the timely structuring of facts and events that caused or contributed to the accident." It provides an "… emerging line of causation".

With the *Factual Exclusion Method*, McCormick and Papdakis explain that facts are collected sufficient to exclude a system or scenario from being a factor. When such a conclusion can be drawn, effort is then curtailed within that area. A forced version of this method involves a protocol or checklist to ensure no facts are left ungathered. It does not attempt to evaluate the facts gathered, merely to act as an aide memoire in data collection.

But for the existence of a certain event or fact, would the accident have happened anyway? If an affirmative answer is given, the *But For Test Method* suggests that the event or fact may not be a factor in the chain of causation. This method centres firmly on cause as opposed to looking at extraneous contributory factors.

The last method suggested by McCormick and Papdakis is perhaps, in the case of independent non-attributory accident investigation, complete anathema. The *Legal Causation Method* only gives validity to facts with probative value. There

is no room for speculation or opinion with this method – only what can be proven.

Standards such as ICAO's Annex 13 prescribe matter to be reported but not a criteria for measuring the adequacy of data or material. There is little disagreement regarding the need for integrity in the investigation which should be "independent, credible and influential" and "of an indisputable quality" (Stoop, 2003b; Marinho de Bastos, 2004) and not an attempt to squeeze "… known events into the most plausible or convenient deterministic scheme" (Dekker, 2005). There can, however, with the best of intentions be substantive variability in the quality of the output. One explanation is that "… the output is not a given with measurable and immutable characteristics, it is an organic entity: a bundle of more or less reliable facts and propositions which will be changed radically as it moves through the system." (Irving and McKenzie, 1993).

The three UK AIBs follows a similar process: data collection; data analysis and conclusion; report writing; and recommendations. Whilst the step-by-step detail can be seen to differ between the Branches, the journey from accident to report is largely the same; the success of each phase very much dependent upon the comprehensiveness of the preceding one.

Data collection: Investigators will attend the site of the accident and according to their remit will preserve and recover evidence. This can be physical, documentary and electronic and include witness statements.

Data analysis: A plethora of analysis tools are available for use, for example: Why-Because Analysis (Ladkin, 2001); the Transportation Safety Board of Canada's Integrated Safety Investigation Methodology; Blackett's (2005) Combined Accident Analysis Method; and more recently, the Australian Transport Safety Bureau's analysis framework (ATSB, 2008). Anecdotal evidence suggests, however, that formal methods such as those above are used infrequently and inconsistently within accident investigation agencies. It would speculative to suggest that these models do not provide the breadth and flexibility that is required but investigators have a preference for relying on intuition and experience.

Report writing: The report is the key deliverable from an investigation as it represents the quality of the investigation as a whole. It should provide a clear explanation as to what happened and why. Some reports are prescribed in terms of structure (eg ICAO's Annex 13) and offer guidelines as to writing conventions (impartiality, objectivity, clarity, conciseness, consistency, phraseology – ICAO, 2003a) but the quality remains largely dependent upon the skill of the investigator.

Not only does a report have to be well written, to be of benefit to the industry it also needs to be produced in a timely manner. The legislation governing the

investigation of accidents by the UK AIBs states the required timescales for report production subsequent to an accident investigation:

The Merchant Shipping (Accident Reporting and Investigation) Regulations 2005 calls for the report to be "… made publicly available in the shortest time possible".

The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996 requires copies of the reports "… in a form appropriate to the type and seriousness of the accident or incident" to be submitted "… without delay" and to be made public "… in the shortest time possible (and if possible, within 12 months of the date of the accident or serious incident)".

The Railways (Accident Reporting and Investigation) Regulations 2005 reiterate the twelve month timescale requiring a report "… in the shortest time possible and normally not later than twelve months after the date of the occurrence."

Self-imposed targets seek to reduce the time available further. The MAIB Annual Report (2006a) stated that reports of investigations that do not involve other administrations are to be completed and made publicly available within an average of 8 months from the date of accident (reducing to 7 months by 2008-2009). Where the investigation involves another administration of either the flag or coastal state, however, another 2 months is allowed.

Reviewing the time taken to publish accident reports by the UK AIBs, the researcher found wide variations in the mean time and range between the Branches. There appears to be variation in the type of reports produced by each Branch but the researcher has concentrated on reports resulting from an accident investigation as opposed to additional special bulletins.

In 2007, the MAIB produced 25 investigation reports which took between 3 months and 14 months to be published, with an average time of 8.5 months.

The AAIB produced 7 formal reports which ranged between 17 and 33 months to produce with an average of 26.7 months. They also produced 209 bulletins from desk-based investigations and 66 bulletins from field investigations. Timescales for production of these ranged from 2 months to 15 months and 2 months to 23 months respectively. Mean times were 5.2 months and 10.9 months.

Finally, the RAIB produced 47 reports in the same year with a range between 3 months and 16 months and an average of 10.7 months. The reason for including this data was to give an illustration of the variation in time taken to publish accident reports in the UK, raising the question of the value of a report produced in some cases more than two years post-event.

Recommendations: All recommendations are written with a view to future accident prevention or in order to mitigate consequences. They are, however,

written in a political and economic environment and there is no obligation to implement them.

The accident investigation process can be thought of in similar terms to that of 'research'. Initially there is a problem to be resolved: why did the accident occur and what can be done to reduce the likelihood of recurrence? There is then a data collection phase followed by the formulation of a hypothesis. That, of course, presupposes an inductive process. The converse, the hypothetico-deductive approach, would structure the data collection from the basis of a hypothesis. There are obviously strengths and weaknesses with both approaches. Induction does not start with a preconception and is therefore heavily reliant on the quality of data to form an accurate picture of events. There are, however, no limits set on the breadth or depth of data to analyse and collate save by legal framework and resource. How much of that data will be extraneous? Will the valuable facts be lost in the superfluity? Hypothetico-deduction, on the other hand, provides a more logical and structured approach to data analysis. The hypothesis will dictate the data collected which will serve to either support or refute the argument. There is a danger, however, that over zealous attachment to the hypothesis may lead to a manipulation of the data to fit or the exclusion of additional information that may or may not lend weight to the argument or provide an interesting corollary.

Either way, the process should follow a logical structure so that its validity can be assessed. To be of value in either the scientific or applied arena, the process should comply with the following tenets which Sekaran (2003) refers to as the Eight Hallmarks of Science: purposiveness; rigour; testability; replicability; precision and confidence; objectivity; generalizability and parsimony.

To demonstrate purposiveness, research is required to have an aim, generally one where a problem is solved. Rigour refers to having a sound, logical methodological design. The project aim must be able to be tested and in principle, the research should be able to be repeated by others. Precision and confidence are shown through the results closely resembling that which is being studied with objective conclusions being based upon facts "stripped of personal values and biases" (Sekaran, 2003). A 'regulative ideal', the more a piece of research can be generalized to other situations, the better and finally, parsimony refers to an 'economy of explanation' where something small but meaningful is described as opposed to something vast and complex (and often shallow).

Accident investigation is not thought of as an exact science. Its measure of success derives not from some "generally accepted decision rules" leading to "reproducible outputs" (Benner, 1980) but is largely dependent upon the philosophy, model and methodology adopted by those undertaking the investigation. As such, it falls short of many of the tenets of scientific rigour or Hallmarks of Science.

There is no agreement as to which methodology is 'best' where best alludes to the most robust, effective manner for pursuit of the absolute (or not so absolute) truth. What can be asserted is that the validity of the process and subsequent conclusions could be strengthened considerably by the adoption of a quality control mechanism which will be discussed further in subsequent chapters of the thesis.

2.8 The role of the accident investigator

At the heart of the global legal framework upon which transportation accident investigation is built, lies the accident investigator. It is axiomatic to state that the success of the overall investigation is very much dependent upon the skills and abilities of the investigator (Marriott, 1996); each phase of the investigation requiring a wide array of skills and knowledge.

"When they reach an accident scene, which can be in just about any type of environment, they may be faced with dead or dying people, pathogens, toxic materials, and other physical hazards. They may also have to deal with jurisdictional disputes, intense media scrutiny, and concerned family members. In the midst of all this, they must act as managers, technologists and investigators in order to collect and assess evidence to support subsequent efforts to identify the cause of the accident." (Sarsfield et al, 2002).

"What is a typical air crash investigator like? There is, of course, no such bird. But they share numerous attitudes and characteristics" (Barlay, 1969). "What is clear is that good investigators do not come about by chance or simply the ownership of a fluorescent jacket." (Braithwaite, 2002).

Just as no two accidents are ever truly the same, so it is with investigators. Differing backgrounds, experience, skills, interests and personalities are brought to bear and yet, as with accidents, scratch below the surface and there are similarities to be found.

As identified in the Introduction to this thesis, a review of current academic literature regarding accident investigators provides little insight into the qualities and attributes specific to the role. A wealth of material exists about accidents and accident investigation; the majority of texts on the subject include a detailed breakdown and analysis of events with varying degrees of conjecture. These do not, however, cast much light on the skills and behaviours of those undertaking the task (Tench, 1985; Owen 1998).

The International Civil Aviation Organization's Training Guidelines for Aircraft Accident Investigators (2003b) states that: "Aircraft accident investigation is a specialized task which should only be undertaken by qualified investigators". Mode not withstanding, ICAO's Manual of Aircraft Accident and Incident Investigation: Part 1 Organization and Planning (2000) elaborates further: "In addition to technical skills, an accident investigator requires certain personal

attributes. These include integrity and impartiality in the recording of facts, logic and perseverance in pursuing inquiries, often under difficult or trying conditions and tact in dealing with a wide range of people who have been involved in the traumatic experience of an aircraft accident" (ICAO, 2000). What the guidelines stop short of specifying is what qualifications an investigator should possess.

This was echoed in a paper published by Taylor (1996) in Forum, the Journal of International Society of Air Safety Investigators, where he comprehensively described the ideal air accident investigator as being "… qualified, trained, experienced, knowledgeable, observant, inquisitive, dedicated, diligent, open minded, independent, impartial, objective, persistent, patient, logical yet capable of lateral thinking, literate, diplomatic, fit, tireless, stable, level headed and much more. He or she should have humility, integrity, a good and ready sense of humour and be able to maintain good working relationships with all other parties involved" (Taylor, 1996).

Wood and Sweginnis (1995) were more concise in their summation: "All good investigators share at least three attributes: They are not afraid to be wrong. They will accept facts that are contrary to their present theory. They readily admit that they don't know everything. When they need help, they seek help. They listen to the other investigators. They don't necessarily believe them, but they listen to them. Those are pretty good traits to acquire."

The International Society of Air Safety Investigators states in its adopted positions on air safety investigation issues (ISASI, 2003) that "… it is desirable that investigators possess the following qualities: an inquisitive nature, dedication, diligence, patience and objectivity, technical skill, perseverance, logic, tact and understanding". It continues that they should have as a foundation upon which to develop their skills, "… flight crew, cabin crew or aeronautical engineering qualifications".

The Marine Accident Investigators International Forum (MAIIF) points to accident investigation being a highly specialized task which should **ideally** (emphasis in original) only be undertaken by highly trained personnel possessing many qualities, following very closely those ascribed by ISASI, "… not the least important of which are an inquisitive nature, dedication to this kind of work, diligence and patience. Technical skill, perseverance and logic are the tools of the profession; humility, integrity, and respect for human dignity his guiding rules." (MAIIF, 2007b).

"One of the most important factors in establishing trust in the investigation process is that of the professional qualities of the individual inspectors" (Smart, 2004). He continues " … it is a relatively straightforward process to establish a candidate's professional qualifications and experience. Far more difficult is to get an assessment of a candidate's personal qualities."

Extending the literature search still further, the role of investigator can be found in other fields within the UK, such as the Health and Safety Executive (HSE) or

as road traffic accident investigators - both independent and police. The fundamental difference between these investigators and the AIB Inspectors is their independent remit. The HSE have a regulatory, inspection and enforcement mandate; police road traffic accident investigators will be working towards building a case for prosecution; and 'independent' investigators are usually working on behalf of an individual or organization which might influence or bias the findings. As well as this level independence, there are often differences in terms of level of education, training and technical expertise, with AIB Inspectors having an increased amount of each. The skills for collecting and analyzing evidence and formulating hypotheses based on findings are not, however, dissimilar.

In the UK police force. Smith and Flanagan (2000) identified 22 core skills in their study of Senior Investigating Officers, which they organized in three clusters: investigative ability; knowledge levels; and management skills.

Smith and Flanagan (2000) quoted a detective sergeant involved in the study, "Some of the 'skills' of the best investigators are inherent in the individual". Interviewees used terms like passion, commitment, dedication, charisma. Also tenacity, attention to detail, patience, enthusiasm, being a 'people' person, sympathy, honesty and an appropriate sense of humour. The more 'effective' Senior Investigating Officers were identified as those that were naturally gifted with many of these personal characteristics.

Similarities to the role of accident investigator can also be found in those of a scientist or researcher which require data gathering and analysis skills, communication skills (written, oral and interpersonal) as well as management skills (leadership and project management skills) (FHCRC, 2009).

The three clusters identified in the Smith and Flanagan study (2000) are comparable to the delineation made in the RAND study at the National Transportation Safety Board in the United States (Sarsfield et al, 2000).

Sarsfield et al (2000) determined three skill sets required by accident investigators:

- basic investigation skills – to understand the application of the appropriate methodology and the requisite steps to successful investigation output;
- management skills – both in the coordination of an investigation team or process and the day-to-day administrative tasks;
- technical skills – domain and industry expertise and experience.

Of these three, the last skill – technical – is seen as the least static. Indeed, Sarsfield et al (2000) described it as "perishable", by which they suggested that with the advances in technology and the changes to system designs, knowledge may have a 'shelf life' and require continual updating to ensure relevance and maintain currency.

They also concluded that the skill set required for investigations would vary unpredictably from accident to accident and often demand reactive self education, particularly when the aircraft type was unknown or unfamiliar. Given the relative stability of the investigation and management skill sets, it is postulated that these will provide a firm grounding upon which the less irregular technical skills could be based.

Robinson et al (2005) conducted a study to determine requisite skills and abilities in aerospace design engineers, both for the current role and for the future. Their findings illustrated the organization's need to balance cognitive and personal attributes with technical expertise in their engineers but that it was anticipated that non-technical skills would become increasingly important to the success of the organization. Aptitude for learning and intellectual capacity were found to be more relevant than crystallized intelligence or technical knowledge.

In his description of the responsibilities of expert witnesses (a duty which many accident investigators are called on to perform), Pamplin (2000) might have been describing accident investigators in general when he stated that their responsibilities or duties are "… to be truthful as to fact, thorough in technical reasoning, honest as to opinion and complete in coverage of relevant matters".

Pamplin went on to state that the desired qualities are:

- A sound knowledge of the subject matter
- The powers of analytical reasoning
- The ability to communicate findings and opinions clearly and concisely
- The flexibility of mind to modify opinions in the light of fresh evidence or counter-arguments
- The ability to 'think on one's feet'
- A demeanour that is likely to inspire confidence.

"There are few roles as specialised or as skilled as accident investigation that do not carry a specific professional qualification or accreditation." (Braithwaite, 2002). Within the aviation industry the AAIB Inspectors are held in high esteem, and doubtless the same could be said for the MAIB Inspectors. This is due to a long history where credibility grows out of a combination of thorough investigations, impartiality and integrity. The RAIB faced an immediate challenge when it formed in that it did not have the same longevity and credibility to bolster its reputation and as such, does not assume such 'unassailability', particularly when facing a legal assault.

AIB Inspectors appear in court as expert witnesses – or at the very least, in the case of the RAIB, as witnesses of fact. Whilst they may have qualifications or licences as pilots, masters or engineers, there has been no specific recognized qualification for the position of accident investigator nor system of accreditation until recently.

Membership of a professional organization such as the International Society of Air Safety Investigators (ISASI) or the Marine Accident Investigators'

International Forum (MAIIF) is not a sufficient indicator of expertise. To become a Member of ISASI requires an individual to be "An Air Safety Investigator who is, or has been actively engaged in the investigation of aircraft accidents or incidents or conducted accident prevention activities designed to identify, eliminate or control aviation hazards before they result in accidents or incidents, including representatives from aircraft manufacturers, air carriers, the military, other government agencies, and members of aviation professional groups." (ISASI, 2007). This position should have been held for not less than five years and any applicant must have participated in at least ten aircraft accident investigations. It does not specify what types of accident investigations qualify (large scale, minor, desk based) nor does it define what an individual's role or responsibility should have been within that accident investigation. Braithwaite (2004) questions whether this defines a level of competence or simply suggests a level of commensurate experience.

MAIIF membership is not as prescriptive and is offered to any individual appointed as a marine accident investigator or any person employed in the process of marine accident investigation.

The question remains as to what part, if any, professional bodies such as ISASI or MAIIF should play in ensuring the competence of its membership. Should inclusion within such a group ascribe inferred capabilities and if so, how can these be measured? Could the experience requirement be better supported with levels of continuing professional development as a means of endorsing the 'expertise' of the investigators?

The newly launched MCIA state one of their objectives to be "to develop and encourage the acceptance of a unified matrix of desired competencies for maritime casualty investigation." Links to an external maritime training provider indicate that these competencies can be measured and appraised through the use of a competency assurance system (IDESS, 2009). Further evaluation of their literature suggests, however, that the terms competence and competency have been conflated as the fundamental units of measurement are competence – the ability to perform specific tasks to a specific standard.

Acknowledging the lack of recognized qualifications available in accident investigation, a number of organizations have sought to provide a solution. In 2002, the Australian Transport Safety Bureau became nationally accredited as a Registered Training Organisation enabling them to formalize their "… minimum operational training requirement' for investigators in a Diploma of Transport Safety Investigation, based upon a vocational training model. There is an expectation that trainees will dedicate approximately 700 hours to the qualification which includes core based training to complement and supplement any shortfalls in prior knowledge or competences, as well as on-the-job training and experience. The Diploma has been successfully implemented and has received international approval. (ATSB, 2002).

Continuing Education Units or equivalents can be earned by individuals who participate in approved training activities, research and development or approved programmes such as the accident investigation courses offered by, amongst others, the National Transportation Safety Board or the Southern California Safety Institute. Such credits contribute to continuing professional development.

In the UK, Cranfield University now offers a part-time MSc in Safety and Accident Investigation (Air Transport) for which credits can be accrued by attendance on their six week Aircraft Accident Investigation course. In addition, there are shorter Postgraduate Certificates and Postgraduate Diplomas offered for those seeking a formal postgraduate qualification in the field.

Two of the AIBs have actively pursued accreditation as a means whereby certification of "… competency, authority or credibility" is presented. This accreditation, however, is approached from differing perspectives based upon the requirements of the Branches.

The MAIB have focused on demonstrating competence through internal accreditation. Their accident investigation accreditation scheme (Professional Standards of Competence in Accident Investigation), implemented in January 2007 (MAIB, 2007b), measures competence of its Inspectors against a framework associated with the major activities in which they are involved. The researcher assisted with the development of the framework that was loosely based upon the National Occupational Standards for Forensic Science (Skills for Justice, 2006). The investigation process was broken down into meaningful units (for example, evidence collection, evidence analysis) and then further subdivided into discrete tasks. For each set of tasks or elements specific performance criteria were established along with knowledge and understanding requirements. These are absolute measures of competence and Inspectors are expected to demonstrate the skill or articulate the required level of knowledge in order to attain the 'tick in the box'. These competences are linked to a "… specialised learning system of theoretical and practical modules" (MAIB, 2008).

The researcher felt that such a competence framework complements rather than conflicts with the current research study and its synergies will be discussed in more detail during the Discussion chapter of this thesis.

The RAIB, it is surmised, are looking to increase their professional standing within the industry by pursuing external accreditation with an accredited certification body. The process of evaluation should be similar in practice: Inspectors' knowledge and skills will be measured against the required standard to determine competence. Once established, accreditation will ensue. What is not clear is whether this accreditation is given to the RAIB as a whole or to individual Inspectors as with the MAIB's scheme.

Accreditation is widely accepted as bringing an element of trust and verification into courts where one is purporting to represent expertise. As George (2003)

commented, " … the primary purpose of the accreditation debate was to produce a system that would endorse an individual's professional competencies and standing in the eyes of the legal community, and ultimately support the acceptance of the accredited person as an expert witness."

That said, accreditation does not necessarily find complete favour with the judicial system. Lord Woolf's "Access to Justice Report" states that an exclusive reliance upon accredited expert witnesses would narrow the pool of available experts creating an uncompetitive monopoly on "professional experts'" out of touch with current practice in their fields. What was wanted in an expert witness was "… a specialist who is up to speed in current practice and who attests to a professional set of standards." (Woolf, 1996).

The skills and experience required can be dependent upon the philosophy and structure of the organization. As explained earlier, national independent accident investigation agencies can be described as multimodal or unimodal – the organization's remit may cover many modes or just the one. And further variation exists within what constitutes multimodal. The National Transportation Safety Board headquarters in the US houses domain specific investigators. Within each transportation function, for example, air, there are specialists whose frame of reference within an investigation is limited and constrained by that specialism. The UK accident investigators, by contrast, are treated more as "specialist generalists" in that they are expected to step outside their specific areas of previous expertise and tackle an infinite assortment of accidents. Countries such as the Netherlands and Finland have taken the principle of generalism one stage further by encouraging cross modal experience.

This standpoint assumes that an investigator can be trained in accident investigation techniques and mode not withstanding, will be able to produce as detailed and accurate a report as an investigator with years of experience and pursuant acquired knowledge in that industry.

2.9 Defining the role

When constructing a model of an occupational role, there are a number of perspectives from which to approach the task. An individual can be described by the specific tasks that comprise the role, the behaviour exhibited whilst performing the task and the psychological constructs employed. These three differences in approach have formed the basic philosophy behind the numerous occupational analysis techniques available for use.

Leaving psychological constructs aside, there are, however, currently two approaches which purport to underpin all aspects of the human resources structure - from recruitment and selection, through training, appraisal and compensation: job analysis and competency modelling. Both claim to be able to offer efficiency savings and enhanced performance; both have been the focus of extensive research and literature and yet, they appear, at face value to

approach the question from diametrically opposing directions. Both have been subject to the vagaries of fashion and semantic confusion, to the point that their epistemological perspectives have blurred.

Job analysis has historically been viewed as a predominantly work oriented approach and competency modelling, worker oriented but proposing such a clear cut distinction would be a fallacy. As will be shown in subsequent discussion the similarities and crossover between the two serve more to perpetuate the "… morass of semantic confusion" (Kershner, 1955) rather than to clarify.

Until now the work versus worker oriented approaches have largely remained separate or where combined through ignorance rather than design have produced skewed and meaningless data (Woodruffe, 1990). There is, however, an increasing call in the literature for a 'blended' approach (Schippmann et al, 2000; Brannick and Levine, 2002).

The present study suggests that it is more beneficial to see the two approaches not as completely distinctive constructs but as points along a continuum with the evaluation and measurement of individual task steps (time and motion studies) at one extreme and the concept of organizational competencies at the other (from micro to macro) and the majority of the research amassed medially. Specifying the requirement of the information sought (for example, for recruitment or job evaluation) will thus determine the most applicable methodology for eliciting and representing the data – that is, how far along the continuum you should be.

Subsequent sections will outline the definitions, applications and historical contexts of job analysis and competency modelling as distinctive constructs as well as looking at crossovers in theory and overarching methodologies.

2.9.1 Job analysis

Job analysis is essentially concerned with the collection and analysis of any type of job-related information (Tiffin and McCormick, 1965; Ash, 1988). It is an umbrella term, including a multitude of data collection techniques, the suitability of each being determined by its fit to the research objective. Definitions in the literature consistently use the terms 'systematic', 'analytical', 'reliable' and 'accurate' (Pearn and Kandola, 1988; Primoff and Fine, 1988) to denote its scientific derivation. Importantly, it should be based upon units of observable behaviour to reduce the need for drawing inferences.

It can be seen in a purely mechanistic way as a process whereby "… a job is dissected into its component parts and those parts are studied to decipher the nature of the work" (Gael, 1983) or more broadly as a multivarious "… host of activities, all of which are directed toward discovering, understanding, and describing what people do at work" (Brannick and Levine, 2002).

Depending upon the requirements of the exercise, job analysis can be used to determine information regarding the work itself (specific tasks) or information associated, but not directly involved, with the work (skills and abilities, characteristics of the work environment) (Gael, 1983). It is, above all, designed to meet a particular purpose and satisfy a particular need (Primoff and Fine, 1988); the importance of purpose being manifest in the definition. Ash (1988) describes job analysis as a way of "analyzing reality".

In the early 20th century the focus of study was upon the potential savings available through efficiency initiatives at work such as time and motion studies (Taylor, 1911). Further inclusion of worker variables into the analysis of jobs was effected by the Gilbreths who were particularly influential in the redesign of tasks to meet the needs of workers with "varying potentialities" (Gilbreth and Gilbreth, 1919).

The two World Wars provided an enormous impetus to the scientific study of job analysis particularly with its applications to military personnel classification and placement. Implications for civilian posts were soon recognized and particularly in the US, job analysis increased in popularity.

Whilst research into new techniques continued in the post War years (Primoff, 1953; Flanagan, 1954; McCormick et al, 1972), the popularity enjoyed by job analysis in the earlier part of the century waned over time. It was seen as a dull and uninteresting subject matter; an image that it was felt to have self perpetuated through lack of development (Pearn and Kandola, 1988). It was "… characterized by neither heated controversy nor prominent visibility in the research literature" (Harvey, 1991).

Legislation in the US regarding Equal Opportunities led to a resurgence in research in the 1970s, in particular the publishing of the 'Uniform Guidelines on Employee Selection Procedures' (1978). The Guidelines state that the choice of a selection procedure should be based on an understanding of the job and that to gain an understanding, some method of job analysis should be used. Whilst there is no legal requirement to do this, the Guidelines are still in effect and used by the courts in the US to determine unlawful discrimination (Brannick and Levine, 2002).

The use of job analysis data covers the entire human resources spectrum. Ash (1988) proposed twelve areas where he felt job analysis data could make a valuable contribution: job descriptions; job classifications; job evaluation; job design and redesign; human resource requirements and specifications; performance appraisal; training; worker mobility; workforce planning; efficiency; safety; and legal requirements. His list sought brevity from previous groupings such as Zerga (1943), Gagne (1963), Prien and Ronan (1971), Wilson (1974), McCormick (1976) and Dunnette and Borman (1979) although interestingly Zerga (1943) included investigating accidents in his summary. Absent but

perhaps implicit in Ash's list is the area of academic research within industry and organizations.

2.9.2 Competency modelling

Schippmann et al (2000) surveyed 37 subject matter experts from a variety of different backgrounds in the development and application of competency models and when asked to define a competency, recorded the following:
"Observable, behavioural capabilities that are important for performing key responsibilities of a role or job".
"Mishmash of knowledge, skills and abilities, and job performance requirements".

A review of the literature also offers the following frequently cited definitions:
"An underlying characteristic of a person. … a motive, trait, skill, aspect of one's self image or social role, or a body of knowledge which he or she uses" (Boyatzis, 1982).
"A knowledge, skill, ability or characteristic associated with high performance on a job" (Mirabile, 1997).
"Underlying characteristics of people" (Spencer and Spencer, 1993) indicating "… ways of behaving or thinking" (Guion, 1991).

One prevailing concern that emerges from the literature is the lack of a precise or commonly held definition of 'competency' (Schippmann et al, 2000; Garavan and McGuire, 2001). The indiscriminateness is further compounded by the tendency to conflate the terms by the use of both 'competence' and 'competency' which, dependent upon the perspective, are either used interchangeably or exist as completely separate entities with entirely different precursors and results (Woodruffe, 1990; Rowe, 1995; Rankin, 2001).

Dictionary definitions use the word 'competence' and 'competency' as synonymous nouns. The Oxford English Dictionary (OED, 2002) alludes to "… a competent capacity"; Cambridge Advanced Learners Dictionary (CALD, 2003) and Longman (2005) defines competency as "… the ability to do something well". Implicit in this is ability or potential.

The adjective 'competent' however is less uniformly defined as "… having adequate ability, knowledge, power, qualifications; sufficient" (OED, 2002); "… able to do something well" (CALD, 2003) and "… having enough skill or knowledge to do something to a satisfactory standard" (Longman, 2005). If a clear definition cannot be found amongst the learned lexicographers, then it is little wonder that disparities and confusion exist within the social science and management literature.

The essential differences between the two terms are their focus, purpose and what they purport to summarize (Wood and Payne, 1998). Rowe (1995) defines it thus: "Competence [is] a skill and the standard of performance

reached while competency refers to the behaviour by which it is achieved. In other words, one describes *what* people can do while the other focuses on *how* they do it." This is reiterated by Woodruffe (1990) who delineates between 'competence' which defines the area of work at which a person is competent, and 'competency' as the dimensions of behaviour underlying competent performance.

The confusion surrounding terminology in this area stems largely from the historical context of two seemingly divergent approaches in the US and UK. In essence, the US 'competency' model emphasizes the personal characteristics of superior performers, typically but not exclusively drawn from the management population whereas in contrast, the UK construct of 'competence' is task or output focused: it is the job that is deconstructed to its minima not the individual's attributes. The standards of competence are more often applied to the general workforce as opposed to the management collective.

McClelland (1973) proposed a number of principles that one would use to "test for competence … [using] … that word as a symbol for an alternative approach to traditional intelligence testing." Intelligence tests, he concluded, were not reliable or valid predictors of future "life outcomes" and were biased against those with lower socioeconomic status and minority groups.

McClelland's principles were a marked departure from the methodologies and tenets of the time. He proposed relabelling what were traditionally called personality variables such as communication skills or patience as 'competencies' (McClelland, 1973).

Spencer and Spencer (1993) proposed five types of competency characteristics:

1. Motives – things that drive or direct behaviour
2. Traits – physical characteristics and consistent responses to situations
3. Self concept – attitudes, values or self image
4. Knowledge – specific content area information
5. Skill – ability to perform a task

They introduced an iceberg model to show the relative depths of these characteristics. Surface skill and knowledge are relatively easy to identify and develop through training. The deeper, core personality characteristics, however, are less easily assessed and less amenable to training interventions. Spencer and Spencer suggest that it is therefore more cost effective to select or recruit for them.

Competencies and competency modelling have been embraced by a US business community who had largely turned away from job analysis towards a technique which offered them a business advantage in an increasingly competitive marketplace (Horton, 2000a). Surveys at the end of the 1990s of competency-based practice showed that between 75-80% of companies

surveyed in the US were using such a competency model (Cook and Bernthal, 1998). This figure will have undoubtedly increased in recent years.

In the UK, competency models have been widely applied in both the private and public sectors (Horton, 2000a; Rankin, 2004) and whether or not it is merely an en vogue human resources construct, it nevertheless purports to provide a common language, readily understood by all facets of industry.

The UK has also been a major proponent of the 'competence' movement, emerging as a result of changing technology and improved performance (Horton, 2000a). The UK had been criticized for a focus upon levels of knowledge in industry and not its application. This had led to a growing skills gap and the call for a more vocational approach to training and education.

The Management Charter Initiative (MCI), created in 1988 as an employer-led organization, supported by Government and the British Institute of Management, was part the UK's response to this increasing gap. Its aim was to "… improve the performance of UK organizations by improving the quality of UK managers" (Cheng et al, 2003). By establishing standards of appropriate performance, the MCI intended to bring all managers up to a requisite level in terms of skill and behaviour.

A comparable programme was initiated for the general workforce and in the same year the National Council for Vocational Qualifications, as it was called at the time, was established to "… secure standards for occupational competence" (Jessup, 1991 cited in Cheng et al, 2003). Although there have been differing oversight bodies and nomenclature in recent years, the desire to reduce the skills gap and improve productivity in the UK has remained. Strategic partners now contribute to the development of National Occupational Standards (NOS). NOS set out measurable performance outcomes to which an individual is expected to work in a given occupation with the skills, knowledge and understanding required to perform competently in the workplace, and have formed the basis of the MAIB's Professional Standards of Competence in Accident Investigation framework. This allows, in a similar way to the American Occupational Information Network (O*NET) database, a common understanding and definition of job roles and standards of performance expected.

A major criticism, particularly of the MCI standards, was that it was focusing on establishing 'adequate' performance where adequate equates to basic. In the meritocratic US, the focus was clearly on superior performance - a reflection, perhaps, of differing business cultures.

There is, however, an indication that the US search for excellence and the UK systematic description of skills for a role are beginning to converge. In 1994, a National Skills Standards Board (NSSB) was established in the US to encourage the development of a voluntary set of occupational standards which were assessable (Horton, 2000a).

Conversely, there has been a burgeoning of competency modelling within the UK (Pickett, 1998; Horton, 2000a) with upward of 95% of the UK Civil Service, to whom the AIBs belong, having adopted or in the process of adopting competency-based management (Horton, 2000b).

Encouraged by the success of US models, many British companies have identified the use of competencies as a means of establishing and maintaining competitive advantage over rivals although as indicated by Smith (2005), how can discrimination between competitors be validly based upon a competency model when ten of the most cited competencies are to be found within two thirds of competency models?

Competency models, not unlike job analysis data, can be used to underpin the entire human resources strategy, providing a common language for an organization and a means of fair and consistent assessment.

Models vary enormously between organizations; each adapting the framework to suit their business requirements and maturity. There are clear warnings against overcomplicating the process by creating an unworkable number of competencies. Surveys have shown that between 8 and 12 competencies is common and more practical although some companies have identified over one hundred.

By way of an example, Rankin's 2004 survey into 49 employers' core frameworks found the top twelve competencies (in order of prevalence) to be: team orientation; communication; people management; customer focus; results orientation; problem solving; planning and organizing; technical skills; leadership; business awareness; decision making; and change orientation.

Competency headings on their own are not sufficient to assess capabilities: they are often too ambiguous to be used consistently. It is usual to develop further layers beneath including definitions, behavioural indicators and in some cases performance levels with behavioural examples. Some organizations include negative behavioural descriptors as an acknowledgement of workplace reality. The most important consideration when constructing the framework is to determine how the model will be most effectively used in the long term.

The Inspectors, as employees of the Department for Transport, are Civil Servants: members of the permanent bureaucracy of Crown employees that supports UK Government Ministers. As with many large organizations within the UK, the Civil Service implements a competency framework: in fact, there appear to be a number in use dependent upon the level of seniority and which department or agency one is associated with.

Given that competencies were originally conceived as "… identifiers of what separates the best from the rest" (Kanaga, 2007), the researcher was interested to discover their use with respect to the accident investigators. One such model, the Professional Skills for Government framework, was designed to

ensure that staff within the Civil Service, regardless of department or agency, have the "… right mix of skills and expertise" to deliver effective services.

Designed for senior grades (which would include the grades for AIB Inspectors), the Professional Skills for Government framework has at its heart the concept of leadership: providing direction; delivering results; building capability and acting with integrity.

This leadership is then complemented with the four core skills of people management; financial management; programme and project management; and analysis and use of evidence.

The AIBs are measured at both an individual and a Branch level. In a written response to a question posed by Greg Knight MP regarding performance assessment of the RAIB, Derek Twigg, then Parliamentary Under-Secretary at the Department for Transport, responded that the Secretary of State assesses the work of the RAIB (and from that one might infer the same would happen for the AAIB and MAIB) on an on-going basis by looking at the quality of the investigation reports issued. This was in addition to one-to-one meetings with the Chief Inspector.

At an individual level, the researcher was shown the DfT Inspector's Performance Report; an annual appraisal covering all three AIBs. Assessed as 'not achieved', 'achieved' or 'exceeded', Inspectors were rated in terms of the following three areas: level of professional knowledge/skills; application of professional skills to accident investigations; and writing and follow-up of reports and recommendations. Each area was further broken down into assessable competences, as shown below. Inspectors could be said to either have demonstrated that competence or not. The level of detail provided is limited which may have implications for completely objective assessment. Note should be taken that the level of measurement is now competence and not competency. It is presumed that this assessment complements the Professional Standards of Competence in Accident Investigation and does not seek to replace it.

Level of professional knowledge/skills: The objective is to develop professional skills to investigate and report on accidents to meet the level of expertise required by the Branch. Inspectors are required to demonstrate current knowledge and expertise in the areas of trends in accidents and accident investigation, industry developments, specialism developments, investigative interviewing and processes, evidence identification, collection and preservation, and developments in operational technology and IT.

Application of professional skills to accident investigations: The objective is to work within agreed time-scales, conduct investigations thoroughly, involving external stakeholders as necessary, obtaining and preserving all human and physical evidence, and analysing it accurately to provide a true picture of the causes of an accident. This is demonstrated by responding to an accident

within agreed times and procedures, effectively project managing contribution to every investigation, identifying and managing risks, dealing sensitively and appropriately with all stakeholders, the media and the bereaved, properly managing physical evidence, effectively gathering human evidence and using a range of appropriate investigative techniques.

Writing and follow-up of reports and recommendations: The objective is to produce timely written reports that explain accurately the causes of an accident and offer sound, well considered recommendations to prevent similar events occurring in the future. This is to be demonstrated by producing reports and coroner's statements within deadlines; constructing reports to Branch procedures; writing in clear, plain English, taking audience need into account; ensuring reports are accurate, thorough, balanced and objective with conclusions and recommendations based on clear logical analysis; and effectively managing post-publication actions.

In 2000, the Job Analysis and Competency Modeling Task Force (JACMTF) published a report on the "Practice of Competency Modeling" (Schippman et al, 2000). The Task Force, sponsored by the Professional Practice Committee and the Scientific Affairs Committee of the Society for Industrial and Organizational Psychology in the US, conducted a two year investigation into the increasing use of competency modelling by human resources professionals and its correlation with the more established job analysis techniques.

One aspect that they considered during their investigation was the perceived differences between the two constructs; some subject matter experts questioned believed that they were one and the same but the vast majority cited the work (job analysis) versus worker (competency modelling) focus as the main differentiator. Given that under the umbrella of job analysis techniques such a split already exists, this was a convenient but not altogether satisfying conclusion.

The JACMTF concluded that one of the weaknesses of both approaches was the need for making inferential leaps from the product of the research. Utilizing either the job analysis or competency modelling data to inform a human resources decision or application and feeling satisfied with its validity could be eased by the presence of ten variables which they believed would "… essentially serve as evaluative criteria" and enhance the "… rigor of the research methodology" (Schippmann et al, 2000).

The variables against which they measured both approaches were: method of investigation; type of descriptor content collected; procedures for developing descriptor content; detail of descriptor content; link to business goals and strategies; content review; ranking descriptor content; assessment of reliability; item/category retention criteria; and documentation.

When evaluated against this model, job analysis was seen to be 'superior' in all categories with one exception: link to business goals and strategies. Brannick

and Levine (2002) determined that job analysis was better at obtaining the necessary information but failed to effectively communicate its value to its users. The value of competency modelling therefore is not in its scientific rigour and validity but how it imbues functions with the focus and direction of the business. Its attraction to the business community, if not the scientific community, is clear – "… it links explicitly the results of the modeling effort with the organization's outcomes of interest" (Brannick and Levine, 2002).

Job analysis and competency modelling include an array of data elicitation and collection techniques (Gael, 1988). They vary significantly in their methodologies and use, and there is an overlap of application.

Within the job analysis literature there is a convenient if sometimes fuzzy delineation between those analysis techniques which focus upon *what* the worker does in terms of function, tasks, context, tools etc. and *how* the worker performs the task: which attributes are requisite. The *work* versus *worker* approaches. In many respects this mirrors the distinction between job analysis and competency modelling as a whole and serves to confuse rather than clarify. To compound this confusion further, job analysis also proposes hybrid methodologies, combining both work and worker orientations (Brannick and Levine, 2002).

The underlying principles of one method, the Combination Job Analysis Method (C-JAM) were of particular interest to the researcher and as such, an overview is now provided.

C-JAM (Levine, 1983) borrows from both job analysis and competency modelling to provide information about what tasks are performed and the requisite skills and attributes for the role. Essentially, task statements are developed and the importance of the tasks rated. The knowledge, skills, abilities and other personal characteristics (KSAOs) needed to perform the task are described and rated, again in terms of their importance.

The process appears to be quite labour intensive, initially requiring a group of job experts to individually generate a list of approximately fifty task statements for the job under analysis. Tasks are defined as involving the "change, or an attempt at changing some material, person, product, subject matter, or set of data from one form to another form. The change is attempted by means of a worker's efforts either applied directly or exerted through the use of particular tools, machinery, equipment or work aids." (Levine, 1983). Task statements are written with an implied subject, verb, object and end with a purpose for the action.

A list of between 30-100 task statements will be compiled by the researcher for rating by the job experts with regards to the relative time spent, the relative task difficulty and the criticality of the task (the degree to which incorrect performance would result in negative consequences). Ratings are made on a 7

point Likert-type scale. From these results the task importance value is calculated where task importance is equal to difficulty x criticality + time spent.

Subsequently, the list of task statements are used by the job experts to generate examples of knowledge, skills, abilities and other personal characteristics (KSAOs) required to perform the tasks with an objective of creating 100 KSAOs. The same group of job experts are then tasked with rating these KSAOs in terms of whether they are necessary for newly hired employees, whether they are practical to expect in the labour market, to what extent trouble is likely if the KSAO is ignored during selection and lastly, to what extent the different levels of the KSAO distinguished the superior from the average worker.

Levine (1983) and later, Brannick and Levine (2002) propose that the results can be used to inform job design and evaluation as well as selection and training and as such, the researcher felt that the technique was worthy of consideration for use in the study. The researcher was particularly interested in the scales used to rate the KSAOs and these have been utilized, albeit in a modified manner, during the course of the research (see Chapter 3 for elaboration).

This research has sought to employ a broad definition of a competency to include knowledge, skills, attitude and behaviours, thus largely removing the 'conceptual ambiguity' of the term (Robinson et al, 2005). It will enable both work and worker oriented competencies to be considered simultaneously.

Robinson et al (2005) suggest two main approaches to competency modelling which have implications for this present study. Based upon Boam and Sparrow (1992), they differentiate between a top-down approach utilizing existing predetermined competency labels, determining which ones are relevant or appropriate to the job being analysed and a more labour-intensive bottom-up approach where labels are emergent from interview data. The latter method has greater affinity with the methodological philosophy adopted in this research and will be discussed in greater detail in the subsequent chapter.

2.10 Conclusion

The literature review for this research study has been relatively broad. Given the minimal academic literature pertaining to the requisite qualities of an accident investigator, the researcher chose to widen the review to illustrate the psychological, moral and economic drivers for accident investigation within the transport industry. Despite differing cultures and histories, there is commonality in the intent of the three UK Accident Investigation Branches, supported by the national, international and legal context in which they operate. And yet, despite the overarching rules and guidance, the process for investigating accident is sufficiently varied so as to produce disquiet about its claims to be transparent and trustworthy. Conflictions in underlying philosophies can lead to

contradictory perspectives, compounded by a myriad of available but inconsistently applied analysis techniques.

At the heart of the process is the accident investigator. The romantic image of the inscrutable detective is supported by the popular literature but little academic work appears to have been undertaken regarding the assessment of skills and behaviours required for effective accident investigation.

The literature has shown that there are a number of techniques available for defining occupational roles and concludes that the most appropriate one for the purposes of this research is competency modelling. The terms ‘competency’ and ‘competence’ are often (erroneously) conflated but this chapter has defined what they purport to represent and measure.

Based upon this review, the research seeks to utilize the construct of competency modelling to determine the requisite skills qualities and behaviours in an effective accident investigator, developing a framework which can be blended with extant competence standards to strengthen and complement whilst answering a call in the literature for the combined use of both measures of performance.

3.0 Methodology

3.1 Introduction

This chapter is written in two parts: methodology and method. It summarizes the philosophical perspective underpinning this research, accounts for the methodology adopted and describes the methods and analytical techniques employed.

3.2 Methodology and philosophical considerations

Within the discussion of the philosophy of social research there remain many unresolved arguments (Toft and Reynolds, 1994). The diverse nomenclature serves to confuse particularly when competing terms appear to be describing a similar perspective. Chia (2002) notes the "… seemingly wide panoply of theoretical perspectives … proffered in recent times in the social sciences". Perhaps they are more usefully considered as a valuable means of situating one's research along a philosophical continuum. At either pole sit the extremist views: positivist, objective 'scientific' method vs constructionist, subjective relativism, representing "… various amalgams of two opposing epistemological impulses" (Chia, 2002). Determining where along that continuum the research sits enables us to better understand and articulate the research objectives and assumptions (Williams and May, 1996).

A positivist epistemology would posit that reality is something that is real and apprehensible; an objective data set exists to describe and explain the subject matter. Through explaining comes the ability to predict (Perry et al, 1999). "An objective truth exists in the world which can be revealed by the scientific method" (Cassell and Symon, 1994). But is this notion of absolute truth illusory? Particularly when the object of research is in part a socially constructed phenomenon.

The researcher in the positivist tradition remains an objective outsider – an impartial observer of fact. This, along with a drive for numerical analysis and quantification and a highly structured methodology which lends itself to replication, makes the scientific method intuitively appealing (Cassell and Symon, 2004) but with little of the flexibility required by this research study.

The opposing view to positivism is constructionism where a purely subjective perspective is adopted. Realities are constructed based upon experience and as such are multiple and interpretivist. This increasingly influential approach "… draws attention to the fact that human experience, including perception, is mediated historically, culturally and linguistically. That is, what we perceive and experience is never a direct reflection of environmental conditions but must be understood as a specific reading of these conditions." (Willig, 2001).

However, as Bryman (1996) points out " … polarization of interests … prevents fruitful discussions."

Borch and Arthur (1995; cited in Perry et al, 1999) argue for a blended approach combining the strengths of both extremes aiming to "… blend the rigour of the 'scientific validity' of objectivist research with the contextual elements and insights of subjectivist research" (Perry et al, 1999). A mix of both objective and subjective perspectives can help to mitigate the criticism that research is not capturing "… real world complexity." Perry et al (1999) suggest taking this blend one stage further by replacing it with a third approach – realism.

This doctoral research has been influenced by what might be thought of as the 'middle ground' – the realism paradigm. This conceptual framework argues that reality exists outside of the subjects but that people's experiences will shape their interpretation of it. Reality is 'real' but unlike positivism, this reality is not perfectly apprehensible. Understanding such a reality requires 'triangulation' from many sources. Perception in itself is not reality but "… a window onto reality through which a picture of reality can be triangulated with other perceptions." (Perry et al, 1999). In essence, to understand how someone sees the world requires looking at their 'reality' from a number of different viewpoints.

"Reality, for the realists, comprises things, structures, events and underlying 'generative mechanisms' which, regardless of whether they are observable, are none the less 'real'" (Chia, 2002). It exists and acts independently of our observations, of our thoughts and beliefs, indicating that "… there are large-scale forces and processes that affect people without their necessarily being aware of the existence of such influences on their interpretations and behaviours." (Saunders et al, 2003).

Perry (2002) inserts a caveat: given the complexity of the social science study, all knowledge gained is real but must be considered fallible.

What kind of knowledge a methodology aims to produce is dependent upon its epistemological position (Willig, 2001). Epistemology addresses questions regarding knowledge: What is knowledge? How is knowledge acquired and what do people know? Is knowledge hard and tangible or soft and subjective? What does or does not constitute warranted or valid knowledge? (Gill and Johnson, 2002). Epistemology is driven by the relationship between the research and 'reality'. How this reality is defined is a question of ontology. Is the reality external or internal to the subjects under study? Is it something that exists objectively outside of the individual or something that the individual subjectively generates? (Burrell and Morgan, 1979). It is the "… essence of phenomena" and the nature of their existence (Gill and Johnson, 2002). Realism, not unlike positivism, stems from an ontology of 'being' – reality is assumed to be relatively stable and discrete (Chia, 2002). This is in contrast to

a ‘becoming’ ontology as would be seen with more interpretivist or constructionist viewpoints.

Aligning research with an approach, therefore, has important implications for methodology and research design (Freeman, 2003). Blaikie (1993) comments that “In adopting an approach to social enquiry, the researcher is buying into a set of choices with far reaching implications.”

One of the downsides to affiliation with a particular philosophy is that the paradigm can dictate which types of research questions are ‘legitimate’. The researcher was concerned that this should not negate the validity of data gleaned from the research if it was seen as being based upon ideologically ‘incompatible’ methodologies.

Research has been described as a “… journey of adventure” (Miller and Crabtree, 1992): the inference being that one embarks on the voyage without knowing quite what to expect and this is particularly most pertinent to research which follows qualitative form. Whilst the freedom to pursue whatever lines of social inquiry appear most interesting is ultimately gratifying, the non-prescriptive format can often be quite daunting. Clearly defined boundaries or variables are expected in many forms of research and yet, the social scientist often rails against such conformity.

With small samples, quantitative comparisons can only be suggestive (Freeman, 2003). It was therefore determined that the most appropriate form for the research to take would be qualitative. This aligned with the researcher’s philosophical perspective that the accident investigator is not a ‘nomothetically described phenomenon’; that is, what is learned about accident investigators through this research is not necessarily generalizable to other non-related groups and would, therefore, be better suited to an ideographic approach where their ‘uniqueness’ could be studied in context.

The researcher also felt that a prescriptive fixed methodology would provide less useful or meaningful information and that the requirements should be emergent from the research process and not shape it. Research plans are revised in respect to things planned but not accomplished or unforeseen changes which had to be made as the opportunity arose. “The tidiness and orderliness of design are usually replaced by the fuzziness and compromise of practice.” (Hall and Hall, 1996). A flexible qualitative approach was therefore more fitting with “progressive focusing” as the concepts developed and narrowed during the course of the research (Hall and Hall, 1996).

Qualitative research is interested in how people make sense of the world. “The quality and texture of experience rather than with the identification of cause-effect relationships.”(Willig, 2001). It focuses upon interpretation as opposed to quantification and seeks to describe and understand as opposed to explain and predict.

Tracing its history back to the beginning of the 20th century, anthropologists such as Boas, Mead et al, developed a fieldwork method whereby observers immersed themselves within another culture to study the customs, habits, beliefs and behaviours of that society. These approaches enabled researchers to develop understanding from the perspective of the 'researched'.

Qualitative research is characterized by being largely exploratory in focus. Whereas quantitative research aims to test hypotheses, a qualitative study will facilitate a direct experience of the research object. But, as Denzin and Lincoln (2005) concede, "… qualitative research is difficult to define clearly. It has no theory or paradigm that is distinctly its own".

This type of research, as a set of interpretive activities, "… privileges no single methodological practice over another." (Denzin and Lincoln, 2005) and is inherently multimethod in focus (Flick, 2002). This "reflects an attempt to secure an in-depth understanding of the phenomenon in question". Denzin and Lincoln (2005) posit that objective reality can never be captured.

Dawson et al (2006) assert that "Researchers should adopt a problem-focused methodological pluralism in which divisive theoretical alliances are overcome in the quest for useable knowledge." This reiterates a call for methodological pluralism, where the phenomenon observed requires multiple methods to account for its nature, and complementarity: "Different kinds of information about man and society are gathered most fully and economically in different ways, and the problem under investigation properly dictates the methods of investigation …" (Trow, 1957 cited in Gill and Johnson, 2002).

"Unlike quantitative methods where technical sophistication of method and statistics are the hallmark of good research, qualitative researchers need reflective skills, and flexibility of method and theorising." (Bishop, 2007).

Research rigour is often seen as being dependent upon the adoption of the concepts and terminology of positivist research, with particular reference to validity and reliability (Morse et al, 2002). Sandelowski (1993) argues that if reality is assumed to be 'multiple and constructed', then "repeatability is not an essential (or necessary or sufficient) property of the things themselves"; "…issues of validity in qualitative studies should be linked not to 'truth' or 'value' as they are for the positivists, but rather to 'trustworthiness'". (Rolfe, 2006).

Paralleling the conventional criteria of internal and external validity, reliability and objectivity, Lincoln and Guba (1985) posit that 'trustworthiness' in research is an important means of evaluating its worth. Trustworthiness involves establishing credibility, transferability, dependability and confirmability. Credibility is built upon the degree of confidence in the 'truth' of the findings. Do the findings represent a credible conceptual interpretation of the data? Demonstration of transferability shows that the findings can apply outside of the research context. Dependability measures the consistency and replicability of the findings requiring the appropriate and consistent application of process.

Lastly, research is deemed to have confirmability when researcher neutrality can be established. The findings of the research are therefore shaped by the respondents and not researcher motivation.

The researcher intends to use a qualitative procedure to determine the perceptions of accident investigators regarding performance in the role. In line with Hayes (2000), "The idea is that the end process will result in a theoretical overview which is a reasonably thorough reflection of the data which have been collected, and which can serve as the basis for future research into the area".

Lincoln and Guba (1985) describe techniques that can be used in qualitative research by which each of the four components of trustworthiness may be established. It is the intention of the researcher to use these techniques during subsequent chapters of this thesis to demonstrate trustworthiness in the research findings.

3.3 Method

The research study has been broken down into three individual but complementary phases; the results of the former phase informing the next.

The first stage called for an exploratory study: "… to find out what is happening; to seek new insights; to ask questions; to assess phenomena in a new light and to generate ideas and hypotheses for future research" (Robson, 2002). This allowed the researcher to become more familiar with the subject, the context and enabled a better understanding of the research question, utilizing semistructured interviews, literature reviews, background research and observation.

Phase 2 involved conducting more in-depth and focused Repertory Grid interviews with Principal Inspectors to determine their perspectives of behavioural indicators of effectiveness in accident investigation.

The final phase of the research utilized the findings from the previous phase and sought to quantify the relative importance of these behavioural indicators for the role of accident investigator, in particular in terms of recruitment and training. Each phase will now be described in turn.

3.4 Phase 1 study

Although the researcher had a working knowledge of the policies and procedures of the Air Accidents Investigation Branch from previous experience in the aviation industry, the finer details of the day-to-day workings of the Branch were unknown. Little was known, too, of the MAIB and at the commencement of the research, the RAIB was still in its design stage.

A desk top review of Branch and departmental policies and procedures, overarching industry and statutory regulations was conducted, but of much greater interest was determining whether these written documents reflected what actually happened in practice and where deviations, if any, occurred and why.

The researcher attended meetings and debriefs in-house in order to gain a better understanding of the terminology and language used and also to understand more with regards to the day-to-day running of the operation: the constraints; the challenges; the opportunities; and the grievances. It was a valuable opportunity to also watch the social interactions of the groups from a non-participatory stance.

3.4.1 Interviews with the UK Accident Investigation Branch Inspectors

Semistructured interviews were conducted with Inspectors and Senior Inspectors, initially at the AAIB and subsequently with the other two Branches in order to gather background information regarding the role of the accident investigator. Combined with desk top reviews and observation of the Inspectors, it was proposed that this would give the researcher a better understanding of the Branches and the research question. The sampling was purposive rather than random or probabilistic, as is normal for a qualitative approach. There was a limited pool from which to select given the size of the organizations involved but the researcher tried to ensure that there was representation from the differing specialisms within the modes (eg flight operations and engineering at the AAIB; signal engineers and permanent way subject experts at RAIB; nautical and engineering at the MAIB) as well as in terms of age and length of service. Flexibility was essential as the stochastic nature of their industry sometimes meant that predetermined interviews needed to be moved or cancelled. Many Inspectors found themselves out in the field, both home and abroad, for extended periods of time in which case a more opportunistic sampling was engaged and alternative interviewees were sought.

The use of semistructured interviews was considered to be an efficient and practical way of eliciting data that cannot be readily observed such as perceptions or emotions. It has been described as a technique with high validity as it allows a degree of freedom to the respondents to express and explain thoughts in depth as well as providing an opportunity for the researcher to resolve any apparent contradictions.

It remained incumbent upon the researcher to maintain focus during the interviews to counter the tendency for interview ‘drift’ but the semistructured interview allowed for a “… pause for reflection” (Freeman, 2003) – questions could be changed during the course of the interview according to the responses from the interviewees; emergent themes could be probed and explored further. Freeman (2003) also advocates that researchers make use of this technique

particularly where they are less familiar with the field as it permits "… proximity to the data" which was particularly relevant to the researcher in this study.

It was important to the researcher that the Inspectors felt themselves to be participants in the research as opposed to subjects. By involving them in the design of the questioning it was hoped that they would feel the research to ultimately be of more value and not something that was merely being 'done' to them (Cassell and Symon, 2004). The researcher therefore used the first two interviews with experienced and well respected Senior Inspectors at the AAIB as a pilot study in which potential questions were trialled and either included in further interviews or discarded as unproductive.

Interviews were arranged at the convenience of Inspectors and were conducted in the Inspectors' individual offices or in a quiet private area where the Inspectors felt able to speak freely.

The researcher remained mindful of ethical considerations regarding research and in line with recommendations from the British Psychological Society advised the Inspectors of the research objectives and obtained their informed consent for continued involvement. They maintained the right to withdraw from participation at any time and to decline to answer questions. Inspectors were assured of the confidential nature of the interviews and that comments made or information gathered would only be used to inform the body of knowledge as a whole. No comments would be attributable to an individual (BPS, 1990 and 2006).

The interview commenced with an overview of the research aims and history and the purpose of the specific interview as a means of learning about what Inspectors did on a day-to-day basis. Classification or demographic data was sought, for the most part to encourage the interviewee to start conversing in a more relaxed and open manner and to establish rapport (Sekaran, 2003).

The Inspectors were asked to explain the investigation process and provide a description of their routine activities. Life at the Branch and the role of the accident investigator in society were explored as well as discussion regarding effectiveness in investigation. An interview protocol is included in Appendix A. It should be noted that not all topics were discussed by every respondent. Given the flexibility of the semistructured interview, respondents were afforded the opportunity to discuss preferred topics in more depth. The researcher ensured, however, that the breadth of topics was covered by the body of respondents as a whole.

The consequent interviews were recorded on a digital recorder to facilitate the interview and to provide a complete and accurate record of proceedings. Recordings were, however, hampered at the AAIB by noise from on-going building work at the premises. Permission was always sought and given before recording commenced. The individual interviews were analysed at length to

determine emergent themes and salient comments made around these themes were extracted and transcribed verbatim.

The interviews were conducted over the course of the first two years of research. In total, 23 Inspectors of varying disciplines, grades and experience were interviewed at the three UK Accident Investigation Branches. Interviews varied in length dependent upon the time constraints of the individual Inspectors but ran from between 50 minutes to 2 hours and 10 minutes. After these interviews, the researcher felt that a sufficient breadth and depth of information had been uncovered and any subsequent interviews would have simply proven repetitious and so this phase of the study was drawn to a conclusion.

The researcher was fortunate enough to have continued access to subjects allowing for changes to be made to the method based upon experience. The researcher was, however, mindful of not occupying too much of any one individual's time and so with only a few exceptions, they were interviewed once, and once only. Inspectors were, however, happy to provide subsequent clarification as required by email or through ad hoc chance meetings.

3.4.2 Interviews with the US National Transportation Safety Board investigators

In addition to conducting interviews with the three UK Branches, the researcher also sought to gain awareness of the functioning of comparable organizations internationally. The researcher was fortunate enough to be able to spend time at the National Transportation Safety Board headquarters in Washington, DC, with investigators in aviation, rail and pipeline, and marine. Interviews were conducted with investigators in these modes as well as with human performance specialists and professional writers. Ten interviews were conducted in total. These were transcribed where pertinent, for salient comments.

A thorough desktop review of available material was conducted, in particular policies and procedures, prior to the visit to gain an understanding of the similarities and differences between the philosophies and operation of these organizations.

3.5 Phase 2 study

The purpose of this study was to identify and discuss those aspects of an Inspector's behaviour deemed to be "effective" with regards to the accident investigation process. This, as previously discussed, is essentially a subjective evaluation; one that reflects how the individual Inspectors have assigned internal weightings to those aspects of behaviour that are important to them. Job incumbents are thought to be able to infer the knowledge, skills, abilities and other characteristics required for the role with some degree of accuracy

(Brannick and Levine, 2002) and the researcher therefore felt it was appropriate to model effective behaviours using the Principal Inspectors. These perceptions were to be contrasted with other studies and civil service competency frameworks at a latter part of the study and found to be credible.

The research called for a technique that was relatively intuitive and easy to administer, that did not require significant investment with regards to material, analysis software or training and that could be used on a relatively small sample, focusing therefore on breadth of representation and depth of analysis. A multitude of techniques for job analysis and competency modelling have been developed, as discussed in the previous chapter. The researcher considered Critical Incident Technique (Flanagan, 1954), Combination Job Analysis Method (Brannick and Levine, 2002) and Repertory Grid (Kelly, 1955) in more detail. No one method fulfilled all the requirements of the researcher and it was therefore decided that the most relevant elements of Repertory Grid and Combination Job Analysis Method should be adopted in Phases 2 and 3 of the study respectively. These are, therefore, explored in more detail below.

Despite being in common use and the technique of choice for Robinson et al (2005), the researcher did not consider Critical Incident Technique (CIT) to be appropriate for this research. Flanagan's (1954) CIT asks job incumbents to describe an incident which did or did not meet a particular job objective. The lead up to the incident is described as well as the behaviour displayed (what the person actually did). Flanagan suggests that for jobs of a supervisory nature, 2000 to 4000 critical incidents are required to cover the critical behaviours for a job role. The researcher considered that it was not feasible to generate such large numbers of incidents from such a small sample size. In addition, the technique does not readily identify the underlying behaviours and skills, requiring an "extrapolitive leap" (Boam and Sparrow, 1992) to bridge the gap between "long lists of discrete behaviours and the identification of the core behaviours and competencies underlying job effectiveness." (Boam and Sparrow, 1992).

3.5.1 Repertory Grid

Repertory Grid technique has become the most widely used aspect of Kelly's (1955) Personal Construct Theory (PCT). George Kelly's work came about as a reaction to and against the prevailing dominance of positivism. He proposed a move away from statistically generated 'laws' of human behaviour to form predictions based on smaller groups and individuals. He based PCT on two notions: "… (1) that, viewed in the perspective of the centuries, man might be seen as an incipient scientist, and (2) that each individual man formulates in his own way constructs through which he views the world of events. As a scientist, man seeks to predict, and thus control, the course of events. It follows, then that the constructs which he formulates are intended to aid him in his predictive efforts." (Kelly, 1955).

PCT suggests that reality is not a fixed entity but that individuals form their own perspective of that reality based upon their life experiences. By understanding someone's 'construct' or life perspectives, it follows that you can understand their history and actions in context, but also go some way to predict their future actions in given situations. This reality is built up of contrasts rather than absolutes (Jankowicz, 2004). Although PCT could be viewed as an essentially constructivist philosophy where individuals construe and reconstrue meaning, Kelly was at pains to emphasize that the "… universe is real; it is happening all the time; it is integral" (Kelly, 1955); a perspective which aligns quite well with the researcher's espoused 'realistic' viewpoint. The methodology for eliciting these constructs is Repertory Grid.

Developed primarily for a clinical setting, Repertory Grid has become a well used technique often employed in therapeutic interventions (Fransella and Bannister, 1977) as well as in business settings: the design of training (Hare, 2004); in market research (Stewart, 1981); and in measuring team performance (Senior and Swailes, 2004). It has been described as "… a measurement device that has a solid conceptual basis for its structure; it provides a succinct representation of the way a person construes his world or some aspect of it; it is flexible in allowing for both individualized and normative kinds of assessment; it can be applied to an almost limitless range of contexts, and it can be used to provide many different kinds of information." (Bell, 1990).

"Rep Grid … enables one to interview someone in detail extracting a good deal of detail about him … in such a way that the input from the observer is reduced to zero" (Stewart, 1981). It also avoids the over reliance on 'expert' opinion to interpret the thoughts and opinions of the subject.

Generalizability is, however, always limited. Comparing or contrasting subjects is a departure away from Kelly's original theory that constructs were ideographic in nature and therefore did not lend themselves to comparison.

Repertory Grid combines elements of work and worker oriented techniques producing an all-encompassing approach that satisfies both job analysis and competency modelling demands. It "attempts to go straight to the underlying behaviours and skills which distinguish between effective and less effective job performers." (Boam and Sparrow, 1992). Described as flexible and relatively easy to use, Repertory Grid appeared to fit the researcher's criteria most comprehensively.

3.5.2 Interview design

Repertory Grid comprises two main parts: constructs and elements. Constructs are, in Kelly's view, a "… reference axis, a basic dimension of appraisal." Bipolar in nature, constructs are the personal perspectives that the interview seeks to uncover. Elements, on the other hand, are chosen "… to represent the area in which construing is to be investigated." (Fransella and Bannister, 1977)

– the ‘objects’ of what is being explored (Freeman, 2003). In this research study the set of elements were effective and ineffective investigators.

Constructs can either be supplied by the researcher or elicited through interview from the interviewee although the latter is more common (Freeman, 2003). Findings generally support the idea that elicited constructs are more ‘meaningful’ (Fransella and Bannister, 1977) although they concede that not all studies have substantiated this claim (Warr and Coffman, 1970), and that there is no definitive evidence that you should not supply them. Fransella and Bannister (1977) provide examples of situations where the supply of constructs are by contrast ‘vital’, in particular with clinical or educational settings.

As this research is in part interested in the subjective views and opinions of the participants, it was decided that neither constructs nor elements would be supplied during the Repertory Grid interviews.

Repertory Grid interviews typically take three elements or people and ask the interviewee to compare and contrast them, looking for how two of them differ from the third. Where elements are supplied, names are written on individual cards and separated into two piles – those who are good at their job and those that are less so. The interviewee is asked to take two cards from one pile and one from the other and then to articulate the ways in which the two are similar to each other and different from the third. The way that the similarities and converse differences manifest themselves are defined as constructs and are recorded as a bipolar statement. This difference is focused by the use of a qualifier expressed ‘in terms of’. The cards are replaced and the process repeated until no new constructs emerge.

Kelly (1955) described constructs as “dichotomous”: for every basic unit of description and analysis there is a contrast. Only by understanding the contrast can the specific context of the statement be understood. Jankowicz (2004) uses the example ‘pleasant’; its precise meaning can only be understood when the particular contrast which is being implicitly conveyed is identified. ‘Not pleasant’ is merely a negative; it lends little to comprehension. Using ‘pleasant’ as opposed to ‘rude’ carries a different meaning than ‘pleasant’ as opposed to ‘exciting’, it is suggested. Implicit in the first is politeness and in the second placidity. A successfully implemented Repertory Grid ensures that elicited constructs have a clear contrast between the poles with an appropriate level of detail and that they are clearly related to the subject under discussion (Jankowicz, 2004).

Feedback gained during the preliminary interviews with Inspectors pointed to a reluctance to discuss or rate individuals within the group. Whilst shortcomings and strengths were freely talked about within the context of a confidential interview, they did not feel it to be appropriate to identify individual Inspectors as elements. As such, the interview protocol asked the Inspectors to “bring to mind” individuals as opposed to determining and categorizing their effectiveness prior to comparing the elements. This was considered to be a

much more useful means of eliciting constructs as it was considered that individual Inspectors had both strengths and weaknesses in differing aspects of their role and given the matrix management structure of the AAIB, Principal Inspectors worked with different groups of Inspectors on an ad hoc investigation by investigation basis.

Data elicited by Repertory Grids can be analysed by content analysis or quantitatively as a grid where each element is then assessed against a construct. As individual people were not identified during the course of the Repertory Grids, and specific comparisons were not felt to be appropriate in this study, it was determined that more value would be gained by rating or ranking the accumulated constructs and this forms the basis of Phase 3 of the study.

3.5.3 Pilot interviews

"Much of the responsibility for the richness of the data that are produced for a Rep Grid falls to the quality of the initial design." (Freeman, 2003). Given the limited sample available and the desire to balance the requirements of the research with the workload and time constraints of the participants, it was felt prudent to test the interview protocol.

Two pilot interviews were conducted with Principal Inspectors to ascertain that the interviewees understood how the Repertory Grid interview worked, that the language and instructions used were appropriate and that the constructs emerging were commensurate with expectations that is that they referred to behaviours, that the poles were captured and discussed and that the constructs were considered in respect of the predetermined qualifiers. The instructions, categorization of elements and qualifiers all performed well. What became clear was that the overall length of interview was longer than anticipated. Both interviews overran the scheduled 60 minutes and were closer to 95. Whilst this did not appear to unduly concern the participants, it was felt that by keeping to the interview script and not indulging in too many anecdotal examples, the length of interview could be constrained without compromising either the depth or breadth of constructs being elicited. It also gave the researcher an opportunity to experiment with a previously unfamiliar technique and to feel comfortable with the language and process.

As the interviews went well and the constructs data was considered meaningful, it was decided to include the pilot interview data with the final data set.

3.5.4 Interview protocol

Individual interviews were arranged at the convenience of the Principal Inspectors from the AAIB and MAIB at their place of work and were conducted in the Principal Inspectors' individual offices or in a quiet private area where

they felt able to speak freely. At this stage of the research the RAIB were no longer involved with the study.

Again, the researcher remained mindful of ethical considerations regarding research and in line with recommendations from the British Psychological Society advised the Principal Inspectors of the research objectives and obtained their informed consent for continued involvement. They maintained the right to withdraw from participation at any time and to decline to answer questions. Inspectors were assured of the confidential nature of the interviews and that comments made or information gathered would only be used to inform the body of knowledge as a whole. No comments would be attributable to an individual (BPS, 1990 and 2006).

The interview therefore commenced with an overview of the research aims and history and the purpose of the specific interview. Interviews were recorded on a digital recorder to facilitate the interview and to provide a complete and accurate record of proceedings. The purpose of the interview was described as a means of determining what the interviewees considered to be an effective investigator. They were not required to talk about specific individuals but to look at generalized behaviours that demonstrated effectiveness. Personality judgements were also not required unless they had a direct impact on the quality of the work.

The Principal Inspectors were asked to think of three people within the Branch whom they considered to be very good at their job and then three people whom they considered to be less effective.

Bringing to mind the three effective investigators, the interviewees were asked to tell the researcher something that made two of the people more effective than the third in terms of the following task-oriented qualifiers:

i. how they collected evidence
ii. how they analysed evidence
iii. how they liaised with families
iv. how they wrote reports
v. how they made recommendations.

The qualifiers were based upon the task related categories emergent from the interviews in Phase 1.

Again, they were asked to think about the three less effective investigators and to report to the researcher something that made two of these people less effective than the third in terms of the same criteria described above.

Permeable or propositional constructs regarding universally observable characteristics (gender, age) were discouraged as too were constructs that were vague or superficial. Where ambiguity was felt in the construct, clarification was sought using the technique known as ‘laddering’. Laddering

repeatedly asks the questions “why?”, “how do you mean?” or “in what way?” in order to “probe the thinking behind the constructs” (Adams, 2001), focus the construct, remove cliché and prompt the interviewee to question their own statements. The interviewees were required to concentrate on the identification of observable and measurable behaviours and the objective questions of how and why facilitated the process for ‘uncovering’ their language for the description of effective or ineffective behaviour.

Interview recordings were reviewed and each bipolar construct transcribed verbatim.

3.6 Phase 3 study

Phase 3 utilized a questionnaire for the purpose of rating the behavioural indicators collected in Phase 2 in terms of their necessity for selection, the likelihood of acquisition or reduction through training and the amount that they distinguished a superior investigator from an average one.

3.6.1 Questionnaire structure

The questionnaire comprised five parts. Part 1 collected general information regarding position within the organization, experience in industry, age and length of service. Professional development was considered in the subsequent section: the time and resource spent to maintain or improve both investigative and technical skills and the types of training/learning interventions participated in.

Part 3 concerned itself with expertise: in both investigation and industry specialisms. The Inspectors were asked to rate their current expertise on a scale of 1 to 5 where 1 equalled little or no knowledge and 5 denoted expert status.

The fourth part of the questionnaire used statements generated through the Repertory Grid interviews. 75 statements with both positive and negative poles were rated against a five-point scale in terms of the following questions.

For positive statements:
a) how necessary the behaviour was in terms of new recruits
b) how likely it was that the behaviour could be acquired or improved through training
c) how much demonstration of the behaviour distinguished a superior investigator from an average one.

For negative statements:
a) how necessary it was to screen out this behaviour at interview

b) how likely it was that the behaviour could be removed or reduced through training
c) how much demonstration of the behaviour distinguished an ineffective investigator from an average one.

The questionnaire concluded with two general free text questions asking respondents to list five skills or behaviours that distinguish colleagues who they most and least admired in their organization. Inspectors were also invited to leave comment about specific skills not included in the questionnaire or with regards to the construct statements.

3.6.2 Questionnaire development

The questionnaire was developed in consultation with the AIB Inspectors: in particular, Inspectors and Principal Inspectors provided assistance with section 3 regarding the individual investigation and technical skills. These statements were discussed at some length to ensure that they reflected their fields in terms of comprehensiveness, language and content.

The fourth part of the questionnaire utilized the constructs gathered through analysis of the Repertory Grid interviews. The original 114 constructs were first rationalized to remove exact repetitions. Where statements offered a variation of perspective on the same construct, however, they remained.

The revised data set of 100 cognitive and behavioural indicators were grouped together in clusters of similarity and then further separated into the following five competency themes: interpersonal and communication skills; work activity management; personal attributes; cognitive abilities; and technical abilities. There was no desire to force fit the statements using a top-down approach. The five competency categories were emergent from the data and not predetermined.

It was decided that the data set should be further reduced to 75 in order to assist with completion of the questionnaire and thus 25% of the 100 were removed. The rationale behind removal was firstly, ambiguity and secondly, duplication. Very often statements did not stand on their own – they were contextual and could only be properly understood in relation to their polar contrast. As the questionnaire called for these to be rated alone, the researcher felt that they were sufficiently ambiguous as to cause confusion.

The questions against which the bipolar constructs were rated lent heavily upon Brannick and Levine's (2002) Combination Job Analysis Method (see chapter 2 for a full explanation of the technique). Knowledge, skills, abilities and other characteristics (KSAOs) derived during the process are rated against specific scales in terms of: being necessary for newly hired employees; being practical to expect in the 'labor' market; the likelihood of 'trouble' if ignored in selection; and the extent to which different levels of the KSAO distinguish the superior

from the average worker. The researcher believed that the questions regarding new hires and selection could be amalgamated and used to measure both ends of the indicator continuum and therefore rephrased them to ascertain necessary behaviour in new recruits and behaviours necessary to screen out at interview.

The researcher was particularly interested in the effects of training on the behavioural indicator and so chose to replace 'practical to expect in the labor market' with the likelihood that the behaviour could be acquired or improved, or conversely reduced and removed through training.

A five-point rating was used for the questionnaire as it was felt to generate sufficient variance for analysis and "less interviewee fatigue" (Varga, 2007).

Finally, the researcher performed a 'sense check' on each remaining statement. The researcher was keen not to alter the sentiment or language of the statements but it was important that they were expressed in terms of observable behaviours and not abstruse generics.

The questionnaires were checked and approved by the Deputy Chief Inspector of each participating Branch prior to administration.

3.6.3 Questionnaire administration

Paper questionnaires were administered to each Inspector and Principal Inspector at both the AAIB and MAIB. At this stage of the research study it was no longer possible to have access to the Inspectorate at the RAIB. Administration assistance for dissemination and collection of the questionnaires was provided by the Branches. Individual emails were sent to each Inspector prior to receipt of the questionnaire, reiterating the objectives of the research and encouraging completion and return within 3 weeks.

4.0 Phase 1 Analysis

4.1 Introduction

The first phase of the study used semistructured interviews to allow the researcher to become more familiar with the subject and the context, enabling a better understanding of the research question.

Phase 1 data was also used to inform the qualifiers used in the Repertory Grid interviews in Phase 2 of the research.

Over the course of the first two years of research, 23 Inspectors of varying disciplines, grades and experience were interviewed at the three UK Accident Investigation Branches. Interviews varied in length dependent upon the time constraints of the individual Inspectors but ran from between 50 minutes to 2 hours and 10 minutes. As previously stated, the purpose of these interviews was to enable the researcher to familiarize herself with the working practices, ethos and culture of the Branches. It was also a valuable opportunity to get to know the Inspectors on a more personal level which facilitated future phases of the research.

Utilizing semistructured interviews in this phase of the research was an appropriate choice of technique for data elicitation. It allowed the researcher to explore new topics of discussion, clarify understanding and challenge viewpoints without compromising the overall intent of the interview protocol. For an inexperienced researcher it also provided the perfect opportunity to improve questioning techniques.

Whilst semistructured interviews inevitably make direct comparison of responses more difficult, the intent was to gather a range of perceptions and perspectives from the Inspectors and, as such, formally structured interviews would not have been as suitable.

The individual interviews were analysed at length to determine emergent themes. Salient comments made around these themes were extracted and transcribed verbatim. Where used within this thesis, they remain unattributable in line with the agreement of confidentiality made with the Inspectors.

The Inspectors were self-selected to some degree by their agreement to participate in the research. Not all Inspectors who were approached were willing to be interviewed. For some, this may have been a saliency issue where they felt the research was not pertinent to them. Others excused themselves with workload.

The remaining Inspectors interviewed were keen to share their experiences and to educate, providing articulate unsolicited insights and personal observations.

They were forthcoming on all subjects raised and were confident in their opinions and in the confidentiality of the interview material. The researcher had no concerns regarding probity but was mindful that comment was subjective and based on experience and should be treated as such.

The interview protocol added much needed structure to what had the potential to decline into nothing more constructive than an informal chat. It allowed the researcher to make good use of limited time, made the interviewing of multiple subjects "more systematic and comprehensive" (Hoepfl, 1997) and kept the interactions focused. The researcher was conscious of the danger of collecting a lot of interesting information but very little 'evidence'.

After these interviews, the researcher felt that a sufficient breadth and depth of information had been uncovered and any subsequent interviews would have simply proven repetitious and so this phase of the study was drawn to a conclusion.

Similarly, ten people were formally interviewed in person at the National Transportation Safety Board in the US including subject matter experts from aviation, marine, rail and pipeline modes as well as human performance specialists and technical writers. These interviews were also analysed and provided insightful comments regarding the differences and similarities of the work of accident investigators in the two countries. Where appropriate, these have been subsumed within the quotations. Only where there are marked differences of opinion or process are they context-identified.

4.2 Content analysis and coding

"There is no single way to analyse qualitative data" but in essence it is the process of "… resolving data into its constituent components to reveal their characteristic themes and patterns." (Coffey and Atkinson, 1996). Miles (1979) describes qualitative data as "an attractive nuisance". Attractive because of its richness but difficult to find analytic paths through the richness. Dey (1993) purports that analysis is a threefold activity involving describing, classifying and connecting.

Whilst semistructured interviews can be time consuming to undertake and then to analyse, due to their lack of strict adherence to a predetermined protocol, they are much 'richer' in terms of the quality of information elicited (Hayes, 2000).

Content analysis was thought to be the most appropriate technique for analyzing and coding the semistructured interview data in this phase of the research. It was found to be a straightforward means of structuring and linking the responses into logical emergent categories. Whilst it has been described as "codified common sense" (Robson, 2002), content analysis is the "… simplest, most robust, obvious, transparent and defendable way of analysing the data"

(Stewart, 1997). Its emphasis lies upon allowing categories to be emergent from the data in the spirit of ethnographic content analysis as opposed to systematically quantifying data in terms of “predetermined categories” (Bryman, 2004).

The primary task was the reduction of data into “analyzable units” (Coffey and Atkinson, 1996) by creating categories. This was done by coding and linking associated data to create categories, having some common property, thereby reducing the data into manageable chunks.

This required using codes as a set of organizing principles. Coffey and Atkinson (1996) state that such principles can be existing theoretical concepts or “… key variables derived from the research literature”.

Codes were applied to the transcriptions using random descriptors at first, but given the “continuous, iterative” nature of analysis (Miles and Huberman, 1994), successive refinement ensured these descriptors were soon rationalized and consistent.

The coding in this phase of the study involved mapping incidence and measuring the relative incidence of different codes. By assigning codes, the researcher looked to identify and interpret the data, enabling the classification and connection as alluded to by Dey (1993).

The researcher used QSR International’s CAQDAS (computer assisted qualitative data analysis software) to facilitate this process; in particular NVivo7. NVivo7 provides a range of tools for data handling and theory building based upon texts derived from interviews, observations, document analysis and literature reviews. In addition, it supports coding and the retrieval of coded material. The researcher found that whilst CAQDAS can be a useful tool for ordering and structuring the analysis of qualitative data, its obvious drawback was that it was not an automatic process; manual coding of the data was still required by the researcher, thus the potential bias of subjective assignment of groupings remained.

It was important that the researcher was not adding layers of interpretation onto the responses given but that any accounts reflected what the Inspectors interviewed actually said and not what the researcher thought was meant (Bartunek and Seo, 2002). Content analysis allows for greater flexibility but with it comes the possibility of increased researcher bias (Speakman, 2007).

The interest for this research was in transcribing the content of the interviews and not pauses, intonations or other non-linguistic features of speech and as such these were omitted from the transcripts.

Given the use of a protocol to guide the semistructured interviews, it was not surprising that the interviewees for the large part, focused upon similar topics and areas for discussion. The individual differences in response were, however,

interesting; exceptions and 'misfits' being seen as equally important as concordant data (Coffey and Atkinson, 1996).

Yet despite differences in opinion and approach between individuals, groups and Branches, the content of the interviews was sufficiently consistent so as to allay fears that use of a relatively small sample might evoke.

Analysis of the transcripts provided the following themes: evidence collection; interviewing; liaison with families; analysis; report writing; recommendations; and inquests. These categories follow the discrete phases of the investigative process or are individual tasks associated with the successful conduct of an accident investigation. In addition, the non-task themes of being an Inspector, the role of the Principal Inspector and comparisons between the UK and US accident investigation agencies were determined. In the subsequent section, exemplars derived from the transcripts have been used to illustrate the perceptions of Inspectors with regards to these categories and particularly where there is an allusion or reference to 'effective behaviour'.

The use of quotes provides "… a detailed account of how those being studied feel about and understand events" (Neuman, 2006); a quote being seen as a legitimate way of ascertaining a person's perspective without the need for a total transcript.

It should be reiterated that it was not the intention of this phase of the research to provide a detailed account of each task within the investigative process but to focus on those aspects deemed appropriate to effective behaviour research by the interviewees.

4.3 Task specific themes

4.3.1 Evidence collection

Given the perception by the lay-person of accident investigation being a quasi scientific activity, the researcher was surprised to find that there were significant differences in the approach that individual Inspectors took when visiting an accident site. In place of a prescriptive methodology, each investigator had a slightly different way of collecting data, all working within the bounds of governing legislation.

> *"We came up with rather nice aide memoires (sic) to use at the site but to be honest, I've never had the time to look at it when I've been on site. I've used it back in the hotel just to make sure I haven't forgotten anything but on site, it's much more difficult to use."*

Many of the comments supported this view and whilst time pressure was cited once or twice, the overriding reason was because every accident is different.

"I asked when I arrived, did people have checklists and things and nobody does, and I can understand now why they don't. Every one is so different. You've just got to go and make your mind up at the time. But there are general broad principles. Go to the accident site, see what's there."

"I don't think it's too structured as every accident site is different."

"There are different ways of doing things but the end result is fairly similar but there is an amount of individuality."

"There is a common thread running through every investigation, but that's just the skeleton if you like. The flesh you put on it comes in different shapes and sizes."

Individuality as a theme ran throughout the researcher's interactions with the Inspectorate. Within each of the Branches, the degree of accepted individuality varied. The Rail Accident Investigation Branch with its incipient problems of trying to gain acceptance from the rail industry as a professional competent organization had employed a more rigid structure to establish standards and consistency across its staff. The Air Accidents Investigation Branch, by contrast, had a long history of individual experts working in isolation and appeared less prescriptive in methods employed.

"I don't have a game plan or book to look at. I just trust my instincts."

Not knowing what would be found at the accident site was the most frequently cited reason for maintaining a flexible approach to data collection. It was felt to be important to be able to prioritize and exercise judgement and not to be constrained by a rigid process.

"When you first get to an investigation you have so much information coming up that you can't physically cover all of it so you have to be a little bit selective so you select things that you think are most time critical and leave the other things to collect at a later date."

"There is such a lot to organize when you first get on site. Asserting yourself and ensuring that your needs are met – without being too officious of course – is really important. You need to work out very quickly who's going to be important to the successful outcome of the investigation."

Very often, time is of the essence. The accident scene cannot always be preserved and decisions need to be made as to what is vital. This is particularly important in rail accidents where there is a business imperative to get the railway reopened as soon as possible after an accident.

4.3.2 Interviewing

Part of the data collection process, interviewing witnesses and family members is an important but time consuming activity. Eyewitness testimony, essentially reconstructive in nature, can however be highly unreliable (Loftus, 1984). The Inspectors interviewed were acutely aware of the variable reports that they could gather from witnesses.

> *"You sometimes have to take things with a pinch of salt and if it doesn't fit then you have to park it elsewhere."*

> *"They [witnesses] can be a bit of a headache. They can be very unreliable, they can be very good. You do get a feeling as to who is likely to be better than others. People are very bad for filling in gaps. You get all sorts of things described to you that you know couldn't have been."*

The discerning Inspector had the ability, it was reported, to extract salient data from extraneous information – during the interview process as well as technically. Nothing was taken at face value and everything required evidential corroboration.

Whilst not required to take official signed statements from witnesses, many Inspectors felt more comfortable having them in order to protect themselves should witnesses move to retract statements at a later date. Other Inspectors, however, felt that their notes and observations taken during interviews were better removed from a potential litigious process and as such refused to have gathered statements signed.

> *"We're empowered to take statements but we're not required. As we're not required, I just take notes. Ours is an investigative process not a legal one."*

4.3.3 Liaison with families

Historically, the accident investigation process proceeded in isolation from both the legal system and interaction with the families and friends of those involved in the accident, particularly where fatalities had occurred. This situation has now changed.

> *"In the past it was like a necessary evil having to speak to people; not very much you could do for them. Now we practically bend over backwards for them. Told it enhances our professional reputation."*

There has been a shift in attitude since the late 1980s, not just within the Branches but across the emergency services, as appreciation grows of the need to not only look after the dead but also to respond effectively with the

living and Inspectors now find that an increasing amount of their time is spent describing their findings to relatives.

In the UK, charities such as Disaster Action (founded in 1991 by survivors and the bereaved from disasters such as the Herald of Free Enterprise at Zeebrugge, the Marchioness and Lockerbie) have done much to provide an advisory and advocacy service for people affected by disasters. In the United States, a dedicated service is provided by the National Transportation Safety Board through the Office of Transportation Disaster Assistance. They are self-described as "… a lighthouse in a storm" (NTSB, 2006). Whilst not an integrated function within the UK Accident Investigation Branches, more emphasis and awareness is now placed on family liaison.

There was little variation in response to a question of how much value liaising closely with families added to the process. Most Inspectors fully appreciated the benefit that families derived from having the facts explained to them by those undertaking the investigation.

> *"We are public servants after all, providing a public service. The least we can do is to explain to people why their loved ones died."*

> *"You lead them gently through it and it helps if you can dejargonize it."*

> *"My strategy [with families] is to be helpful, answer any questions as opposed to being there for emotional support."*

Far from being an onerous task, liaising with family members was considered to be a tremendously important aspect of the role:

> *"I felt like I'd done something worthwhile."*

> *"We get an amount of job satisfaction from it that we perhaps didn't think was in it for us."*

> *"It's a bit tricky but I've not found it too bad. I think it's down to people's approaches to be honest. I find it quite rewarding because I never consider myself to be a people person."*

But not one without its difficulties:

> *"You can help a family by doing a thorough investigation even if the result might not have been what they wanted. Every family wants it to be that the pilot struggled heroically with the aircraft to avoid a school, to land it in a field at great cost to himself and that it was unavoidable. But most of them aren't like that. Getting that across is not an easy job."*

"It's one of the hardest things because you never know how someone's going to react. However they react, you have to keep it professional and on the level and it's hard not to react to their reaction. You can get called all sorts of names under the sun."

"A widow became irrational and accused me of doing a cover up. Whatever else I get accused of here, I always give my best when I'm doing an investigation."

"Try not to make any crass remarks: it's not difficult; it's not rocket science."

Inspectors felt that a balance of empathy and detachment, professionalism and humility when dealing with families was admirable.

4.3.4 Analysis

There are a plethora of data analysis tools available to accident investigators, including Why-Because Analysis (Ladkin, 2001), the Transportation Safety Board of Canada's Integrated Safety Investigation Methodology, Blackett's (2005) Combined Accident Analysis Method and most recently, the Australian Transport Safety Bureau's analysis framework (ATSB, 2008). Whilst these tools and many others are familiar to the Inspectors, anecdotal evidence suggests that they are neither widely nor consistently used. The AIBs, similarly, vary in their levels of prescription in terms of methodologies used, which was unexpected to the researcher. It would be speculative to suggest that these models do not provide the breadth and flexibility that is required, but there was no evidence from the interviews to indicate that it was felt that employment of any one specific methodology would greatly benefit the overall outcome of the investigation. Inspectors have, it would appear, a preference for relying on intuition and experience. One Inspector commented:

"If it's not an engineering problem then you are down to speculation."

Another compared the process to that of constructing a jigsaw puzzle (hence the term 'jigsaw men').

"You've got to find all the bits of the puzzle and see what pieces you have in order to make up the overall picture. If it's a violent impact there will be huge bits of the picture missing. But we've got a few of the corners and a few straight edges. There may be a few blanks but you can roughly get the picture."

"Most of them [accidents] you get a comfortable feeling about what happened, you can't show evidence but you've got an idea. Sometimes you just can't find a solution."

The lack of a concrete solution, whilst unsatisfactory, does not appear to cause too much consternation with the Inspectors interviewed. It is not thought to be a reflection on the abilities of those involved or the methodology used but as a result of insufficient available evidence and system complexity.

> *"It doesn't hang over me, I don't feel guilty that I couldn't find the answer. There were quite a lot of possibilities and some of them do remain open. One of the first things I say to families is that there might not be a cast iron answer."*

> *"As aircraft get more complex there are going to be one or two where we just don't know 100% what happened. But people do adapt with new technologies. We will keep abreast of it."*

4.3.5 Report writing

As previously discussed, the accident report is the culmination of the investigative process – the quality of the latter being measured entirely by the quality of the former. Of all the aspects of the investigation, this is the part that many Inspectors claim to find most difficult.

One aspect of report writing that was alluded to frequently was the length of time it took to produce reports. Inspectors were mindful of the constant need to balance the creation of a comprehensive and evidentially based report with the need for industry and families to get timely information. Some felt that the time taken for a report to be published often detracted from its impact. As was noted in the literature review, this can take anywhere up to three years, although many reports are published in much less time.

> *"I'd rather have a report come out within six months and be useful as opposed to waiting three years for the polished article. Everything moves on."*

> *"Although accident information is confidential there is great benefit in giving that information back out to industry as soon as possible. I'd rather get a report out in six months with some useful information than have a fault free report come out in three and a half years."*

> *"No point in producing a report that's too old."*

The 'need to know', however, is always weighed up against the veracity and resilience of the evidence within the report and as such, appropriate levels of scrutiny are required to maintain the expected standards.

> *"Good quality takes time. And sometimes it's like every paragraph's hewn from granite."*

"We've become a lot more professional. Our reports are a lot more professional but it takes us longer to do them."

"The writing is the most important skill. This job is essentially a writer's job and once in a while they let us go out and play in the dirt."

Whilst it was suggested that the variability in writing abilities amongst the Inspectors was acknowledged to sometimes negatively impact the report production process, the internal workings of the Branch, a hierarchical editing process (alluded to in section 4.4.2 of this chapter) and the often unique nature of the accident themselves could mean that even the most effective investigator could find their report taking a considerable length of time to produce.

Reports, particularly where there is more than one Inspector involved, can be a result of a 'collision' of two separate reports, an amalgamation written by one of the Inspectors or an 'assemblage' created by the Principal Inspector. These differences in report writing process can once again lead to variability in quality and production time.

4.3.6 Recommendations

Recommendations form a transaction between those investigating and those whose responsibility it befalls to implement improvements and changes.

The Branches are not empowered to enforce recommendations and as such, it is encumbent upon those developing them to do so in such a way as to instigate change in a timely and cost effective manner.

As a consequence of the report findings, recommendations will be made to prevent recurrence. Not unlike the reports themselves, recommendations will stand or fall dependent upon the way they are written and interpreted.

"When you write a recommendation you might think you've written what you intend but somebody can take it and interpret it in different ways and it actually hasn't cured the problem. In name, 80% of them are taken up but you need to look at how satisfactory the action has been."

"The recommendation is the most important part of the report. It's important that we factually understand what happened but the big thing is to stop the next one."

There is ultimately a trade-off between what the Accident Investigation Branches would like to recommend and what the company or industry is prepared or able to do. A well-crafted recommendation will satisfy on multiple

levels and the most astute Inspector will have the ability to balance cost and safety benefits. Recommendation writing is seen as no time for crusading.

> *"Some investigators can become too attached to the issues and that actually clouds their vision."*
>
> *"It's frustrating if you've come across something before and you want to make the same recommendation again."*
>
> *"You have to have an accident to make the safety measure."*
>
> *"People want to know that their loved ones haven't died in vain. I think if recommendations are made which would help prevent the accident happening again, it would also help the family."*
>
> *"A few good recommendations are much better than a lot of mediocre recommendations."*

Significant and far-reaching changes are possible: for example, the MAIB's investigation and report, on behalf of the Bermudan Government, into the fire onboard the cruise ship, the Star Princess in 2006 led to one cruise company having to change over 160,000 balconies (MAIB, 2006a).

A fire had broken out on a cabin balcony, spreading quickly until a substantial part of the port side of the ship was ablaze. Balcony areas had not previously been included within the fire risk assessment of cruise ships but given the combustible nature of the materials used in the balcony screens, furniture and decking, the MAIB issued immediate recommendations, which were accepted, to counter the risk of this type of marine casualty.

The majority of recommendations, however, are acknowledged to be only minor incremental adjustments to an already tightly run system or safety conscious industry. Timeliness becomes an issue, particularly when reports take a long time to be published. It is not unusual, however, for recommendations to be acted upon prior to publication particularly where there is an immediate safety implication.

4.3.7 Inquests

Not unlike liaising with families, involvement with inquests, whilst not essentially a task item within the investigative process, is, nevertheless, an ever-increasing aspect of the role of Inspector.

It is not unusual for Inspectors to be called to an inquest to provide an account of their findings. Whilst the Inspectors interviewed acknowledged that inquests were a necessary part of the legal process, they were experiencing more

pressure to be mindful of the legal ramifications of their investigation over and above the regulatory requirements.

> *"In a bounty hunting and compensation culture" … "You've got to keep the legal train going at the same speed as the investigative one."*

Many Inspectors expressed concern at the impact that juggling such requirements was having on their investigations and some felt that the NTSB process might be beneficial. NTSB investigators are prohibited by law from giving evidence in a court. The accident report, a purely factual document, remains the property of the Board and is inadmissible. In the UK, however, Inspectors from the MAIB and AAIB can be called to give evidence based upon their findings. They are entitled to voice 'opinion' where the lay person would be constrained to 'fact' and provide "… technical analysis and opinion inferred from factual evidence" (Pamplin, 2000). The RAIB Inspectors have precluded themselves from giving opinion by appearing as a 'witness of fact'.

> *"I'm not going to take written statements so that they can be taken by the courts and misinterpreted."*

> *"Coroners inquests. Really quite daunting. You get a good going over."*

4.4 Non-task specific themes

In addition to the previously described task-oriented themes, content analysis of the interviews also offered additional groupings. These are general descriptors which traverse the task-oriented phase. Illustrative quotes will now be offered for each of the following coding groups: being an Inspector; the role of the Principal Inspector; and US/UK comparisons.

4.4.1 Being an Inspector

The day-to-day reality of the role of accident investigator is very often shrouded in mystery and legend, particularly within aviation, making it a coveted position for many within the industry.

> *"People outside have this impression that we're this amazing world leading organization. As long as we've got the reputation I think we'll be doing OK. We do do a good job."*

> *"The reputation that this Branch enjoys around the world – people do actually step back and say we're glad you're here. That's not the individual, that's the collective image that we deliver. So our corporate image is very very good, with industry, in this country and abroad. It's just the internal bits."*

"This place isn't unique but it's subtly different."

And whilst the Inspectors were justifiably proud of their respective reputations at home and internationally, there was a feeling expressed that, perhaps understandably, not all applicants or new starters really understood how the Branch functions.

> *"You don't really know what the job's about until you get here. There's a little on the internet, but not much. It's only when you get here that you find out what people really do, how the job is organized. In some ways, it's quite difficult because you're applying for a job that you don't know anything about, technically."*

The Inspectors offered opinion regarding the types of individuals that they felt would be best suited to the role:

> *"You don't want people who are too quiet – they might find it difficult to cope. Extraverted would be a problem as well. It's an exercise in moderation; you don't want extremes of people."*

> *"Going back to the sort of person you recruit here, they have to be motivated, they have to be self-starters. They don't have to sit there pathetically saying where can I find this. They need to go and fish it out themselves."*

> *"The kind of person you get here has to demonstrate they're good at a steep learning curve."*

> *"You have to be of a certain intellect and you have to demonstrate that you have a curious mind, an inquiring mind. If you need to find out something then you can, you can learn it. That's one of the main qualities of somebody coming here."*

'Curiosity' and 'motivation' were two terms continually used during the interviews, at all three Branches, and the researcher was interested to see whether these would continue through the subsequent phases of the research.

Given the stochastic nature of accidents, many Inspectors experience occasional difficulties with the balance of workload.

> *"In no other job have I had workload that builds up like it does here. It's peaks and troughs but when you're in a trough you wonder how you're ever going to get out of it. It's out of your hands. It's quite a unique situation."*

This can be ameliorated in part by the structure of the organization but as accident investigation is purely a reactive function, it is not uncommon for

Inspectors to find themselves 'juggling' the pressing attentions of two or three concurrent investigations.

Accident investigations involve splitting time between the accident site or 'field' and the office. Most Inspectors interviewed expressed a preference for being out in the field: collecting evidence; talking to witnesses; "playing in the dirt". They are self-styled 'active intellectuals'; many feeling their purpose to be anywhere but the office. These out-of-the-office activities inevitably needed to be balanced with internal paperwork and report writing.

There is a natural, if not gruesome, public fascination with death (Henry, 2004) and Inspectors learn, not only how to deal with the inevitable fatalities:

> *"You don't really know what you're letting yourself in for, you just have to know that you have an interest in that sort of work. No one can come along and say hand on heart, that is the job for me. There are still aspects of the job that you have doubts about."*

but also how to deal with the public's morbid preoccupation:

> *"I tend to say I'm a pilot. I don't like the barrage of questions that come with saying you're an accident investigator. It's not very long before they're asking what do you do with bodies and you don't want to go there really."*

Research has shown that there are relatively low rates of psychological distress in occupational groups such as accident investigators, attributed in part to their well-defined role and clear sets of responsibilities (Schein, 2006). This was supported by the Inspectors who asserted that concentrating on the task in hand enabled them to look past the emotive aspects of their role.

> *"You do develop a sort of tunnel vision where there's a body but there's a bit of wreckage that you need to look at. You just sort of concentrate on that. The professional drive to get things done properly does help you through some of the worst of the gory bits."*

> *"I was very surprised that it didn't affect me at all, and I thought it really should have done. At the time, there's a job to be done and other things to think about."*

That was not to say that the Inspectors denied the potential impact that dealing with fatalities could have.

> *"There are some people that might be affected in which case they're going to need a heck of a lot more training than you get on the Cranfield course but you've just got to make sure you get the right people in through the door."*

"I know that the day will come when something about the job will affect me."

Psychological interventions such as Critical Incident Stress Management (Leonhardt and Vogt, 2006) which encourage guided debriefing post accident to mitigate the impact, were dismissed as non-essential. Less formal coping strategies such as the use of humour and discussions "over a few beers" were felt to be sufficient. There was an acknowledgement that specialist services were available if required but it was rare (or at least not publicized) should an Inspector avail themselves of this aid.

"You need a good sense of humour here. You develop a type of black humour that if it ever got out into the press you'd be castigated for it."

There are slight variations in the organization of each of the Branches, with RAIB and MAIB operating with dedicated teams and Principal Inspectors for both the operation and man-management functions and the AAIB using an on-call rota basis for individual Inspectors and Principal Inspectors rather than teams, producing ad hoc pairings between Engineering and Operations Inspectors.

Inspectors at the AAIB suggested that:

"Teamwork happens on an individual investigation basis but not as a Branch on the whole."

"We work very much as individuals."

There was an acknowledgement that a team orientation was, however, desirable:

"When you're out in the field it's OK to be a loner but when you're back in the office or liaising with your colleagues at the end of the day, you need to be a team player."

In a study conducted at the AAIB, Viney (1992) quotes an Inspector describing their role as the "Last home of the rugged individualist." This is responded to by another Inspector: "Part of the strength, part of the weakness." It was felt that the organizational structure was in part responsible for perpetuating this "rugged individualist" characteristic of the Branch.

The proclivity for working as individuals was noted by the researcher to be greater at the AAIB. Possible explanations for this include the physical structure of the working environment at the Branches where AAIB Inspectors have individual offices in contrast to the MAIB and RAIB Inspectors who work in an open plan environment with their team colleagues. The style of leadership has also been suggested as an influencing factor as has industrial background

– particularly at the MAIB which, in the researcher's estimation, demonstrates the most effective teamwork of the three Branches.

One of the tenets or guiding principles of the three AIBs is the preservation of independence or impartiality. Whilst paid for by the Department for Transport, the Inspectors feel themselves to be answerable only to the public for whom they were created to serve.

> *"We are completely independent so we can impartially tell people what happened. The relatives and the other people connected."*

Being removed from the political arena and detached from the regulator is vital for the effectiveness of an investigation.

> *"You have to leave party politics out of this job. We have no axe to grind, we really don't. And that is one of our greatest weapons. The lack of an axe."*

One Inspector commented that remembering who the reports were writing for (that is, the families and the industry) went some way to disincline investigators from 'crusading'. Reports are written and recommendations made to a largely mature industry where "… there aren't huge great solutions out there." An effective investigator would accept the limitations of the role to provoke ongoing dramatic changes to safety.

> *"It's very difficult to make a big step forward in safety."*

> *"It's not a world changing job – you personally are not going to have an impact on safety."*

> *"It's just chipping away. All we can do is to find out what happened and come up with an explanation."*

4.4.2 The role of the Principal Inspector

The role of the Principal Inspector within the UK Branches is twofold. They are expected, by turn, to perform a man-management role (performance, attendance, holidays, expenses, etc) as well as acting as an Investigator-in-Charge (IIC).

Each investigative body has its own interpretation of the role of the IIC (Koning and Peters, 2006). Typically it implies a responsibility for the conduct of the investigation including the production of reports (ISASI, 2004). On a large-scale accident or high profile where many investigators are deployed, such as Lockerbie or the Marchioness, the IIC will become the focal point for the investigation.

In the US, the NTSB's employment of the party system calls for an IIC to have an overarching control of the investigation 'life-cycle' (Koning and Peters, 2006).

> *"As IIC, I'm a generalist – I look at the forest so to speak. I'm a project manager."*

Whereas the Board Members will provide the focal point for the media and other interested parties, the IIC's role in the background is to ensure the Members are fully apprised.

Given the thankfully small number of large-scale accidents that the UK Branches attend, this is often a nominal role - much to the vexation of some of the Principal Inspectors. There is a conflict as to whether this should be a hands-on role – out in the field, taking command - or whether it is purely an office based activity, providing coordination, support and oversight to the Inspectors in the field.

Principal Inspectors offer a "technical sounding board" to their colleagues:

> *"An experienced PI who has been here a long time has an awful lot to offer in terms of mentoring or where you might go for guidance if he can't give you the guidance himself."*

Given the flat structure of the organization and the combined seniority and experience of the Inspectorate, the position of Principal Inspector was, however, seen as an unenviable role. Removed from the day-to-day investigation and managing others with sometimes greater seniority.

> *"I can't imagine anyone wanting to do that role. It's neither fish nor fowl."*

What became apparent from these exploratory interviews as well as those with the Principal Inspectors themselves in Phase 2 of the research, was that their primary role had evolved to be that of principal report editor. Further discussion of the role of the Principal Inspector can be found in the discussion chapter of this thesis but with regard to this editing function, there was universal disapprobation regarding how well this was carried out.

> *"It's the PI's job to bring together all the parts of the report and this can be a problem when everyone has different workloads and priorities."*

At the MAIB, given the fixed team structure, Inspectors will have their reports edited by their own Principal Inspector whereas at the AAIB, the more fluid organization means that initial editing (all reports are subsequently read and revised by the Deputy Chief Inspector and Chief Inspector) can be done by one of four Principal Inspectors. This has the potential to cause conflict:

"You can have four PIs each with a different perspective."

Depending upon personalities and writing styles, this process was reported to range from easy to combative in style.

The overall structure of the aviation accident investigation report is essentially governed by the ICAO standards which have been adopted and adapted by other industries as required. Whilst this remains fixed, there can be a high level of variability in the content and writing style. The role of the Principal Inspector is meant to go some way to mitigate this diversity but seemingly only adds to the issue. One extreme view was that Principal Inspector's offered nothing more than "… destructive criticism for not doing things properly when there's no proper way to do it." If so, it could be proffered that the standardization is not quite as standardized as required.

4.4.3 UK / US comparisons

The purpose of including quotes regarding accident investigations from both the UK and the US was to illustrate how the structure and philosophy of the organization might have a bearing upon the way in which the investigators function and their output. Interviews were conducted at the National Transportation Safety Board in the US to enable the researcher to gain insight into the varying operational and political differences and to determine whether once these were removed, the basis for measuring effective behaviour would remain the same.

The NTSB's party system approach to accident investigation ultimately shapes the entire process. Unlike their UK counterparts, investigators at the NTSB operate as specialists in their discrete fields. There is a trade-off between the breadth of generalist knowledge and experience that is found at the UK AIBs and the depth of in-house specialism (for example aircraft systems, human performance, operations) at the NTSB.

The party system supports this specialist functionality by inviting qualified technical and labour representatives to join the fact-finding field phase of the investigation. Under the direction of the NTSB, technical background information is gathered for use in the Board's factual reports (NTSB, 2002). Based upon this information, the five Presidentially-appointed Board Members determine probable cause and issue safety recommendations.

Particularly within the NTSB HQ in Washington, DC, investigators accepted that sometimes the party process can be "cumbersome" but "… it can bring a lot of eyes to the table. It's a check and a balance."

The UK Inspectors acknowledged that whilst more specialist knowledge in-house would often be beneficial in expediting the investigative process, they perceive there to be shortcomings in the US system; inefficiencies that

surprised them, echoing Uff's concerns about the wastefulness of multiple enquiries (Uff, 2000):

> *"In spite of all the dedicated expertise, there were still large gaps in understanding and it's surprising with all that manpower."*

> *"Everyone works in little holes in the ground and stuff gets missed. We have a fewer number of groups that we think are more pertinent to the job. Because we're all inherently nosy, we all sort of look over into one another's holes and so there's an awful lot of overlap."*

US investigators, particularly within aviation, spend a considerable proportion of their time investigating overseas or foreign accidents, where an American product or citizen is involved.

> *"There's a lot we can learn and if we didn't learn from foreign investigations, we'd have to wait for them to crash here before we could learn. So, I'm a full defender of the international work that we do."*

Whilst necessary, the US investigators acknowledge that very often these investigations are "frustrating".

> *"Even dealing with people like the TSB in Canada; even the AAIB is difficult to work with sometimes. Their rules are different to ours. What some of the rules do is to handcuff how much information we're likely to get."*

This was rejoindered by an AAIB Inspector who commented:

> *"The NTSB believe their system is global. But their system is their system, it's not ICAO's system. It's not how everyone else does it."*

Both groups acknowledged, however, that:

> *"There are different ways of doing things but the end result is fairly similar."*

4.5 Conclusion

Whilst the purpose of Phase 1 was very much to provide background information and familiarity with the context, the researcher was still mindful that the research should be of worth in its own right. Applying Lincoln and Guba's (1985) principles of 'trustworthiness' as a qualitative alternative to reliability and validity, the researcher reviewed the findings of Phase 1 in terms of its credibility, transferability, dependability and confirmability.

The similarity in the Inspectors' responses gave the researcher confidence in the truthfulness and therefore credibility of the data. Whilst opinions held differed, no comments were made that were found to be in complete contrast to the collective lines of argument. Qualitative research is not necessarily characterized by generalizable findings: the degree of transferability was, therefore, thought to be somewhat limited to the functional group although not necessarily to simply those working in the UK Branches. Similarities were also felt to be possible in aspects of police work or external investigative bodies. Dependability required an appropriate and consistent application of the process and whilst the interview format allowed for a certain degree of flexibility because of its semistructured nature, it nevertheless retained consistency through the use of an interview protocol which ensured that the interviewing of multiple Inspectors remained systematic and comprehensive. Whilst qualitative research is by its nature a subjective activity, the researcher remained mindful during the analysis of the interview transcripts of the need for reflexivity and that layers of biased interpretation were not added but that any accounts were a reflection of what was actually said. By doing so, the researcher intended to demonstrate neutrality and thus confirmability.

5.0 Phase 2 Analysis

5.1 Introduction

The second phase of the study sought to determine the perceptions of Principal Inspectors regarding behavioural indicators of effectiveness in accident investigation. This was achieved by employing the Repertory Grid technique to structure interviews and elicit responses.

Interviews were conducted with each of the nine Principal Inspectors from the MAIB and AAIB. The interviews lasted between 55 minutes and 2 hours and 16 minutes; the average length of interview was 1 hour and 40 minutes.

The interviewees were asked to compare and contrast the behaviours of firstly effective and then less effective Inspectors with regards to task-oriented qualifiers (how they collected evidence; how they analysed evidence; how they liaised with families; how they wrote reports and how they made recommendations), resultant from Phase 1 of the research. Their statements were recorded as constructs.

Each of the Principal Inspectors spoke confidently and without reserve. When asked to bring to mind effective and less effective Inspectors, they were able to do so and whilst the majority used exemplars from their own team, two Principal Inspectors preferred to use Inspectors that they had worked with previously.

Asking the interviewees to centre on the task-oriented qualifiers enabled the researcher to maintain control over the flow of the interview and ensure that requirements of the interview were met. Constructs were either to be 'behavioural' (visible behaviours, actions and abilities) or 'cognitive' (hidden thought processes which are usually inferred) (Robinson et al, 2005; Spencer and Spencer, 1993). Whilst this research focuses mainly upon behaviours, the researcher wanted to capture constructs regarding cognitive abilities that could be inferred from an Inspector's behaviour.

The laddering technique, used to focus the constructs, worked well and enabled the researcher to clarify ambiguous or vague statements by repeatedly asking what the interviewees meant. Laddering repeatedly asks the questions "why?", "how do you mean?" or "in what way?" in order to "probe the thinking behind the constructs" (Adams, 2001), focus the construct, remove cliché and prompt the interviewee to question their own statements. It was important that both the researcher and the interviewee shared an understanding of the constructs being put forward as "… such a discrepancy can be an important threat to the content validity of a construct" (Bartunek and Seo, 2002). The Principal Inspectors were observed to refrain, for the most part, from passing comment regarding personalities and any such comments were discounted from the transcripts.

The Repertory Grid technique worked well for this phase of the research as a means of focusing the interviews on the specific examples of effective and ineffective behaviour. Being asked to bring to mind specific individuals ensured that the constructs were grounded in behaviours that reflected what actually occurred at the Branch as opposed to introducing behaviours that were idealistic. It is usual for interviewees to rate the elements (in this case the Inspectors) against the constructs determined from the interview but the Principal Inspectors indicated unease at performing this task. Therefore, for the purposes of this research, ratings were not considered to be appropriate which concurred with the expressed intention of the researcher that this should not be an evaluative study. The constructs were generated to form the basis of the questionnaire used in Phase 3 and were designed to be rated against the qualifiers of recruitment, training and the superior investigator.

Slater (1977) suggested that "… a single grid may contain as much data as a postgraduate student might not long ago, have collected in the course of a research project for a doctorate". With this in mind, it was important for the researcher to be selective in what aspects of the data the analysis would focus upon.

5.2 Establishing constructs

Computer packages are available and offer an advantage to researchers with large grids and many calculations to perform (Freeman, 2003). For the purpose of this study, however, the decision to not employ such a program was made as the data set gathered during the course of the Repertory Grid interviews was largely qualitative and therefore did not lend itself to what is primarily a quantitative analysis. This decision was supported by Fransella and Bannister (1977) who issued a "… reminder to those in danger of being caught up in the number game, that there are many interesting things that can be done working directly with the grid's raw data".

Recordings of the nine interviews were replayed and statements identified as constructs were transcribed verbatim. Constructs were defined as a basic unit of description of a behaviour that demonstrated effectiveness in accident investigation or its polar contrast. The Repertory Grid interview required each construct to be dichotomous or bipolar (Kelly, 1955) so that a contrast existed for each unit of description: for example, 'stubborn when challenged' was offered as the negative polar contrast to 'willing to compromise'.

Content analysis was used to elicit constructs and contrast from the transcribed data. Content analysis, as previously described, is a generic term for the core of the activity where reporting assumes the presentation of findings that are representative of what was said (Jankowicz, 2005). It provides a "… robust mechanism for identifying the common, and most important, constructs" across

interviews (Freeman, 2003) and is used in Repertory Grid to build up a picture of the skills deemed effective (Stewart, 1981).

In total, 114 constructs or behavioural indicators were determined from the data. These behavioural indicators were initially rationalized, reducing the number down to 100, removing duplications where there was an allusion to similar aspects of behaviour through a semantically different expression. They were retained, however, if they clearly offered a different perspective on the same behaviour. Propositional constructs regarding characteristics such as age and gender had already been removed as well as personal attributes that did not have any bearing on behaviour.

Further analysis of the remaining 100 bipolar constructs suggested five competency themes by which the behavioural indicators could be divided into groups: interpersonal and communication skills; work activity management; personal attributes; cognitive abilities; and technical abilities. The researcher, once again, used QSR International's computer assisted qualitative data analysis software, NVivo7, to facilitate this process.

As only the researcher was used to code and analyse the behavioural indicator, there were no issues with regards to inter-rater reliability but there remained a possibility of bias which in qualitative research is "practically unavoidable" (Freeman, 2003). This was compounded by using generated categories as there were none predetermined or predefined within the literature. The groupings were, however, reassessed on more than one occasion and only three behavioural indicators out of the total set had to be moved to a different category.

As indicated, there was no pre-existing framework or schema to be found in the accident investigation literature against which to compare these emergent competency themes but the researcher felt comfortable that they were 'grounded' in the data and not force fitted; that themes "suggested themselves" (Stewart, 1997). Parity was found, however, with Robinson et al's (2005) research into aerospace design engineering competencies which supported the researcher's belief regarding the credibility of the competency themes. Again too, the CIPD (2007b) survey offered comparable findings to support the groupings.

Honey (1979) states that the researcher should be prepared to have items that do not fit the main categories neatly to deter them from not "… imposing an order on the raw data that wouldn't otherwise be there." There is a degree of unavoidable overlap between the five descriptors employed as competency themes. They are not mutually exclusive but as no behavioural indicator fell outside the five themes, they are still considered to be a valid means of description.

As the behavioural indicators were to form the basis of a questionnaire in Phase 3 of the study, the indicators were reduced by a further 25% leaving 75 positive

and negative indicators remaining. The reduction was facilitated by a frequency count of indicators across the sample and within the interviews. Some behavioural indicators were mentioned more than once during the course of the interview using different but similar words which was taken as an indication of the relative importance placed upon that construct by the individual. The researcher, however, needed to abstract to a relative importance which was calculated by the frequency of incidence across interviews – the number of interviews in which it was mentioned rather than the number of times overall, to avoid "double counting" (Freeman, 2003). Reducing the number of behavioural indicators was essentially a subjective task, requiring a degree of reflexivity. It became an iterative process: each subsequent review of the data removed further constructs. The researcher took care to ensure that suitable behavioural indicators were not being discarded based on whim or bias and that removal could be justified. Once the required number were removed, the researcher repeated the review to ensure that the constructs left were representative of the overall thoughts expressed by the Principal Inspectors and were not simply a reflection of what the researcher felt should be included.

Varga (2007), however, also suggested that constructs unique to particular interviewees may indicate "old values perhaps no longer shared by most people" or "emergent values" yet to be adopted. Careful consideration of this fact was given before the removal of any behavioural indicators from the list.

It was important that each behavioural indicator (with its positive and negative polarity) stood on its own as a statement and was not contextually dependent for comprehension. Any ambiguities were thus removed and tenses changed where necessary to standardize the statements. No particular order is ascribed to the 75 remaining behavioural indicators; the order was derived from the transcription process. The behavioural indicators are set out below, separated into each of the five derived competency themes.

5.3 Competency themes

Whilst the primary purpose of the construct elicitation process was to inform the questionnaire used in Phase 3 of the study, there are some interesting observations to be made with the data it is own right. The number of behavioural indicators within each of the five competency themes was variable. As indicated, there was no attempt to force fit constructs in order to have comparable numbers of behavioural indicators in each group and consequently two of the categories (interpersonal and communication skills and personal attributes) account for nearly half of all the data. Whilst the competency themes are not weighted in any way, the researcher felt that the increased number of constructs elicited for interpersonal and communication skills as well as personal attributes gives an indication of the relative importance the Principal Inspectors placed upon those two competency themes.

5.3.1 *Interpersonal and communication skills (n=27):*

Construct - positive	Construct - negative
Makes things clear on paper	Unable to show continuity of argument in report
Makes a powerful case for change	Evidence for recommendations lacking
Team player	Appears to be an individualist
Writes an objective and impartial report	Report is vehicle for own agenda
Clear communicator at all levels	Does not modify style of communication depending on audience
Manages confrontation successfully	Can be belligerent
Uses social skills adeptly	Gets people's backs up
Shares information / time / experience	Withholds assistance as knowledge is power
Plays the game with respect to the rules of the organization	Think the rules don't apply to them
Treats people with respect	Contemptuous of others
Demonstrates trust in colleagues	Does not trust other colleagues
Has good written English	Has poor written English
Puts together a readable report	Produces a report that doesn't flow
Understands needs of readership	Writes for self, not audience
Puts information across succinctly	Provides longwinded explanations
Broad generalizable safety message apparent in reports	Makes recommendations too specific
Able to put aside personal differences	Aspects of personality get in the way
Succinct and factual with media	Statements misinterpreted by media
Thoughtful and understanding with relatives	Insensitive to relatives or friends
Visible and contactable at all times	Office never knows where they are
Takes control of situation	Allows others to control situation
Asks searching questions	Uses superficial questioning
Able to delegate tasks effectively	Overly controlling
Accepts differences and works to strengths	Dismissive of others' working styles
Appears approachable	Standoffish / aloof
Listens well	Hears what they want to hear
Interviewees respond well to their questioning	Loses cooperation of interviewees

5.3.2 Work activity management (n=12):

Construct - positive	Construct - negative
Thorough	Superficial when investigating
Plans ahead	Unstructured - shoots from the hip
Productive in output	Takes too long to produce report
Collects pertinent evidence	Collects information not evidence
Not sidetracked by detail	Gets bogged down in the detail
Files ordered and structured	Office / desk is chaotic
Evidence well documented	Lack of transparency in continuity of evidence
Researches previous incidents and recommendations thoroughly	Does not research previous history of accidents
Paperwork available and up to date	Paperwork never up to date
Willing to deal with DfT admin	Feel themselves above DfT admin
Mindful of the cost to the taxpayer	Wasteful with money
Maintains focus in the office as well as when in field	Loses focus when back in the office

5.3.3 Personal attributes (n=22):

Construct - positive	Construct - negative
Shows flexibility in approach	Is unaccommodating
Assertive - has needs met	Does not have needs met
Confident - without arrogance	Comes across as arrogant
Attends to detail	Careless with detail
Self sufficient	Requires constant hand holding
Calm under pressure	Excitable
Shows humility	Acts like a 'know it all'
Willing to compromise	Stubborn when challenged
Prepared to learn	Believes they know everything
Dependable	Unreliable and full of excuses
Uses initiative	Needs to be told what to do
Diplomatic	Tactless
Recognizes privileged public servant position	Overly status driven
Willing to listen to constructive criticism	Too precious about the report
Excited about making a difference to the industry	Too ready to accept the status quo
Emotionally mature	Has had little life experience
Reacts positively to new challenges and ways of working	Likes things to remain the same
Internally robust	Prone to bouts of doubt
Cares about the report with their name on	Has no ownership for report

Puts effort into producing almost perfect report	Leaves the tidying up of the report to the PI
Recognizes impact of own behaviour	Oblivious to how they are perceived
Balances technical and social skills	Prizes technical knowledge above social skills

5.3.4 Cognitive abilities (n=10):

Construct - positive	Construct - negative
Demonstrates an inquisitive nature	Shows no curiosity
Clear thought processes	Shows muddled thinking
Makes realistic recommendations	Makes impractical recommendations
Suggests alternative solutions	Rigidly fixed on one explanation
Balances specifics with bigger picture	Investigation proceeds on too broad a front
Quick thinker	Needs too much time to deliberate
Learns quickly	Slow to grasp new information
Sees past standard responses	Accepts what's said at face value
Produces a structured flow of analysis	Analysis does not follow in a logical process
Good at practical problem solving	Rather too theoretical and academic

5.3.5 Technical abilities (n=4):

Construct - positive	Construct - negative
Understands industry	Has lost touch with real world
Technically competent	Lacks basic technical understanding
Knowledgeable about standards/regulations	Not up to date with regulatory information
Has detailed technical knowledge	Unfamiliar with many aspects of industry

5.4 Conclusion

Once again, the researcher was keen to review the findings of this phase of the study in terms of Lincoln and Guba's (1985) principles of 'trustworthiness': credibility; transferability; dependability; and confirmability.

Credibility was thought to be demonstrated as the transcribed constructs were entirely fitting based on the researcher's experience of the Branches and the Inspectors. The competency themes were also in line with comparable research findings. The Repertory Grid, a structured interview technique, accompanied by preset qualifiers was thought be an important step to demonstrating dependability. Focusing responses on the behaviours and attributes of specific individuals could be said to constrain transferability but

whilst the findings might be thought to be limited to an individual or the group, the method used is entirely appropriate for employment outside of the research area. Lastly, the coding, categorizing and reduction of the behavioural indicators was essentially a subjective activity compounded by the use of only one researcher. This was countered by a constant reflexive inner dialogue to ensure decisions made could be justified in relation to the research question and methodology.

6.0 Phase 3 Analysis

The final phase of the research utilized a five-part questionnaire that aimed to capture the relative perceptions of the UK MAIB and AAIB Inspectorate with regards to what constitutes effective behaviour in accident investigation.

This chapter describes the type of data collected and provides elaboration on the findings from each of the five sections of the questionnaire.

6.1 Administration

The questionnaire was designed in consultation with the AIB Inspectorate and based upon the cognitive and behavioural indicators derived from the Repertory Grid interviews in Phase 2. The questionnaires were distributed and collected through the kind assistance of the Branch administration personnel.

6.2 Data preparation

Each returned questionnaire was initially screened by the researcher for anomalous or missing responses. The researcher was mindful of large blocks of questions being responded to with the same rating indicating that the questionnaires had not been "correctly or thoughtfully completed" (Freeman, 2003). Some respondents favoured high scores but these were consistent with the overall scoring structure.

Data was entered and stored using Microsoft Excel v11.3.7. Each entry was double checked to ensure accuracy.

6.3 Types of data

Part 1 – Position and Background: comprised free text, continuous numerical data and discrete numerical data restricted to a certain range of values.

Part 2 – Professional Development: comprised dichotomous variables scored via a dummy-variable coding (using 1=Yes and 0=No) and free text.

Parts 3 and 4 – Areas of Expertise and Behaviour Statements: ordinal data using a rating score of 1 to 5 to denote rank order dependent upon the variable and linguistically constructed referents. Questionnaire items deemed not applicable or appropriate were scored 0 by the respondents.

Part 5 – Skills Most/Least Admired: entirely comprised free text.

Comments: free text.

Any missing data/values were designated with an X and all free text was transcribed verbatim.

6.4 Response rate

A total of 54 questionnaires were distributed to Inspectors and Principal Inspectors at the MAIB and AAIB. 30 questionnaires were returned, resulting in a 56% response rate.

The table below shows the relative return rates by Branch.

	Distributed	Returned	% Returned
MAIB	20	16	80
AAIB	34	14	41
Total	54	30	56

Figure 1: Questionnaire return rates by Branch

One questionnaire was only partially completed and therefore called for listwise deletion of the entire case to prevent bias in the data, leaving an overall N of 29. Removal of the case was not thought to adversely affect the sample reliability. "We should be less concerned with reduced sample size than with the ever present risk of bias" (Oppenheim, 1992).

The researcher was satisfied with the rate of response given the length and complexity of the questionnaire; particularly with the response from the MAIB. It is recognized that response rates drop significantly for longer questionnaires and that there is a general decline in response to surveys in general because of their overuse (Neuman, 2006).

Caution has been encouraged with regards to response rates; the representativeness of the sample being more of a concern for validity than the number of returned questionnaires. Respondents within this research are a self-selected subgroup by virtue of their inclination to report and respond. Anonymity of response precluded subsequent follow-up with non-respondents and there was, therefore, no way of validating that the respondents were indeed a representative subgroup (Sarsfield et al, 2000).

6.5 Questionnaire data

Neuman (2006) notes that the people most likely to participate in surveys are the most interested, informed, and active in society. Following this, there was a presupposition that the Inspectors would not be motivated to respond untruthfully although this was tempered with an understanding that, in the absence of 'absolute veracity', this truth would be relative with regards to "experience and understanding" (King, 2004).

Descriptive statistics were felt to be the most useful way of representing the data and as such, the median has been used as the measure of location and

central tendency. The median, or middlemost score, is seen as the most appropriate measure for use with ordinal data (Hayes, 2000). The researcher was keen to avoid "statistical silliness" by attempting to calculate means on ordinal data, which Argyrous (2005) notes is not an infrequent occurrence even with academic institutions. Means have, however, been used with continuous numerical data.

Numerical data was manipulated and analysed using Microsoft Excel v11.3.7. QSR International's computer assisted qualitative data analysis software NVivo7 was employed for all free text responses.

6.5.1 Part 1: Position and Background

Data regarding position and background is a means of characterizing the workforce and served to further inform the researcher about the varying backgrounds from which the Inspectorate were drawn. Whilst it is essentially generalistic, it is informative nonetheless and contributes to the body of knowledge regarding how different populations work and train (Sarsfield et al, 2000).

All respondents had had previous careers within the mode specific industry, in a variety of disciplines including the military, operations, technical, research and training. The majority of MAIB respondents cited seagoing operational management experience in either the Royal Navy or Merchant Navy and several AAIB respondents had come from a background in the Royal Air Force or airlines.

6.5.1a Q1.3 and Q.14: Time in Branch and Time in Industry

The length of time respondents had worked at the Branch and within the mode specific industry was calculated in years and months and is represented below in terms of mean and range.

	Mean	**Range**
MAIB	4yrs	<1yr - 17yrs 6m
AAIB	12yrs 4m	<1yr - 30yrs 3m

Figure 2: Q1.3 Mean and range time worked at the Branch

The lower mean for the length of time served at the MAIB can be explained in part by the fact that the Branch was established relatively recently, in comparison to the AAIB, and that changes in organizational structure has increased recruitment in recent years.

The majority of respondents have had long careers in their respective industries with means of 30.5 years for the MAIB Inspectors and 27.5 years for the AAIB Inspectors.

	Mean	Range
MAIB	30yrs 6m	11yrs - 40 yrs
AAIB	27yrs 6m	7yrs 6m - 45yrs

Figure 3: Q1.4 Mean and range time worked in Industry

6.5.1b Q1.5: Age

Respondents were also asked to indicate their age using the following ranges of values: 20-30; 31-40; 41-50; 51+.

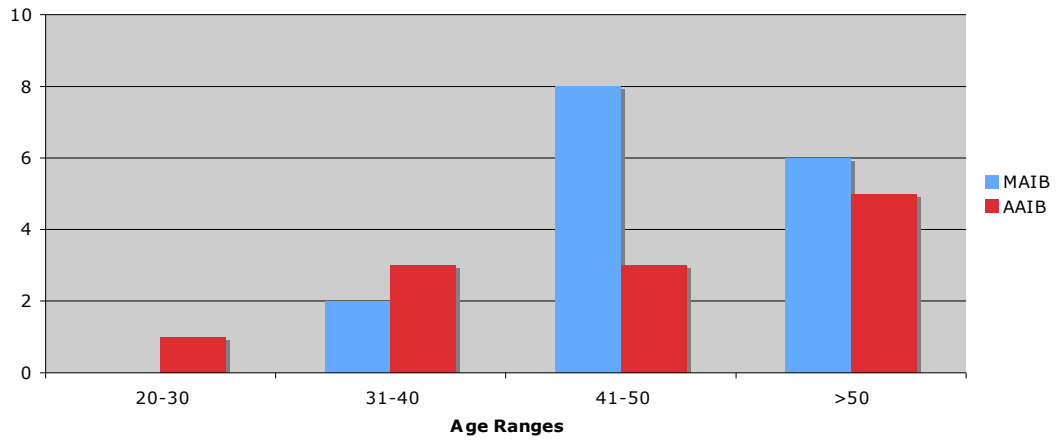

Figure 4: Q1.5 Age distribution of respondents

With the average length of time worked in their mode specific industry reported to be over 27 years, it is unsurprising to find that the demographics are slanted towards the older age ranges. The majority (78%) of respondents were over 40 years of age – with an equal split of combined respondents between the older age ranges. Note: one AAIB Inspector declined to respond to this question.

"A by-product of hiring experienced professionals is a staff with an age distribution that is skewed towards older ages" (Sarsfield et al, 2000). Not only do the Branches attract older 'second careerers' with subsequent experience, they are also successful in retaining them to retirement. This retention is particularly noticeable within the Engineering group of the AAIB, which might be explained by the fact that salaries within the industry are not comparable unless at a senior position. Conversely, the Operations Inspectors at the same Branch were quick to report a pay decrease on joining the Branch so financial

incentives were discounted as a motivation for the retention of that group. Given the flat structure of the organizations, there are implications for retirement and succession planning with an age-skewed workforce particularly where a large number of employees fall within a narrow age range.

6.5.2 Part 2: Professional Development

The researcher was interested in what forms learning typically took for the Inspectorate and whether they felt that sufficient time and resource had been expended in the maintenance or improvement of their skills; both investigative and technical.

	Investigative skill	**Technical skill**
MAIB	Y = 93.75%	Y = 56.25%
AAIB	Y = 84.62%	Y = 61.54%

Figure 5: Q2.1 & 2.2 Sufficient time/resources expended in maintaining skills

The table above indicates that whilst the majority of respondents are satisfied with the time and resource expended on investigative skills training, there was a perception that less consideration was given to the maintenance and improvement of technical skills. As noted by Sarsfield et al (2000), technical skills are those most likely to suffer from degradation over time, particularly with the introduction of new technologies.

6.5.2a Q2.3: Learning

The learning activity most frequently engaged in by the responding Inspectorate involves formal in-house training with 28 out of the 30 respondents (93%) having undertaken some form of formal instruction during the preceding 12 month period. Second to this came self-study which had occupied 80% of the respondents.

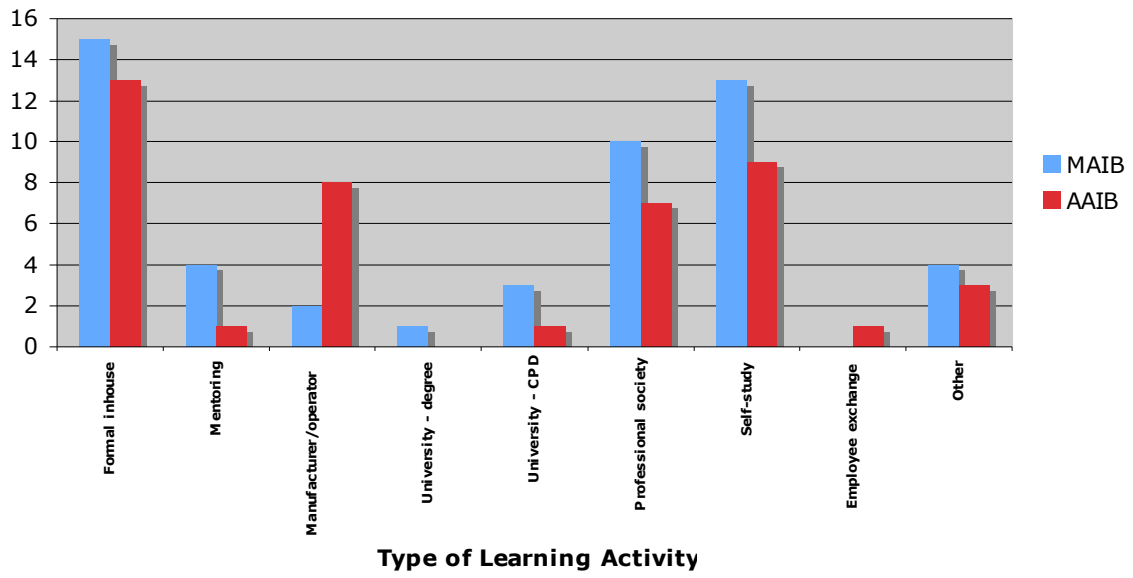

Figure 6: Q2.3 Breakdown of learning activities

From initial discussions with the RAIB, the researcher was made aware of an extensive and comprehensive training programme that had been designed for the newly appointed Inspectorate. This training programme aimed to significantly increase the knowledge and understanding of Inspectors across the range of technical subjects. In adopting this strategy, the RAIB showed a commitment to raising and maintaining the professional standards that the industry would be looking to them to demonstrate.

Conversely, Inspectors at the MAIB have adopted specific areas of the industry in which to become subject matter experts. This encourages the Inspectors to acquire a greater depth of knowledge and experience.

Training guidelines published by ICAO (2003) with respect to aviation accident investigators state that there are several phases to ensuring that investigators receive "appropriate levels of training" commensurate with their role. These phases include " … initial training, on-the-job training, a basic investigation course and an advanced accident investigation course supplemented by specialized courses."

Each of the phases is associated with differing forms of training intervention but given the low predictability of technical skill needs (ie it is difficult to predict what technical skills may be required on a specific accident or in the future), during interviews most Inspectors referred to their training as continual on-the-job training complemented from time to time with formal specialist courses.

6.5.3 Part 3: Areas of Expertise

Following on from what is learnt by the Inspectors and how, the researcher sought to determine how the acquired knowledge was dispersed within the Inspectorate. Respondents were asked to rate their perceived levels of expertise on a 1 to 5 scale where 1 indicated little or no knowledge and 5 indicated expertise or ability to teach and lead others.

Both accident investigation and mode specific areas of expertise were assessed.

6.5.3a Q3(a): Accident Investigation

The chart below illustrates the perceived differences in expertise between the MAIB and the AAIB with regards to accident investigation skills. The median score was calculated and is used for comparison. It was anticipated that the Inspectors would rate themselves quite highly on the Investigative Skills section as many had previously expressed their abilities in confident terms during the course of the preceding interviews. Most areas were scored with a 4 suggesting extensive knowledge where currency is maintained and the knowledge is regularly applied.

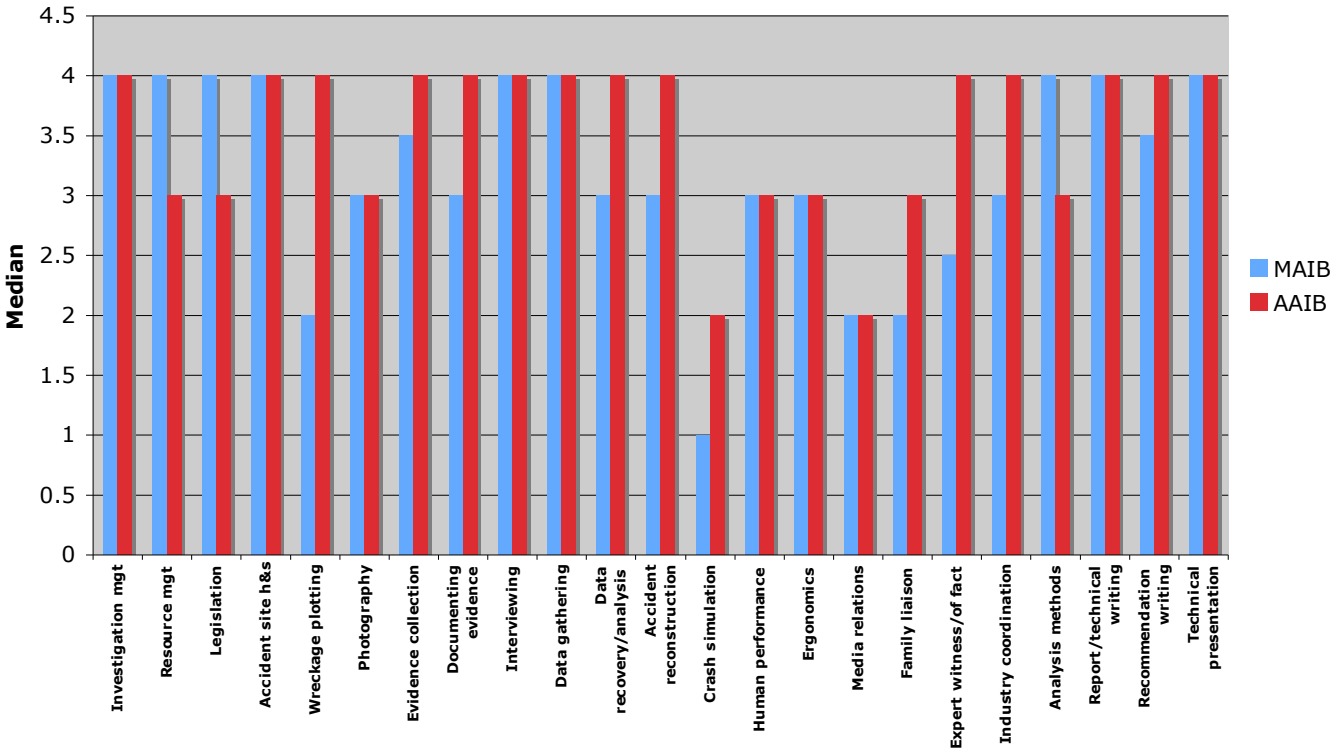

Figure 7: Q3(a) Areas of expertise in investigation – comparison between MAIB and AAIB

Overall, as anticipated, the median scores were high. Low ratings were given to wreckage plotting (2), crash simulation (1), media relations (2), family liaison (2) and expert witness (2.5) by the MAIB. The AAIB rated crash simulation and media relations with a low score.

The low score for crash simulation can be accounted for, in part, by a number of respondents who rated it 0 or not applicable to the role; twice by the AAIB and five times by the MAIB.

Media relations was scored low by both Branches suggesting an area for improvement.

Within the MAIB, four areas were scored with a 1 indicating little or no knowledge, on multiple occasions: expert witness; media relations; photography; and wreckage plotting. These scores were predominantly made by staff with less than two years service at the Branch.

Only two Inspectors at the AAIB indicated that they had little or no knowledge for any subject. These were in the following areas: wreckage plotting; documenting physical evidence; ergonomics; and analysis methodologies. Of the two Inspectors, one was a relatively new starter with less than two years served – not unlike the MAIB low scorers – but the other had over 14 years service so it could not be concluded that the knowledge shortfall could be attributed to length of time served.

The researcher was pleasantly surprised by the confidence shown in expertise relating to analysis methodologies as interviews during both Phases 1 and 2 of the research had repeatedly revealed a difficulty in articulating which specific analysis methodologies were employed at the Branches; personal preference appeared to dictate how analysis was performed with some Inspectors expressing a reluctance to adopt any one methodology for fear of limiting and confining the analysis unnecessarily.

Observation of the raw data showed that AAIB staff were more likely to rate themselves as an expert. Half of the AAIB Inspectors rated themselves as a 5 in one or more areas, in particular, report and technical writing, recommendation writing and investigation management. A third of the MAIB Inspectors rated themselves as an expert, predominantly in the area of investigative interviewing.

It is, perhaps unsurprisingly, the longer serving, more experienced Inspectors that reported themselves as expert more frequently, although this did not hold true in every case.

6.5.3b Q3(b): Mode Specific Expertise

Respondents from the MAIB were asked to rate their expertise with regards to marine specialisms and those from the AAIB rated themselves with regards to aircraft design and operations. For aircraft design and operations, several areas had been subdivided in the questionnaire but for ease of comparison, these have been amalgamated and the cumulative median presented.

6.5.3c Maritime Specialisms

The median ratings for this data were fairly uniform showing at least a moderate degree of knowledge across the range of specialisms.

The highest rated areas were Ro-Ro ferries and passenger ships and navigation, each of which was rated as a 4 or having extensive knowledge, followed by lifeboats and life saving appliances scoring 3.5.

Conversely, Inspectors rated their expertise as low in the areas of propulsion, hydrodynamics and underwater technology, each receiving a score of less than 2.5.

Navigation, whilst receiving an overall median score of 4, otherwise elicited polarized responses. Inspectors either rated themselves as expert (5) or having no knowledge of the area (1).

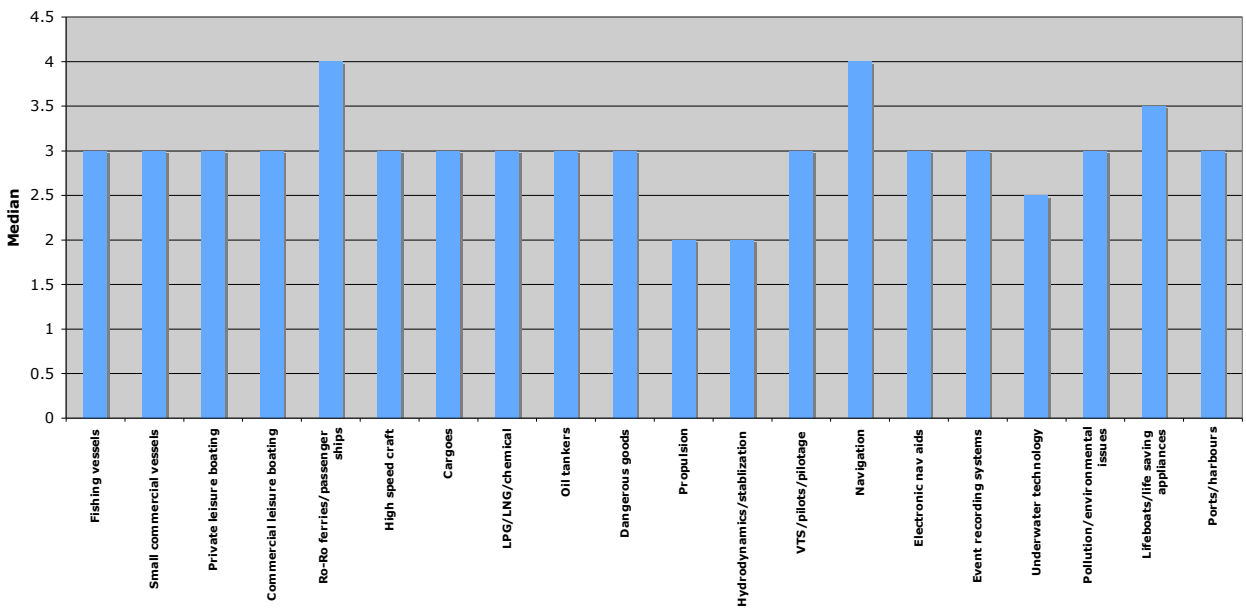

Figure 8: Q3(b) Maritime specialism expertise

6.5.3d Aircraft Design and Operation

Again, the median ratings for these data were fairly consistent across the various sections; no one area scoring more than a moderate rating of 3. It was unexpected to find that there were no scores of 4 and above as, as previously noted, the confidence in ability expressed during interview by the Inspectorate led the researcher to predict higher scores in terms of self perceived technical expertise.

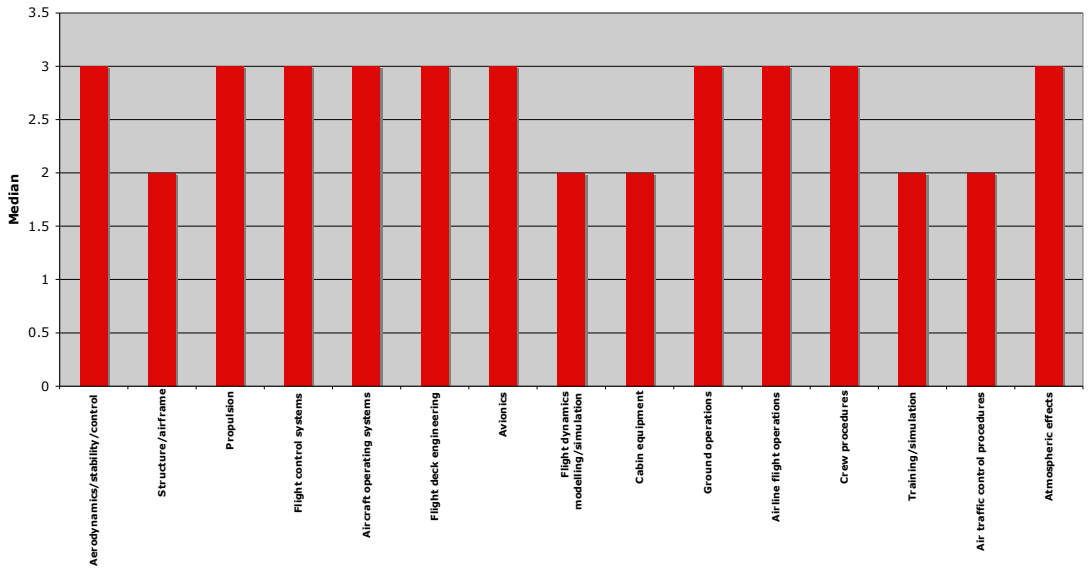

Figure 9: Q3(b) Aircraft design and operation expertise

Low scores indicating limited knowledge (score 2) were given for the following areas: structure/airframe; flight dynamics; modelling/simulation; cabin equipment; training/simulation; and air traffic control procedures.

One point of personal interest to the researcher was that the low score ascribed to cabin equipment was, in part, attributable to the number of AAIB Inspectors who indicated that knowledge of cabin equipment was not applicable to their role. Cabin equipment includes not only internal soft furnishings on aircraft but seating and personal safety equipment. In a recent study by the Civil Aviation Authority into Mandatory Occurrence Reporting data for maintenance incidents (CAA, 2007), cabin equipment was implicated as one of the top 3 ATA Chapters or parts of the aircraft involved. There is high maintenance traffic associated with cabin equipment and this, in combination with its perception as a 'lesser' maintenance task which can be performed by less qualified or experienced personnel, increases its potential with regards to maintenance error. It is not seen as a high risk area as cabin equipment rarely represents a direct hazard to the integrity of the aircraft but its potential failure could have enormous ramifications in an otherwise survivable accident.

6.5.4 Part 4: Behaviour Statements

Whilst the preceding sections of the questionnaire elicited informative data regarding the Inspectors as individuals, the next section of the survey was concerned with their relative opinions and perceptions.

The questionnaire called for the Inspectors to rate the 75 positive and negative behavioural indicators against a five-point scale in terms of the following questions.

For positive statements:

a) how necessary the behaviour was in terms of new recruits
b) how likely it was that the behaviour could be acquired or improved through training
c) how much demonstration of the behaviour distinguished a superior investigator from an average one.

For negative statements:

a) how necessary it was to screen out this behaviour at interview
b) how likely it was that the behaviour could be removed or reduced through training
c) how much demonstration of the behaviour distinguished an ineffective investigator from an average one.

The median, as the most appropriate measure for use with ordinal data, for each behavioural indicator was calculated for each Branch individually and then collectively. The data were then divided into the five corresponding competency themes (interpersonal and communication skills; work management activities; personal attributes; cognitive abilities; and technical abilities) for each question. Due to the small sample size it was not possible to ascribe any differences in response to the inclusion of any one group or Branch. Given the quantity of data generated, the median data for all the individual questions, competency themes and behavioural indicators can be found in Appendix C. The cumulative competency theme medians are, however, presented below.

6.5.4a Q4A(a): How necessary the behaviour is in terms of new recruits

Competency	MAIB Mdn	AAIB Mdn	Total Mdn
Interpersonal and communication skills	4	4	4
Work activity management	3.25	4	3
Personal attributes	4	4	4
Cognitive abilities	4	4	4
Technical abilities	4	3.5	4

Figure 10: Necessary behaviour for new recruits by competency theme

The median scores for this question are fairly uniform. The competency themes rated most highly with regards to behaviour sought in new recruits were: interpersonal and communication skills; personal attributes and cognitive abilities. With the exception of work activity management rated 3.25 by the MAIB and an overall median of 3 (fairly necessary), and technical abilities rated 3.5 by the AAIB, all other accumulated competencies were deemed necessary, but not essential by the respondents.

Observation of the individual behavioural indicator ratings revealed those aspects of behaviour perceived to be most necessary in newly recruited Inspectors. Below are the highest rated statements, where one or both Branches gave a median rating of 5 or essential, grouped by competency theme.

Interpersonal and communication skills

- Treats people with respect
- Team player
- Clear communicator at all levels
- Manages confrontation successfully
- Has good written English
- Puts together a readable report
- Able to put aside personal differences
- Thoughtful and understanding with relatives
- Writes an objective and impartial report
- Asks searching questions
- Interviews respond well to their questioning

Work activity management

- Thorough
- Collects pertinent evidence

Personal attributes

- Dependable
- Attends to detail
- Self sufficient
- Calm under pressure

Cognitive abilities

- Demonstrates an inquisitive nature
- Clear thought processes
- Makes realistic recommendations

Technical abilities

- Technically competent

Further thematic exploration of the corresponding indicators revealed two clear groupings around the concepts of report writing and dealing with people.

6.5.4b Q4B(a): How necessary it is to screen out behaviour at interview

Competency	MAIB Mdn	AAIB Mdn	Total Mdn
Interpersonal and communication skills	4	4	4
Work activity management	3	3	3
Personal attributes	4	4	4
Cognitive abilities	3.75	4	4
Technical abilities	4	4	4

Figure 11: Necessary to screen out behaviour at interview by competency theme

Again, the median scores for the negative behavioural indicators for this question were uniform, with an average median score of 4, necessary but not essential. Work activity management, however, was ranked as fairly necessary with a score of 3. Given the lower score attributed to work activity management with regards to the positive behavioural indicators, it would appear that overall, this competency is seen as less important than the others with regards to the recruitment and selection process.

The behavioural indicator ratings were once again considered and the highest rated statements (where at least one Branch rated it with a 5 or essential) appear below.

Interpersonal and communication skills

- Withholds assistance as knowledge is power
- Contemptuous of others
- Report is vehicle for own agenda
- Gets people's backs up
- Loses cooperation of interviewees

Work activity management

- Superficial when investigating
- Unstructured – shoots from the hip

Personal attributes

- Unreliable and full of excuses
- Requires constant hand holding
- Acts like a "know it all"
- Believes they know everything
- Tactless

Cognitive abilities

- Shows no curiosity
- Shows muddled thinking
- Rigidly fixed on one explanation

Technical abilities

- Has lost touch with real world
- Lacks basic technical understanding

Again, a thematic exploration revealed that the majority of behaviours rated most highly in terms of being necessary to screen out in new recruits focused mainly upon dealing with other people.

With regards to the technical competency theme, the statements rated most highly were associated with technical ability overall (lacks basic technical understanding; lost touch with real world) – a propensity for things technical rather than specific acquired knowledge.

6.5.4c Q4A(b): How likely it is that the behaviour can be acquired or improved through training

The second question related to the acquisition or improvement of behaviours through training interventions. Scores for this question were consistently lower than the previous question. Personal attributes scored the least overall with a 3 or fairly likely to be amenable to change through training, closely followed by work activity management and cognitive abilities. Technical abilities, conversely, scored the highest with 4 or likely but not definite and were therefore considered to be more amenable to change.

Competency	MAIB Mdn	AAIB Mdn	Total Mdn
Interpersonal and communication skills	4	3	4
Work activity management	3.5	3	3
Personal attributes	3	3	3
Cognitive abilities	3.5	3	3
Technical abilities	4	4	4

Figure 12: Likelihood of behaviour being acquired or improved through training by competency theme

It was less common for the positive behavioural indicators to be given a rating of 5 with only ‘writes an objective and impartial report’ being deemed definitely likely to be acquired or improved through training. The next highest scores

(where one or more Branches gave the score of 4, likely but not definite) are, therefore, shown below.

Interpersonal and communication skills

- Writes and objective and impartial report
- Makes things clear on paper
- Has good written English
- Puts together a readable report
- Puts information across succinctly
- Broad generalizable safety message apparent in reports
- Takes control of the situation
- Able to delegate task efficiently

Work activity management

- Collects pertinent evidence
- Files ordered and structured
- Evidence well documented
- Researches previous incidents and recommendations thoroughly

Cognitive abilities

- Makes realistic recommendations

Technical abilities

- Understands industry
- Technically competent
- Knowledgeable about standards/regulations

No personal attribute indicators were given a high rating in this section, suggesting, as previously stated, that personal attributes are considered less likely to be amenable to training interventions. Once again, report writing was evident as a theme in the highest rated indicators for the likelihood of behaviour being acquired.

6.5.4d Q4B(b): How likely it is that the behaviour can be removed or reduced through training

The cumulative competency scores for the negative indicators regarding the behaviours perceived to be more amenable to removal or reduction through training are presented below. These scores are lower than previous questions suggesting that it was thought that there is less likelihood that interventions would be successful in modifying behaviour in general.

Competency	MAIB Mdn	AAIB Mdn	Total Mdn
Interpersonal and communication skills	3	2	3
Work activity management	3.75	2.5	3
Personal attributes	3	2	2.75
Cognitive abilities	3	3	3
Technical abilities	3.25	4	3.5

Figure 13: Likelihood of removing or reducing behaviour through training by competency theme

Once again, personal attributes were seen to be least likely to be receptive to change and technical abilities as most likely to be receptive to change. No behavioural indicators relating to personal attributes or cognitive abilities were given high ratings.

Interpersonal and communication skills

- Unable to show continuity of argument in report
- Evidence for recommendations lacking
- Statements misinterpreted by media

Work activity management

- Takes too long to produce a report

Technical abilities

- Not up to date with regulatory information

The ability to produce effective written communication is raised once again, this time focusing upon removing or reducing the lack of skill in producing a coherent evidentially based argument running the course of the report. Training interventions were also thought to be likely to bridge gaps in knowledge, ensuring Inspectors are up to date with regulatory and technical advances.

6.5.4e Q4A(c): How much demonstration of the behaviour distinguishes a superior investigator from an average one

Competency	MAIB Mdn	AAIB Mdn	Total Mdn
Interpersonal and communication skills	4	4	4
Work activity management	4	4	4
Personal attributes	4	4	4
Cognitive abilities	4	4	4
Technical abilities	4	4	4

Figure 14: How much demonstration of behaviour distinguishes superior investigator from average one by competency theme

At a competency level, there are no apparent differences between ratings for the five competency themes for the positive behavioural indicators for this question. All competency themes score 4, indicating that the behaviour distinguishes a superior investigator from an average one to a greater degree. The homogeneous scores are an indication that no single competency theme is deemed specifically more important by the respondents.

Review of the highest rated statements shows a similar profile in terms of behaviour statements to recruitment. Many of the same statements were selected, in particular, in terms of dealing with people.

Interpersonal and communication skills

- Asks searching questions
- Treats people with respect
- Takes control of the situation
- Listens well
- Thoughtful and understanding with relatives
- Interviewees respond well to their questioning

Work activity management

- Collects pertinent evidence

Personal attributes

- Attends to detail
- Prepared to learn
- Dependable
- Uses initiative

Cognitive abilities

- Produces a structured flow of analysis
- Learns quickly
- Good at practical problem solving

Technical abilities

- Technically competent
- Has detailed technical knowledge

It could be inferred that whilst training is of importance, it is recruitment that provides the opportunity to bring in the skills and abilities necessary for a superior investigator.

6.5.4f Q4B(c): How much demonstration of the behaviour distinguishes an ineffective investigator from an average one

Again there was homogeneity of data across the competency themes for this question, with each competency being given a 4 or greater degree, in terms of distinction between an ineffective investigator and an average one.

Competency	MAIB Mdn	AAIB Mdn	Total Mdn
Interpersonal and communication skills	4	4	4
Work activity management	4	4	4
Personal attributes	4	4	4
Cognitive abilities	4	4	4
Technical abilities	4	4	4

Figure 15: How much demonstration of behaviour distinguishes an ineffective investigator from an average one by competency theme

Those behavioural indicators where one or more Branches used the rating of 5 are presented below. No behavioural indicators relating to the work activity management competency theme were given a high rating.

Interpersonal and communication skills

- Contemptuous of others
- Loses cooperation of others
- Unable to show continuity of argument in report

Personal attributes

- Unreliable and full of excuses
- Careless with detail

Cognitive abilities

- Shows no curiosity

Technical abilities

- Lacks basic technical understanding

The most common theme running through the statements associated with behaviour distinguishing an ineffective investigator from an average one was, once again, dealing with people.

6.5.5 Part 5: Skills Most / Least Admired

Respondents were asked to think about those colleagues in their Branch who they most admired and with them in mind, to list five skills or behaviours that distinguished them from the rest.

They were then asked to repeat the exercise bringing to mind five colleagues that they least admired, listing five skills or behaviour that distinguished them from the rest. Neither listings were deemed to be in hierarchical order and therefore they were not weighted in any way.

Whilst this section of the questionnaire was not designed specifically to elicit information regarding effectiveness in terms of behaviour, the researcher had inferred from the interviews conducted during Phases 1 and 2 of the researcher, that the colleagues whom the Inspectors had most admiration for, were in practice those who were considered most effective in their role.

The listed skills and behaviours, both positive and negative, are presented verbatim in Appendices D and E and a summary (where the skills or behaviours were volunteered more than once) is presented below. No distinction has been made between the two Branches on this occasion as there would not have been enough data available to make any meaningful comparisons.

The verbatim lists were analysed using the qualitative data analysis software NVivo 7 and any duplicates or semantically similar skills or behaviours counted.

Most Admired Skills and Behaviours	**Count**
Analysis - analytical skills/problem solving	2
Approachable	4
Attention to detail	3
Communication	7
Competence - technical	2
Courteous	2
Decisive	2
Determined	3
Drive	2
Experience - technical/industry	3
Focus	3
Honest	2
Humour	3
Inquisitive	3
Integrity	3
Interpersonal skills	2
Knowledge - technical	7
Leadership	2
Listening skills	4
Logical thinker	2
Memory	2
Objective	2
Open-minded	6
Organized	2
Professional	2
Reliable	2
Report writing skills	10
Sharing - time/knowledge	6

Team player	4
Tenacity	3
Thoroughness	6
Tolerant	2

Figure 16: Q5 Most admired skills and behaviours

Those admired skills and behaviours most frequently cited were, in order: the ability to write a report well; verbal communication; technical knowledge; being open minded; sharing time and knowledge with others; being thorough; being approachable and being a team player. These findings concur with the behaviour indicator ratings in the previous section with report writing and dealing with people being the behaviours rated most highly.

Least Admired Skills and Behaviours	**Count**
Abrupt	2
Arrogant	12
Commitment (lack of)	3
Communication (poor technique)	6
Critical (overly)	2
Dishonest	2
Dismissive	7
Experience (lack of) - technical/industry	4
Focus (lack of)	2
Illogical	2
Indecisive	4
Interviewing (poor technique)	3
Knowledge (lack of) – technical/industry	3
Lazy	5
Loud	2
Management (lack of skill)	3
Overambitious	2
Report writing (lack of skill)	8
Rude	2
Sharing (lack of) - time/knowledge	8
Sloppy	2
Superficial	4
Team player (inability to be)	4

Figure 17: Q5 Least admired skills and behaviours

The most frequently cited least admired skills and behaviours were, in order: being arrogant; poor report writing; not sharing time and experience with others; being dismissive; inability to communicate effectively; and being lazy.

Again, report writing and dealing with people are apparent as themes continuing through the responses.

6.5.6 Part 5: Comments

Respondents were invited to make additional comments with regards to a skill or experience not referred to in the questionnaire. 7 comments in total were made with regards to the length and complexity of the questionnaire. The remaining 10 comments provided further clarification of those skills and behaviours that the Inspectors felt were essential for an investigator to be effective and therefore successful in their role. One referred directly to the personal development of Principal Inspectors and another to organizational structure and management.

Analysis of the comments did not reveal anything particularly novel but they proved an excellent summation of the views expressed by the Inspectors during the three phases of the research. As such, they have been transcribed verbatim and are presented below.

> *"A good inspector requires to be: practical; understanding; thorough; technically sound; logical and a good communicator, both written and verbally."*
>
> *"Acceptance that accident investigation* ***is*** *an exact science; and poor investigation / report is due to inability of inspector to ask correct questions or find the evidence."*
>
> *"I am surprised to apparently see no references to 'diversity' or similar - guess this area is covered under general openmindedness? Ability/experience of dealing with those from different cultures is a valuable skill from the diverse industry of shipping."*
>
> *"Experience in an office environment; social conscience; environmental awareness."*
>
> *"An inspector needs to be a good communicator at all levels and shouldn't be afraid to talk to a high ranking official or to a member of the public and shouldn't be afraid of being in the media spotlight. To obtain you need to give, ineffective communication can lead to ineffective results."*
>
> *"Sustained desire to improve flight safety; lateral thinking - prepared to tackle status quo and address basic causes: both essential; distinctly lacking in some areas of the AIBs that I have come across."*
>
> *"Need to have a sense of humour."*
>
> *"Inspectors ideally should possess the widest range of knowledge and experiences but not wholly limited to aviation matters. Question 4.1 is*

most important: "should demonstrate an inquisitive nature"! And be able to write logically as well!"

6.6 Conclusion

It became apparent from feedback from the Inspectors that the questionnaire proved to be overly long and complex in its construction, a reflection of inexperience on the part of the researcher coupled with the need for more rigorous pilot testing. Despite its shortcomings, it proved an appropriate instrument for capturing the perceptions of the Inspectors with regards to the behaviours of effective and ineffective investigators.

Utilizing Lincoln and Guba's (1985) principles of once again, the researcher reviewed the findings of the final phase of the research and despite concerns with the length and complexity of the questionnaire, trustworthiness was felt to have been demonstrated.

There were similarities between the findings of this study and the conclusions drawn by Robinson et al (2005) with regards to the increased criticality of interpersonal and communication skills and there was nothing determined from the analysis that conflicted or contradicted with the general impression gained by the researcher in the interviews in Phases 1 and 2.

Transferability remains an elusive concept with regards to this research. The researcher has attempted to provide sufficient contextual detail through all phases of the study in order that there can be an evaluation as to the extent that the findings are transferable but would argue that the very nature of qualitative research focused upon a single group will always have limitations in this area.

Dependability is demonstrated through the consistent use of the questionnaire, albeit with limitations. There exists the opportunity to utilize the structure and questions posed in further studies, as required. Lastly, neutrality has been maintained as this section of the study is largely characterized by descriptive statistics which are less likely to be susceptible to bias and subjectivity.

7.0 Discussion

The discussion chapter seeks to synthesize the various elements of the research, to further consolidate the knowledge acquired during the course of the study and to determine what the implications are for this knowledge.

The chapter will follow the three phases of the research to summarize the salient findings within the context of the AIBs. It will discuss how well the research design performed and conclude with consideration of the overall limitations of the present study.

7.1 Phase 1

The first phase of the study allowed the researcher to become more familiar with the subject of accident investigation through the use of semistructured interviews with Inspectors from all three Branches. Whilst adherence to a protocol ensured that focus was maintained, the method had sufficient latitude to allow the researcher to follow lines of enquiry that might otherwise have been closed off in a more formal interview stetting. As such it was a valuable opportunity to step beyond the public persona of the accident investigator and look in more depth at the individuals that make up the Branches.

Analysis of the transcripts revealed two distinct groups of comments: task and non-task specific themes. The task specific themes (evidence collection; interviewing; liaison with families; analysis; report writing; recommendations; and inquests) focus upon individual activities that need to be undertaken in order to successfully complete an accident investigation. Non-task specific themes reveal more about the context in which accident investigators work including being an Inspector, the role of the Principal Inspector and comparisons between the accident investigation bodies in the United Kingdom and the United States.

Reviewing the transcribed comments in the Phase 1 analysis chapter, the pervasive motifs of individualism and variability characterize the working practices of the Branches. These, with the role of the Principal Inspector, will be explored in more detail.

7.1.1 Individualism

By individualism, the researcher is alluding, not to a moral stance or political philosophy, but to an outlook stressing independence and self-reliance, promoting the exercise of one's goals and desires, while opposing most

external interference upon one's choices. It is meant as a descriptive, not a judgemental, term.

Despite being UK government civil servants, Inspectors have expressed a feeling of being removed from the rest of the Civil Service with its consequent 'bureaucracy'. Righteous indignation was apparent, for example, at having to complete necessary forms or diversity training.

This individualism continues at a Branch level where there is little call for inter-Branch cooperation although when it occurs, it is very successful: as exampled by the recovery of and data retrieval from the Voyage Data Recorder of the sunken ferry Al Salam Boccaccio '98 in the Red Sea in 2006 by the MAIB with assistance from an AAIB Flight Data Recorder engineer. The three Chief Inspectors form a Board of Transport Accident Investigators which purports to pursue joint initiatives, identify opportunities to share best practice and the efficient use of shared resources (MAIB, 2008a). It was unclear from interviewing the Inspectors, however, how such 'synergies' were being translated into changes in practice at their level.

Although the structure at the Branches is the same with regards to hierarchy (the chain of command rising from an Inspector to a Principal Inspector through to the Deputy Chief Inspector and finally to the Chief Inspector), the AAIB differs in its day-to-day operation with the use of matrix management. The RAIB and MAIB both have dedicated functional teams led by a Principal Inspector who operates as both man-manager and technical investigator-in-charge with overall responsibility for the investigation of the accident and production of the report – the 'legwork' being undertaken by the Inspectors within that team.

The Inspectors at the AAIB, on the other hand, have established Principal Inspectors for man-management tasks but the ad hoc pairings of Inspectors based on the rota system for attending accidents results in a random assignment of Principal Inspector in the role of investigator-in-charge. There are obvious pros and cons to this system. The small team cohesion could be absent but two Inspectors pointed out in interview that the rotation meant that it was rare to have to work with someone you did not like on more than a few occasions.

Although differing levels of individualism are apparent between the Branches, nowhere is it more evident than at the AAIB, described previously as "the last home of the rugged individualist" (Viney, 1992). The AAIB Inspectors gave the impression that accident investigation can be quite a solitary affair exacerbated to some degree by the organizational structure and with Inspectors having individual offices. There were conflicting opinions as to the ability of the Branch to operate as a team overall but it was felt that this could only truly be tested in the face of a major accident on the scale of Lockerbie or Kegworth.

The downside to the individualist nature is that it is more difficult to engender a team oriented approach to the running of the Branch as a whole; this is

exemplified by a comment at the AAIB suggesting that teamwork might happen in an individual investigation but not at a Branch level. Whilst this research did not set out to measure the effectiveness of the Branch as a function of teamwork, the findings do have implications for the research question. The skills and attributes required to operate effectively in a team can be different to those required to operate effectively as an individual. The MAIB, by contrast, appear to have a more team-oriented philosophy that certainly presents as more cohesive and cooperative in its working style. From the limited opportunity the researcher had in observing the RAIB Inspectors, it was surmised that the team-oriented structure had been adopted but that as staff were relatively new to their role, it would take time for the teams to bed into the organization.

In order to work effectively as a team, there is a requirement for a "… constellation of social skills" including: social perceptiveness; persuasion; negotiating; instructing and helping others. "Strong social skills enable individuals to adopt the social roles needed to manage conflict, coordinate their work, and otherwise work in a more cooperative and integrated fashion with others". (Morgeson et al, 2005).

It has been suggested that the skills, knowledge and motivation needed for teamwork "… go well beyond the core technical skills often measured in traditional selection contexts." (Morgeson et al, 2005).

Individuals need both the competencies to work as individuals as well as the skills and behaviours to work as part of a team (West and Allen, 1997) and 'knowing' how to work in a team which Stevens and Campion (1999) refer to as 'situational judgement', or "getting along" behaviour.

Team members' declarative knowledge regarding teamwork competencies (ie how a team functions successfully) was found to positively affect planning and task coordination, collaborative problem solving and communication skills. Those occupying the most 'critical' position in the team were found to benefit most from this knowledge (Ellis et al, 2005).

Although most work is usually organized around teams, Morgeson et al (2005) point to the dearth of empirical research on how individuals are selected for team-based settings. Those AIBs who operate a team-based philosophy should, it is posited, be mindful that "… the knowledge, skill, ability, and other characteristics (KSAOs) needed for successful performance in team contexts might be somewhat different than the KSAOs needed in more traditional individually oriented jobs." (Morgeson et al, 2005).

It is not clear, however, if the organizational structure at the Branches has driven the collective culture and preferred working style of the Inspectorate or vice versa. The question is how this individuality is best managed in order to maintain an effective operation. It has implications for the structure and

leadership of the Branches particularly in terms of the skills and behaviours required for its Inspectors.

7.1.2 Variability

As a corollary to individualism, there is a perceived variability in the organizational practices of the Branches that ran contrary to the researcher's preconceptions at the commencement of the research. Nowhere is this more apparent than in the accident analysis methodologies applied.

It was determined through the interviews in Phase 1 of the research that despite a plethora of accident analysis tools being available for use by accident investigators, and that each Branch had a preferred if not commonly articulated approach, that they were neither widely nor consistently used, in the UK or within the industry as a whole.

Some might argue against their necessity. Sennewald and Tsukayama (2001) would posit that investigation is an imaginative process: more of an art than a science. "Despite all the modern technological assistance available to the investigator, and regardless of what marvellous things machines and computers can do, for the successful investigator there is no substitute for … imagination and creativity."

There is a romantic notion of the investigator piecing together the puzzle "like a fictional private detective" (Tench, 1985) or " … the individual of brilliant insights … who engages in an intuitive exercise which ultimately leads to the solution." (Repetto, 1978). And whilst the image of the 'jigsaw man' is seductive in many ways, there is a conflict between this and the expectation of a quality-controlled, process-driven investigation. There is a calling now for 'more science' and 'less art'. In order to do this, the industry has to ensure that underlying methodologies leading to reproducible results are rigorously and consistently applied**.**

It could be speculated that the analysis frameworks and tools available do not provide the breadth and flexibility required or that there should be one all-purpose methodology (Woodcock et al, 2005) but that in principle the adoption of such a methodology would go some way to allaying the criticism that "Different people with different knowledge, experience, interests and outlooks may be able to draw different conclusions from the evidence." (Kletz, 2006).

In their work with the UK police force, Irving and McKenzie (1983) showed that an improved knowledge about the ergonomics of the overall investigative system would enhance the process and improve the decisions and conclusions made. "Judgements have to be made … so relevant instruction as to how to make such judgements needs to be provided, otherwise the vacuum will be filled with dense PHOG (Prejudice, Hunch, Opinion and Guess)".

Later studies with the Kent Police Force recognized that an investigative model would "… display transparency and integrity" – if findings are to be challenged then not only the findings but the entire process needs to withstand scrutiny. Accident investigation is an emotive subject and this need for counteracting criticism echoes the comment by Wood and Sweginnis (1995) that if a report can be challenged based upon its logic and content then it will be.

In the US, the Board of the NTSB have ownership of the investigation report and as such the individual investigators have no responsibility with regards to the findings. This is not the case elsewhere as demonstrated recently in New Zealand.

An investigation report published by the Transport Accident Investigation Commission in New Zealand into a helicopter crash in 2001 suggested that the cause was attributable to maintenance. Subsequent investigations into two further helicopter crashes led to metallurgy tests which confirmed that the initial crash was probably caused by fatigue failure and not by poor maintenance thus exonerating the mechanics. Given the detrimental effect the findings of the original report may have had upon the reputation of the maintenance organization, the engineers were reported to be considering suing the investigators (TVNZ, 2006a). Whether or not in practice this is achievable, it demonstrates that the standing of the investigative body is not unassailable and that its reputation can easily be tainted by inaccuracy or ambiguity or lack of evidence. There are calls for the TAIC's processes to be more transparent, in the wake of this situation, allowing its findings to be publicly scrutinized (TVNZ, 2006b).

This echoes the concerns expressed with regards to whether transparency is truly attainable in government accident investigation. Whether investigations conducted in private as opposed to through public inquiry fulfil the requirement of "full, accurate, and timely disclosure of information" (Elliman et al, 2007); when there is a lack of public scrutiny of evidence and an inability for the public to be able to challenge what evidence was considered and what was omitted.

Benner (2007) states that the consequences of "getting it wrong" with accident investigations are manifold: injustices; litigation; misdirected future investigations; wrong policies; distrust; delays; flawed data and research; and above all missed opportunities for preventing recurrence. There are pressures from all quarters to ensure that all aspects of the investigation are robust, none more so than the analysis itself.

Zotov (2002) argues for the pursuit of the "scientific approach" to investigations to build in quality control, reflecting Benner and Rimson's earlier call for defined steps following an input-operation-output-feedback loop (1991). "Scientific methods may offer the possibility of better quality investigations, with more rigorously argued analysis and more persuasive recommendations in consequence."

“Analysis activities ultimately rely on the judgement of investigators, but analysis has been a neglected area in terms of standards, guidance and training of investigators in most safety investigation organisations.” (ATSB, 2008).

“Many investigators (from most safety investigation organisations) seem to conduct analysis activities primarily using experience and intuition which is not based on, or guided by, a structured process. It also appears that much of the analysis is typically conducted while the investigation report is being written. As a result, the writing process can become inefficient, supporting arguments for findings may be weak or not clearly presented, and important factors can be missed.” (ATSB, 2008).

Recognizing the multiplicity of analysis techniques available for use by the investigation agencies, the Australian Transport Safety Bureau (ATSB) sought to clarify their position by reviewing best practice in this area and building upon it to create a new analysis framework thus providing them with standardized terminology and definitions, an accident development model, a defined process for conducting analysis activities as well as a set of tools to document the process. This suite of products was complemented with policies, guidelines and training for investigators. The ATSB cite the aims of the new analysis framework to be to “… improve the rigour, consistency and defensibility of investigation analysis activities, and improve the ability of investigators to identify safety issues in the transportation system”.

The system is in its infancy but the ATSB believes that whilst no approach to investigation will receive global approbation, theirs offers a “… balanced approach which most effectively achieves its aims” and encourages debate and discussion within the industry.

The Transportation Safety Board of Canada launched a similar initiative in 1998 with the desire to improve its operational effectiveness and efficiency. The Integrated Safety Investigation Methodology was developed to “… systematically integrate the TSB’s efforts in determining findings as to causes and contributing factors, identifying safety deficiencies, assessing the associated risks to safety in the national transportation system, evaluating options for mitigating those risks and for communicating the resultant safety message in the most convincing way.” (TSB, 2000). It offered a holistic context in which to address safety issues, looking at going far beyond establishment of the immediate cause to the assessment of risks associated with safety deficiencies (Ayeko, 2002).

The researcher found throughout the interviews with the Inspectors that Branches differed in their amenability to the employment of analysis tools. One criticism expressed regarding accident analysis tools was that they were considered to be either overly complex or too simplistic and as such were not highly regarded. It is not known whether this is as a result of being new to the role, functional leadership or cultural drivers but the RAIB appeared to be ‘satisfied’ with using an analysis tool to structure their evidence and report

although some confusion remained as to which was the most appropriate tool to use.

There is little evidence to suggest that a lack of a prescribed methodology has had a serious impact on the validity or reliability of an accident investigation report published by one of the AIBs, at least not in recent years and no methodology is without its flaws and shortcomings. It is predicted that adherence to protocol, however, should lead to less variability in the quality of investigations. The consistent use of a methodology allows for replicability, a clearer articulation and greater transparency of the process and continuity of argument. Answers to causal questions are then based upon accepted decision rules and methodology as opposed to judgement predicated primarily upon experience. It is speculated that a highly prescriptive analysis process would, however, sit uncomfortably with some of the Inspectors interviewed; a view expressed during the Phase 1 interviews was that Inspectors were employed for their "… experience and expert opinion, and not to merely follow a flow chart".

7.1.3 The role of the Principal Inspector

The researcher felt that the role of the Principal Inspector had important implications for the overall effectiveness of the accident investigation. Their function is manifold: by turn they are mentors, technical sounding boards, team leaders and report editors as well as being man-managers and performing the role of Investigator-in-Charge (IIC). It should be noted that the IIC has definitional connotations of taking control of a large-scale accident but in this instance they are notionally responsible for the investigation, performing more of a facilitative, coordinating function for the types of investigations that are more prevalent for the three AIBs. The Phase 1 interviews revealed that there was a resigned acceptance amongst the Principal Inspectors that the role was no longer hands-on, out in the field, taking command but more of a coordination, support and oversight function.

The AIBs have dedicated publications staff but it appeared, at the time of the research, to be an over-reliance upon the Principal Inspectors to produce the final, edited version of the report. The interviews confirmed that a large percentage of the Principal Inspectors' time was spent editing the reports created by the Inspectors. This received universal disapprobation from both Principal Inspectors and Inspectors alike.

Whilst it was expected that Principal Inspectors would use their knowledge and experience to comment upon technical comment or logic of analysis and conclusions, it was felt inappropriate that such a resource should be used to correct spelling, grammar and typographical errors. The inconsistency of 'standards' in terms of writing styles and expectations amongst the Principal

Inspectors was noted by the Inspectors as well as a high degree of variability in man-management and operational styles.

Despite the perceived variance, there appeared to be a general consistency amongst the Principal Inspectors interviewed in terms of their defined effective behaviours. Not unsurprisingly, it was found that those aspects of behaviour that the Principal Inspectors themselves regarded highly were reflected in what they sought in the style and content of the report. For example, one Principal Inspector commented on the need to get the facts back out to the industry and families as soon as was possible. Factual correctness delivered in a timely manner. The 'niceties' such as grammar, punctuation and presentation were deemed to be secondary. Conversely, other Principal Inspectors felt that the integrity of the report content and recommendations could be adversely affected by "sloppy writing". Whilst the differences between the Principal Inspectors was not observed to be marked, they were sufficient to have raised continual comment by the Inspectorate.

It was felt by some to be entirely logical that such the function of report publication should be undertaken by support staff in line with a house style – not unlike the process at the NTSB in the United States, but with more individual control over the initial report construction.

Benner (2008) comments that the IIC or similar function has two fundamental quality control issues to manage: the quality of the investigation process and the quality of the work product. It is their responsibility to ensure that the overall investigation process is efficient, effective and unassailable as too are the investigation report and recommendations, by way of the work product. The Principal Inspectors' focus with regards to the report production is, therefore, not inappropriate. What is of concern is the ability to balance the time and effort expended with relation to the other added-value activities that could be undertaken.

The existence of the Board of Transport Accident Investigators where the Chief Inspectors of the three UK AIBs have agreed to pursue joint initiatives provides the perfect opportunity for not only the Chiefs but as, if not more, importantly the Principal Inspectors to maximize on the potential 'synergies' that exist.

The flat hierarchical structure of the AIBs and the longevity of the position holders leaves little room for advancement and development, particularly for Principal Inspectors. One proposal would be for there to be more inter-Branch endeavours to capitalize upon best practice and differing perspectives.

As an example, the RAIB reported (RAIB, 2007) that as part of their internal audit process, peer reviews of reports were performed which also encompassed the standards of the investigations themselves. Inter industry peer reviews of investigation reports by Principal Inspectors from the three UK AIBs would provide an independent quality assessment of the product as well as fresh ideas, expanding the knowledge and experience of the Principal Inspectors.

Finally, an accident investigation provides the opportunity for the industry to learn: to learn why a specific accident occurred and what corrective action could prevent recurrence. As importantly, the investigation itself provides valuable lessons in terms of the process, the methodology, the tools used and so forth. Benner (2008) believes this is a vital role for the IIC and in this case, the Principal Inspector to undertake. Having oversight of a number of investigations, they are in a position to offer insights that would benefit the overall advancement of the "state-of-the-art of investigation". This aligns with the remits of both the existing professional societies for marine and air investigators: the Marine Accident Investigators' International Forum which aims to "… promote and improve marine accident investigation" and the International Society of Air Safety Investigators which, as well as promoting air safety, strives towards "… mutual development of improved investigations".

7.2 Phase 2

The second phase of the study sought to determine the perceptions of Principal Inspectors regarding behavioural indicators of effectiveness in accident investigation. This was undertaken by employing the Repertory Grid technique to structure interviews and elicit responses.

Behavioural indicators, both positive and negative constructs, were extracted from the interview transcripts and once rationalized for duplication and saliency, formed the basis of the questionnaire used in the final phase of the research.

Further analysis of the remaining behavioural indicators suggested five competency themes: interpersonal and communication skills; work activity management; personal attributes; cognitive abilities; and technical abilities.

As indicated, there was no attempt to force fit constructs in order to have comparable numbers of behavioural indicators in each group and consequently two of the categories (interpersonal and communication skills and personal attributes) account for nearly half of all the data. Whilst the competency themes are not weighted in any way, the researcher felt that the increased number of constructs elicited for interpersonal and communication skills as well as personal attributes gives an indication of the relative importance the Principal Inspectors placed upon those two competency themes.

Whilst interpersonal and communication skills have been taken as one competency group or theme within this research, it could be argued that with reflection on the findings of Phase 3 which indicated the relative importance of dealing with people and report writing, that the competency theme could be separated out into interpersonal skills and communication skills.

There was no pre-existing schema specific to the role of the accident investigator available against which to compare these themes, the Chartered

Institute of Personnel and Development's recent Learning and Development Survey (CIPD, 2007b) found the most 'popular' (ie most frequently utilized) competencies to be, in order: communication skills; people management; team skills; customer service skills; results orientation; and problem solving.

This concurred with earlier findings in Rankin's (2004) survey into 49 employers' core frameworks which showed the top six competencies to be: team orientation; communication; people management; customer focus; results orientation; and problem solving.

More recently, and specific to an aerospace design engineering organization, Robinson et al (2005) found the comparable competency groups of: personal attributes; project management; cognitive strategies; cognitive abilities; technical ability; and communication. These similarities in groupings indicated to the researcher that there was credibility in the findings (Lincoln and Guba, 1985), and that the competency themes determined were valid grouped descriptions of behaviour for this role. There was also a feeling of 'fit' with what the researcher had experienced during the study which Corbin and Strauss (2008) offer as one measure of the quality of the findings.

It was not the expressed intention of the research to create a competency framework per se, but the method employed for generating the behavioural indicators followed the typical process for the development of competency frameworks: collecting job role behaviour and skills information using observations, interviews and questionnaires; analyzing raw data and creating subgroups from statements with related behaviours; and identifying specific competency names to represent the smaller subgroups of behaviour.

The resultant competency framework is therefore a credible tool in its own right and has applicability and usefulness (Corbin and Strauss, 2008). The Repertory Grid interviews used in this phase, stopped short of comparing 'elements' or individual Inspectors and rating them using the positive and negative constructs or behavioural indicators as this was not considered to be appropriate by the Principal Inspectors interviewed. This aligned with the researcher's intent that this should not be an evaluative study. Not using a method in its entirety or 'method slurring' attracts the possibility of losing some of the credibility associated with using that particular method (Corbin and Strauss, 2008). The researcher felt that the change to the method was valid, however, in the context of the study and it was the use of the Repertory Grid to frame the interviews rather than the ensuant element ratings which was of value. There is, however, the opportunity to revisit the use of this framework by the Branches should they wish to employ such a measurement tool.

Phase 2 determined 200 indicators of effective and ineffective behaviour in accident investigation as positive and negative constructs. In a typical competency framework these would be used as either illustrations of behaviour that would characterize the possession of a competency or else could be used as a measurement of competence.

It is the assertion of the researcher that elements of the competency framework could be incorporated into the MAIB's Professional Standards of Competence in Accident Investigation framework by the inclusion of all requisite values and behaviours.

The ubiquitous drive for performance assessment has manifested itself at the MAIB in terms of their adoption of a competence framework that guides internal accreditation of Inspectors. The MAIB used the structure of establishing performance criteria with discrete elements, accompanied by requisite knowledge and understanding, following National Occupational Standard (NOS) principles. Whilst it is typical for the NOS to focus primarily upon activities and knowledge, there is the possibility of extending the framework to include values and behaviours. Competencies traverse the different elements of the standards of competence. For example, communication skills are required within each of the four units and with many if not all of the underlying elements of which the unit is comprised.

As such the competency aspects of this research, including the behavioural indicators generated in Phase 2, could be used to further strengthen the Professional Standards of Competence in Accident Investigation tool. This answers a call in the literature for more blended approaches to determining competences and competencies (Schippman et al, 2000; Robinson et al, 2005).

The value of using behavioural indicators and competency themes developed with the Principal Inspectors is that there is a degree of saliency in being able to use the statements that reflect the language used by the group although the researcher would wish to review these to ensure that whilst keeping the sentiment of the original intention, the tone and language used matched that of the competence framework.

It is possible to apply weightings to behavioural indicators based on whether they are deemed to be mandatory, desirable or optional for the role. Likewise, weightings can be applied at the competency level: a percentage value can be set as a means of communicating to the Inspectors the relative value and priority the Branch attributes to each competency. This enables behavioural indicators and competencies to be more focused in measuring what is of real importance to the organization as opposed to the blanket application of a generic model.

7.3 Phase 3

The final phase of the study sought to utilize the behavioural indicators generated by the Repertory Grid interviews in the previous phase in order to capture the relative perceptions of the UK MAIB and AAIB Inspectorate with

regards to what constitutes effective behaviour in accident investigation. This was undertaken with the use of a five-part questionnaire.

The first three parts of the questionnaire (position and background; professional development, and areas of expertise) sought to characterize the Inspectors: their backgrounds; length of industry experience; their thoughts on learning and development at the Branch; and lastly, their perceived levels of expertise in both technical and investigative subjects.

As has been shown, the majority of respondents have had many years experience in their industry which as Sarsfield et al (2000) pointed out, tends to skew the age distribution of accident investigators towards older ages. Whilst there are implications for retirement and succession planning given the flat structure of the organizations, this experience brings with it more than just an accumulation of technical knowledge. The majority of the Inspectors are 'second careerers' and will have had the opportunity for developing social and organizational skills which this research has indicated are desired qualities for the role. A caveat to this would be that if these interpersonal and communication skills are not apparent in those of an older age at recruitment then they are less likely to be amenable to development, referred to as a 'cognitive lock-in' (Murray and Häubl, 2007). This is not to comment upon cognitive functioning and ability to acquire new skills but habits and ways of working may become more engrained as age increases; this is tempered, however, by an increase in knowledge and expertise.

The Inspectors interviewed expressed high levels of confidence in their own abilities and the findings reflect this with an equally high rating in terms of their levels of expertise, in particular with respect to accident investigation skills. The perceived levels appear to be lower for technical / mode specific skills but this could be a reflection of the spread of expertise across the Inspectorate. It could be surmised that whilst an Inspector will be required to employ all of the investigation skills in the course of investigating an accident, that it is not a requirement for them to have expertise in all technical areas – this is stated with a presumption that the Branch as a whole should possess these skills.

Expertise is largely defined as a special skill or knowledge attained through training or experience but the literature reveals that there are various idiosyncrasies associated with expertise that have ramifications for the performance of an organization.

Being able to articulate and communicate the analysis process and conclusions drawn is a vital part of the role but from a cognitive perspective, as expertise increases, mentally represented tasks become more abstract and simplified which can "… interfere with experts' ability to share their expertise". (Hinds and Pfeffer, 2003). Knowledge, acquired as a result of experience (Polanyi, 1966) becomes tacit and held at an unconscious level increasing the challenge of articulation. Experts somehow forget what it was like not to know and have an oversimplified view of what might actually be a complex task (Hinds, 1999).

This is of particular concern if they are communicating with someone considered to be significantly less expert as there is a need to 'bridge the gap', referred to as "… the curse of knowledge" (Camerer et al, 1989). This can have unwelcome consequences where experts are encouraged and expected to pass on knowledge through mentoring.

It is the successive development of procedurally oriented knowledge structures that facilitate the processes of expertise, a product of experience rather than "… of superior intelligence." (Clark, 1999) This reiterates a point made by Argyris and Schön (1974) " **…** the ease with which they can process large amounts of information and produce elegant and effective outputs tempts one to assume they have superior mental capabilities or aptitudes." Expertise is more likely to have implications for long term memory and schemata: "Many so-called indicators of talent are not inherited prerequisites for exceptional performance but rather capabilities acquired as a result of intensive practice." (Ericsson, 1990) It is therefore impractical to expect new Inspectors to demonstrate the same degree of expertise in the field of accident investigation as those who have had many years in the role.

Limitations are not just cognitive but can also be motivational. Where there is a competitive environment with a flat hierarchy as at the Branches, knowledge is power held in the individual rather than the collective. Status is accorded to those who provide assistance to others (Blau, 1955) and an exchange of knowledge for status is effected. Hinds and Pfeffer (2003) suggest that organizations need to create systems that motivate or reward sharing knowledge and information between and within groups to sustain assistance.

Not only are there issues with regards to communication, expert opinion, for that is what the Inspectorate offers, is reliant upon a rational deference to 'epistemic authority'. There is an acknowledgement of superiority in terms of knowledge but with it comes an ineluctable element of trust. Accident investigation processes need either to be so transparent and proceduralized that they can be undertaken by the layperson, or there needs to be trust not only in the reliability of their knowledge (for one can only truly tell whether an expert is competent by becoming an expert oneself), but also in their characters and motivation. "Where there is expertise, knowledge is not in fact open and accessible to all." (Hardwig, 1994).

The Inspectorate requires public trust in order to function, and that trust is largely built upon the perceived epistemic authority derived through experience and technical knowledge.

7.3.1 Recruitment, training and the superior investigator

The final part of the questionnaire required respondents to rate both the positive and negative behavioural indicators with regards to importance at recruitment,

amenability to change through training intervention and how they distinguished superior behaviour.

The positive behavioural indicators rated in terms of how necessary they were in new recruits and conversely how necessary it was to screen the behaviour out at interview fell predominantly into the interpersonal and communication skills, cognitive abilities and personal attributes competency themes. Negative behavioural indicators were more evenly spread but again, were mainly found in the same competencies. Conversely, work activity management was seen as a less important competency to consider at recruitment. The researcher surmised that the latter was more likely to be amenable to interventions once recruited and could therefore be developed whereas there might be less possibility of improving the ability to communicate and deal with people effectively.

It was considered to be necessary to screen out individuals who showed no proclivity towards the technical aspects of the role but technical knowledge was not seen as essential for recruitment. This concurs with Robinson et al (2005) who found that technical abilities were ranked lower than personal attributes and project management skills, not so much because they were deemed less important but more likely because there was an expectation of a particular level of technical ability and experience as a prerequisite for initial selection into the role. Technical expertise was the starting point and not an aspirational acquisition. "Differences in technical ability are only likely to emerge when increasingly technical fields are considered." "When personal attributes and project management competencies are considered, there is likely to be far greater differentiation in ability … consequently, it is the non-technical competencies that are more critical to excellent performance." (Robinson et al, 2005).

Recruitment and selection of new Inspectors is conducted by external organizations. The status of the role is such that it attracts many responses when vacancies are advertised; some applications are purely speculative but the remainder are subject to a series of filters before short lists are developed. Potential candidates are screened through one-to-one telephone calls with the recruitment agency and the successful applicants invited to the Branch for a one day assessment centre. It was reported that the AIBs have enjoyed a stable relationship with the selection organization, if not the recruitment agency, over successive rounds of recruitment.

Application forms for recent recruitment campaigns at the AIBs call for proven experience in the competency areas of critical thinking (intellectual capacity, critical analysis, inquisitive outlook), interpersonal skills (engaging people, professional empathy, working with others), results focus (resilience, delivery, structured task planning) and decision making (managing information, pragmatic decision making, impartiality and objectivity) as well as communication skills, integrity, credibility and a positive attitude. These concur with the competency themes and underlying behavioural indicators elicited during the research.

The assessment day (as experienced by the researcher during Inspector selection at the AAIB in 2007) comprises a group discussion typically based upon a mode neutral traffic accident; psychometric personality, verbal and numerical critical thinking tests, a psychological exploration with an external psychologist and a formal interview with a three person Board. In addition, a written exercise is conducted based upon the subject matter of the group discussion.

The nomothetic psychological tests in use at that time were the Watson-Glaser Critical Thinking Appraisal UK and the Rust Advanced Numerical Reasoning Appraisal used to assess intellectual ability. These tests are complementary and co-norming and purport to measure analytical and cognitive skills including: drawing inferences; recognizing assumptions; argument evaluation; deductive reasoning; logical reasoning; and "… the intuitive recognition of equivalence or sufficiency of information" (Rust, 2002). All these have been deemed requisite skills in the field of accident investigation.

In addition, the 15FQ+ personality test was also administered. Based upon Cattell's (1946) 16 PF test, Psytech's 15FQ+ has remained true to the original personality factors with exception of the 'Intelligence' variable. In line with current research, this has been replaced by the term 'Intellectance' denoting a self-expressed cognitive style or preference rather than a straightforward measure of ability. This test includes an impression management scale known as 'social desirability'. Candidates rating highly on this scale are thought to be desirous of presenting "… an unrealistically positive image of themselves" (Psytech, 2008). The researcher was advised that the longstanding relationship between the AIBs and the selection psychologist had enabled the 'preferred' psychological profile of the candidate to be refined over time although it was posited that it was unlikely that a template for the ideal accident investigator existed as each Branch had ventured its own preferred profile dependent, it was suggested, upon the culture of the Branch and industry.

Questionnaire-based measures of personality and values provide "… a fair, objective and cost-effective method of predicting likely behaviour" (Psytech, 2008). "To the extent that every individual 'has' a personality that is stable and relatively permanent, behaviour will be consistent from one situation to another; an alternative view is that behaviour is largely determined by situational factors and that behaviour will show considerable inconsistency across situations." (Gross, 1996).

Detractors would posit that a flaw in tests for personality and to some degree ability also, is in terms of ecological validity. Are the tests able to reflect what people would actually do in 'real life', for example, quick thinking in times of emergency (Hayes, 2000); people behaving in a manner not predicted by personality tests. "When a group is populated by individuals who are saying and doing one thing but thinking and feeling another, high effectiveness in the

long haul is unlikely" (Porter et al, 1975). If nothing else, they provide signposts for the Branches to use to indicate generalized acceptable qualities.

Selection is the obvious opportunity for ensuring that those candidates perceived to exhibit behaviours detrimental to the effectiveness of an investigation are eliminated, unless those behaviours are deemed sufficiently amenable to improvement or reduction through training interventions. Bonnstetter (2000) argues that selection rarely focuses upon attitude – usually due to the fact that skills and knowledge are the easier components of performance to define and therefore measure. Experience has shown, however, that organizations "hire for skills and fire for attitude" (Bonnstetter, 2000).

What was noticeable to the researcher during observation of the selection assessment at the AAIB was that there was not more rigorous testing of report writing and the ability to deal with people, particularly in confrontational or emotive situations.

As these two areas are consistently rated highly as essential for new recruits during this study, the researcher would encourage the Branches to look at ways to incorporate more opportunities for demonstrating capacity, if not ability, in these areas.

More demanding writing exercises where not only the fundamentals such as grammar and spelling can be assessed but also the ability to analyse and assimilate facts and figures to create a fluid coherent report.

Further exploration of the manner in which candidates cope with challenging role play interviews with 'witnesses' and 'relatives' would inform the selection assessment with regards to capacity for pertinent questioning, articulation of findings and essentially, demeanour and interpersonal skills under pressure.

Whilst there is an appreciation that additional or longer exercises would increase the costs involved with running an assessment centre, better initial screening and a full day of exercises would ensure that only those candidates most appropriate would be called back for interviewing at a later stage.

Historically, particularly at the AAIB, there has been an emphasis on selecting for technical knowledge and experience both of which are considered prerequisites for establishing expertise. Technical knowledge, however, has been shown to have certain limitations. Sarsfield et al (2000) stated that there are three 'clusters' of knowledge and skills required by accident investigators: investigation (understanding and implementing appropriate methodologies and requisite steps to successful output); management (coordination of teams, time management, etc); and technical (domain and industry knowledge). Their studies showed that of all these, technical knowledge and skills were seen to atrophy and date much quicker than either investigation or management. But

with a basic proclivity towards the technical aspects of the role, such a knowledge shortfall could be supplemented on a continued development basis.

From the findings of the Phase 3 questionnaire, it was shown that technical abilities were perceived to be most amenable to change or improvement through training and in particular, behavioural statements pertaining to report writing were rated most highly. Conversely, personal attributes were rated as least amenable to training suggesting that if the role of investigator was desirous of those aspects of behaviour then they were better sought at recruitment and selection rather than reliance on improvement or acquisition once in the role. This concurs with Spencer and Spencer's iceberg model (1993) which found that surface skill and knowledge was relatively easy to identify and develop through training whereas it was better to recruit for the deeper, core personality characteristics as these were less likely to be amenable to interventions.

"Training in this very practical art is essentially an apprenticeship." (Zotov, 1997) It is generally accepted that investigators, particularly effective ones, are not created simply by "… the ownership of a fluorescent jacket." (Braithwaite, 2002) It is a role where experiential learning is essential; where experience is transformed into knowledge.

There are several phases to training investigators. ICAO (2003b) in its Training Guidelines proposes that aircraft accident investigators undergo initial basic training, followed by more advanced specialist courses, on-the-job training and mentoring. Many structured investigation courses are available, particularly in aviation. These are often conducted by universities and other educational institutes, as well as by investigation authorities, manufacturers or military establishments (ICAO, 2003).

Cranfield University ran its first course in 1977. It was initially conceived and developed in association with the Chief of Air Accidents due to the increasing strain placed upon the Branch by requests for assistance for training by foreign agencies (Tench, 1985). Principally designed for civil aircraft accident investigation, its syllabus and scope has widened to include military and in recent years has been 'enhanced' through collaboration with the MAIB and RAIB to incorporate the investigation of accidents in other modes of transport.

Braithwaite (2004) points to the need for industries to learn from one another's mistakes; to "… learn lessons across modes". With the formulation of multimodal agencies in many countries such as Australia, Canada, the Netherlands and the US, there are advantages of sharing resources, and more readily sharing information or "lessons".

"Perhaps one of the most valuable outcomes of bringing investigators from different modes together has been in revealing differences in approach. Some of the differences are entirely logical and are a function of the operating environments. However, some of the others do suggest an opportunity to

question whether 'the way we have always done it' is necessarily still valid. … The philosophical difference may be for some valid historical reasons, but there is considerable value in asking why we do certain things the way we do." (Braithwaite, 2004).

The introduction to the Cranfield course notes in 2003 included the comment that "It is not intended to convey the impression that on completion of the course you will be fully competent .. investigators. For it is only through continuity of practice, diligent application and experience that you can achieve that distinction."

This is echoed by ICAO's training guide: "As an investigator gains experience, he will realise that the need to increase his knowledge and upgrade his skills is a continuing process. While training is essential, the optimization of an investigator's capabilities generally depends upon a personal commitment to excellence." (ICAO, 2003b).

Given the tendency for technical knowledge to decline over time (Sarsfield et al, 2000), the AIBs are inclined to employ generalists, exemplary in the investigative and management aspects of the role and make use of external expertise as and when required. Whilst there are questions regarding the impact upon impartiality and independence, it has proven a successful process and removes the issues of replacing in house specialists upon retirement or transfer.

The RAIB, during its infancy, sought to offer an extensive training package to its newly appointed Inspectors with nearly 170 days training provided during their first year in the role. This was a move to turn 'generalists' into 'specialists'. Sarsfield et al (2000) commented upon giving relatively inexperienced people greater volumes of training to acquire skills needed, suggesting that the effectiveness of such an 'employee development plan' was unclear.

At the start of the research, both the sponsors and the researcher were keen to determine what behaviours and skills distinguished a superior investigator from an average one. Superior was operationally defined as resulting in a higher quality investigation. The researcher found, however, that the Phase 3 findings showed all attributes or competencies received comparable ratings: no one competency theme attracted a higher rating than any other. Whilst this may have been a reflection on the manner in which the question was phrased, the researcher felt that it was more likely to be attributable to the requirement for the superior investigator to have a balanced complement of skills.

Further analysis of the data showed that the behavioural indicators attracting the higher scores mirrored those perceived to be essential at recruitment leading the researcher to surmise that effective selection of non-technical skills was paramount in developing the quality of investigations.

Competency and competency modelling have been synonymous with enhanced or superior performance since the term was first proposed (McClelland, 1973). The reason cited for the introduction of competency modelling to many organizations is the increased business advantage – an opportunity to outperform competitors (Horton, 2000a). It could therefore be concluded that a well-constructed competency model should capture those elements of superior behaviour that the organization wishes to maximize upon to capitalize upon.

In practice, this has not proven to be quite so straightforward. Superior behaviour can be difficult to specify (Bonnstetter, 2000) as there are usually no defining thresholds. Bonnstetter (2000) argues that it is context dependent: the best performer in one organization might be deemed average in another. It is therefore more likely to be associated with measuring investigators "relative to mission" (Collins, 2005) and determining what is fit for purpose as opposed to defining a "one size fits all" discrete set of attributes.

The researcher believes that the competency themes developed during Phase 2 of the research form a base against which to measure performance. If defining thresholds are thought not to exist, then it could be argued that performance should be considered to be a continuum. Expected minimum levels of performance are dictated by competence measures as definite indicators of attainment of a standard. Any increases upon that level of effectiveness could therefore be considered to be superior, something that adds value and would be measurable through a competency framework.

The last part of the questionnaire called for the Inspectors to bring to mind colleagues that they most and least admired and list qualities that distinguished them from the rest. There was an assumption, based on the findings of the first two phases of the research, that the colleagues for whom the Inspectorate has most, and conversely, least admiration for, were in practice those who were considered most effective in their role.

The researcher was keen to see how these compared with the overall findings of the questionnaire and noted that there were many similarities, lending credibility to the findings. The most frequently cited skills and behaviours that Inspectors admired in colleagues were, in order: the ability to write a report well; verbal communication; technical knowledge; being open minded; sharing time and knowledge with others; being thorough; being approachable; and being a team player. These findings concur with the behaviour indicator ratings with report writing and dealing with people being the behaviours most highly rated.

The most frequently cited skills and behaviours that Inspectors least admired were being arrogant; poor report writing; not sharing time and experience with others; being dismissive; inability to communicate effectively; and being lazy. Again, report writing and dealing with people are apparent as themes continuing through the responses.

This study has repeatedly pointed to the concepts of report writing and dealing with people. The next section of this chapter now looks at these in more detail.

7.3.2 Report writing

"In safety, the story is not mere packaging, a wrapping to make the principles palatable. The story is the important bit, what really happened." (Kletz, 2001).

As alluded to in the literature review, the accident report is the key deliverable from an investigation, representing the quality of the investigation as a whole.

"A superbly written report cannot do much to overcome a bad investigation, but a poor report can definitely ruin a good investigation." (Wood and Sweginnis, 1995). These sentiments were echoed by Tench (1985), "Writing an accurate and properly assessed accident report is by far the most difficult part of the investigator's task, but it is the investigator's only end-product. No matter how efficiently the investigation has been conducted, an inadequate report nullifies the effectiveness of the investigation".

Unless an investigation is able to present a logical coherent argument in a manner which is readily understood by both technical specialists and lay people alike, then the opportunity to effect change is compromised. Investigations and ensuant reports are often contentious despite their eschewing culpability and liability and "If the report can be attacked and refuted based on its logic and content, it will be" (Wood and Sweginnis, 1995).

One aspect of report writing that was alluded to frequently in the interviews was the length of time it took to produce reports. Inspectors were mindful of the constant need to balance the creation of a comprehensive and evidentially based report with the need for industry and families to get timely information. A divide was observed amongst the Inspectors in terms of their opinion regarding this balance. This can be illustrated by the following quotes taken from the Phase 1 interview analysis:

> "*No point in producing a report that's too old"*
>
> *"Good quality takes time".*

During the interviews in Phase 1, the value of a report and findings published in some cases nearly four years after the event was questioned. Corrective actions are put in place and the industry moves on in that time. It is, however, only a relatively small percentage of the overall accidents investigated that overrun the 12 month figure (described as a 'notional' target by one Chief Inspector). Looking at the reports published in 2006 and 2007, the overrun figures for the Branches were as follows: RAIB – 15%; AAIB – 8%; and MAIB – 7%. Two notes of caution should be made with respect to these figures: the

RAIB was very much in its infancy at this time and establishing the preferred report format; and 100% of the AAIB formal reports leading from Inspectors' Investigations overran the 12 month figure. One Inspector commented that this was largely due to the fact that these investigations tended to be far more bureaucratic and political in nature, implying their investigative work was done expeditiously but that the process was delayed by agencies and influences beyond their control.

The structure of narrative reports, such as used by the AIBs, follows the facts-analysis-conclusion format promoted through ICAO's Annex 13, and as such provides a framework to guide the content of the accident report. Annex 13 also provides report writing 'conventions' (ICAO, 2003a) ranging from the general "… convey an attitude of impartiality and write objectively" to the specific "… pronouns should be placed close to their antecedents to ensure clarity".

Such guidelines may not, however, be sufficient to guarantee consistent, appropriate or correct use of grammatical rules and spelling. As reported by one Inspector, "… when it comes to spelling and grammar, you either get it or you don't – and quite frankly, I don't!" The impression gathered from this comment amongst others was that some people had a natural proclivity towards such things and that training and education could only help the situation so far for those that did not. Whilst report writing courses are made available to Inspectors, there are those who readily admitted during interview that it was often too difficult to sustain the required changes and that without constant conscious effort, Inspectors reverted to habit and preferred writing style.

The interviews in Phase 1 suggest a high degree of variability in the writing styles and expectations of the Principal Inspectors in their role as investigation report editor. One Principal Inspector commented upon the need to get the facts back out to the industry and families as soon as possible. Factual correctness delivered in a timely manner. The 'niceties' such as grammar, punctuation and presentation were deemed to be secondary.

Conversely, other Principal Inspectors felt that the integrity of the report content and recommendations made could be adversely affected by "sloppy writing". Whilst the differences between Principal Inspectors were not observed to be marked, they were sufficient to have raised continual comment from the Inspectorate.

One of the solutions discussed with the AIB Inspectors was the adoption of the US NTSB process of using professional writers to collate and edit investigation reports. The writing team assemble the reports based upon the information passed to them by the investigators. In principle this appears to have merit as an idea but in practice it was often reported to be quite difficult. Investigators were said to be disparaging regarding the technical understanding of the writers and the writers felt undervalued by the investigators and not given sufficient respect with regards to their professional writing abilities. Whilst many UK

Inspectors acknowledged the potential benefit of having a dedicated writing resource (particularly as it would free up the Principal Inspectors for more management centric activities), there was a reticence: as if somehow ownership of the investigation would be diminished. It was conceded, however, that it would be easier to control the 'house style' and thus standardize the output.

Whilst it was suggested that the variability in writing abilities amongst the Inspectors was acknowledged to sometimes negatively impact the report production process, the internal workings of the Branch, the hierarchical editing process and the often unique nature of the accidents themselves often means that even the most effective investigator could find their report taking a considerable length of time to produce.

The variability in styles and expectations has meant that the report is not yet something "with measurable and immutable characteristics" (Irving and McKenzie, 1993) but remains organic, honed and shaped by successive layers of contribution and editing.

7.3.3 Dealing with people

One of the most important aspects of the role of Inspector, as determined through the interviews in Phase 1 of the research and the findings in the Phase 3 questionnaire, is that of interacting with other people. As well as the friends and family of those involved in air, marine and rail accidents, Inspectors need to be able to communicate effectively with the media, manufacturers, operators, other technical specialists and coroners to name but a few. As importantly, they will need to work with colleagues within the Branch.

Sometimes popularly described as 'emotional intelligence' (Goleman, 1995), the ability to understand and manage other people is well documented as a requirement for survival and adaptation; whether in business or life in general. Whereas the predominant focus on intelligence has been associated with cognitive abilities, concepts such as 'social intelligence' (Thorndike, 1920) and 'interpersonal intelligence' (Gardner, 1983) fit well with the competency literature and have been embraced as viable complements (rather than alternatives) to traditional intelligence tests.

A debate exists as to whether emotional competencies are innate talents or learned capabilities and as such susceptible to improvement through training interventions (Goleman, 1998). The findings of this research suggest that there is a perception that they are less likely to be changed through training and are better selected for during recruitment.

Defining, measuring and validating such emotional intelligence has, however, proven difficult despite its popular media interest and whilst emotional intelligence has an intuitive feel about it, caution should be exercised in its use as a predictive instrument.

As an extension of emotional intelligence, social intelligence (the use of emotional intelligence in social settings) is made up of social awareness (including empathy, attunement, empathic accuracy and social cognition) and social facility (synchrony, self-presentation, influence and concern) (Goleman, 2006). Sternberg (1999) interprets this as 'successful intelligence' defining it as "… the ability to balance the needs to adapt to, shape and select environments in order to attain success."

An interesting corollary to research in relation to social intelligence is teamworking which has been alluded to earlier in this chapter. Although participatory and collaborative work is encouraged at all the Branches, it was not clear from the interviews conducted that it was necessarily the natural working style of some of the Inspectors. The researcher has found that the individual competencies required for effective performance as an accident investigator will always be context dependent and it will be equally important for an Inspector to demonstrate the competencies required for working as part of a team or group, which may differ.

Soft skills, as illustrated through the concept of 'dealing with people', should not be seen as a replacement for technical knowledge or skill but essentially complementary, unlocking the potential for highly effective performance in order to gain flexibility and adaptability.

7.4 Research limitations

Undertaking PhD research is described as akin to an apprenticeship served on the journey towards becoming a professional researcher (Phillips and Pugh, 1987). As such, it provides an opportunity to acquire the associated research skills and to demonstrate their acquisition in an appropriate manner. Phillips and Pugh (1987) indicate the 'holistic' nature of the process "… involving guesses, reworkings, corrections, blind alleys and above all inspiration".

At the commencement of the research project, it emerged through discussion with each of the sponsors that there was insufficient common understanding of the terms 'competence' and 'competency' and as such, differing expectations as to the preferred direction the research should take. Unfortunately, it was not simply a question of semantics as there are, as explained in this thesis, clear differences in the concepts and subsequent implications for the research methodology. Additionally, each of the three UK AIBs was individually involved with projects that had implications for the study. A consultancy had been employed to develop a competency framework and both the MAIB and RAIB were pursuing accreditation although along widely differing lines.

Given the amount of work already being undertaken in the area, there appeared to be diminishing room for unassisted innovative research. In order to produce work that was original, the researcher was obliged to step outside of the original

‘remit’ of simply developing a competency framework for the Branches to inform training and assessment. In doing so, the researcher found the RAIB unconvinced of the value in continuing to support the research at a time when resources were more usefully employed in shaping the operation. Their withdrawal from the research was disappointing and regrettable as the researcher was denied a quite different perspective but the researcher was grateful for their contribution nonetheless.

The question should be raised as to how appropriate social research is when a thesis is published a number of years after the start of a project. “In doctoral work – in the rigours that it requires and the constraint on resources – there is a limit to the speed in which one can progress, and this is significantly slower than is generally expected in practice.” (Freeman, 2003). Organizations are dynamic entities and change is constant making a study over a long period of time (as opposed to a longitudinal study) more difficult. Changes at the Branches over the course of the research - some extensive, others minor - have included the formation of the RAIB and the commencement of its operation, alterations to organizational structures, changes in personnel in both the Inspectorate and at senior levels largely as a result of retirements, as well as in terms of senior government officials with responsibility for transport.

And yet there are constants: accidents and serious incidents continue to occur, the nature of which do not appear to be changing even if frequency and scale do. Neither have the skills and behaviours required by the accident investigators appeared to have altered greatly over the course of the research. Branch initiatives will have been introduced since the study was undertaken that may have had some bearing upon the findings and conclusions drawn but qualitative research, such as this, can only ever be thought of as a snapshot in time.

The Inspectorate at the AIBs is a fairly small population resulting in a limited sample. This was reduced further by the subsequent non-inclusion of the RAIB Inspectors. This sample size gave little scope for deriving anything statistically meaningful from the data and the researcher felt that as a result, a qualitative study was considered the best approach. Interviewees were not selected randomly but opportunistically; based upon availability and to some degree willingness to participate.

The research was influenced by the realism paradigm, where reality is thought to exist outside of the subjects but that people’s experiences will shape their interpretation of it, was strengthened by the adoption of a “multi strategy” approach (Dawson et al, 2006).

Gathering various types of information, from various sources, enables “… different facets of the data” to be revealed (Coffey and Atkinson, 1996). Such multi strategy research can attract adverse comment. This is largely because of the notion that aligning one’s research to a particular methodology carries with it

‘epistemological commitments’ thus self-imposing delimitations with regards to how data is collected, analysed and presented.

The researcher holds the view that the research question should dictate the method of investigation (Trow, 1957 cited in Gill and Johnson, 2002) and not the alignment with a particular philosophical stance. A pluralistic approach to data collection, that is collecting information in more than one form, answers the call for ‘complementarity’ or cross-referencing (Hammersley, 1996 and Trow, 1957 cited in Gill and Johnson, 2002).

The researcher was fortunate to have relatively unhindered access to the Inspectorate but this varied between Branches, subject to their workload, availability and amenability. It enabled the researcher to acquire first hand a working knowledge of the individual Branches, their operation and the apparent differences and converse similarities between Inspectors.

The Inspectors who took part in the interviews in Phases 1 and 2 were found to be open and candid. As previously noted, the researcher had no concerns regarding probity but was mindful that by its very nature, comment was subjective and based upon the experiences of the individual Inspectors and should be treated as such.

The research topic appeared to be salient to the Inspectors who were all able to clearly articulate their perceptions of what constituted effective behaviour in accident investigation. They were all happy to discuss the topic at length and offer opinion and insight.

Despite some logistical problems with regards to availability and ambient noise levels (as a result of construction work at the AAIB), the face-to-face interviews in the first two phases of the research worked well; the process becoming more refined with each subsequent interview. The adoption of an interview protocol ensured the interviews remained constructive and by restraining to some extent the breadth of topics covered, focused the researcher on attaining requisite depth. The structure provided by the interview protocol also facilitated the transcription of interviews.

It became apparent from the comments written on the returned questionnaire employed in Phase 3 of the research, that the researcher had underestimated the time implication for completion and indeed the patience of the respondents in tackling what turned out to be a lengthy and complex questionnaire. This was a reflection on the inexperience of the researcher.

It would appear that those individuals from whom the researcher sought comments regarding the design and content of the questionnaire were perhaps not harsh enough in their critique or were content that the questions were not contentious and appeared at face value to represent the tone and language of the Branch. A more rigorous pilot study would have gone a long way to allay some of the issues experienced with the final questionnaire.

With the benefit of hindsight, the researcher acknowledges that the questionnaire should have been condensed and extraneous questions 'cut' for the sake of brevity. Concentrating upon the core questions, in this case the rating of behavioural indicators, may have increased the response rate although the researcher is not sure the percentage increase would have been significant.

As previously noted, response rates for the questionnaire were adequate overall (although exemplary from the MAIB). Response rates are recognized to drop significantly for longer questionnaires (Neuman, 2006) and the possibility exists that tedium will set in and latter questions may be answered randomly or without sufficient thought (Brown, 1992; Bryman, 1989). The interest or motivation for completing surveys varies by respondent with different people valuing either positively or negatively specific aspects of the process. This could be the topic, the length of questionnaire, the researcher or the reward offered for completion. Neuman (2006) refers to this as leveraging the saliency: akin to "what's in it for me?"

The data from the questionnaire in Phase 3 did not lend itself to inferential statistics which in itself was not an issue but the application of quantitative techniques to what is essentially qualitative data could have added "… power and sensitivity" when attempting to determine patterns in a set of observations (Miles and Huberman, 1994).

As this research is largely concerned with perceptions of a small sample, it was also inappropriate to use inferential statistics to make inferences from the data to more general conditions. Descriptive statistics, however, provide "… a powerful summary that may enable comparisons across people or other units" (Trochim, 2006).

The behavioural indicators were rated using an ordinal scale. Ordinal scales are commonly used to measure opinion or attitude as opposed to specific interval data points such as height and weight. An ordinal scale establishes an ordered relationship between the objects being measured. Numbers are used to rank order on a continuum but the units of measurement are not equal; for example, 1 to 2 is not equal to 2 to 3 (Kranzler, 2003). The numbers reflect relative merit; "The alternative amounts or degrees of intensity that the states represent" (Hildebrand et al, 1977) but not how much.

Ordinal scales are sometimes ascribed the same characteristics as interval scales where the numerical values are seen as a "… representation of a continuum expressible as a real number, albeit a fuzzy one" (Hassall, 1999).

One criticism regarding the employment of ordinal scales is that ratings are based upon "… a set of imprecise (or vague) referents which may represent concepts to which varying degrees of membership may be assigned (Hassall, 1999). Given that the absolute distances between ranks cannot be known,

respondents can only provide "… an imprecise judgement in relation to a range of hypothetical statements" (Hassall, 1999).

It was felt that there was no value in investigating gender differences during this research as the sample size (there are currently only two female Inspectors and one female Chief Inspector) was too small from which to draw any meaningful conclusions.

Given the qualitative nature of this research, data is produced and collected as part of a social process or interaction; a creative process from which it would be all but impossible to remain value neutral. A bias-free interview cannot exist, as a result of the interaction between interviewer and interviewee. "The spoken or written word has always a residue of ambiguity, no matter how carefully we word the questions and report or code the answer" (Fontana and Frey, 1994). Language used can be misinterpreted and the researcher's intentions not made clear.

The researcher, however, remained aware of the need for reflexivity during her interviews with the Inspectors; a self-awareness of the integral role played by the researcher in the overall study. And whilst the use of only one researcher had the potential to impact objectivity and introduce bias, this was tempered by a greater feeling of intimacy with the data and subjects.

Despite the pursuit of impartiality, assumptions were made based upon the preceding reputation of the Inspectors as a group. Their putative professionalism and technical expertise was broadly accepted and nothing transpired as a result of the interviews to challenge this view.

"… there are no operationally defined truth tests to apply to qualitative research." (Eisner, 1991 cited in Hoepfl, 1997) and "Judgements about usefulness and credibility are left to the researcher and the reader." (Hoepfl, 1997). Whilst accepting that the call for methodological rigour in qualitative research remains contentious (Willig, 2007), the researcher sought to determine an appropriate measure of "usefulness" (Fransella, Bell and Bannister, 2004) as a more practical alternative.

Sekaran's Eight Hallmarks of Science (2003) were thus applied as a measure, including: purposiveness; rigour; testability; replicability; precision and confidence; objectivity; generalizability; and parsimony (see section 2.7 for fuller explanation). Purposiveness was demonstrated by establishing a clear objective for the research, which was to determine the required skills and behaviours for an effective investigator. A sound methodological design was developed as a measure of rigour but the researcher felt that the ease of completion for the questionnaire used in Phase 3 could have been greatly improved by more thorough pilot testing. The aim of the research was in fact testable and the detailed procedure included in the methodology allows for replication.

The researcher believes that the findings of the research 'make sense' within the context of accident investigation, resembling what is being studied, thereby demonstrating precision and confidence. Objectivity was strived for, ensuring personal biases and values did not impact on the process or the findings. The use of only one researcher, and the qualitative nature of the research can increase subjectivity but this was avoided where possible through constant reflexivity and the use of verbatim exemplars. The study focused upon UK AIBs and as such the findings are pertinent to that group. The research method, however, is generalizable and affords comparison with other investigation bodies and comparable roles. Lastly, the role of the accident investigator is a wide ranging topic and there were many other aspects of the role that could have been studied. In order to demonstrate parsimony, the researcher stated the intent to look at skills and behaviours rather than attempting to cover the entire topic at no great depth.

The researcher has determined that, however inviting a notion it might be, an 'identikit' accident investigator does not exist. Particularly within the UK, and most specifically within the AAIB, an individualistic nature is present and prized. What is evident is that a competent investigator has a balance of investigation, management and technical skills commensurate with the role. Success, however that is defined, is not entirely dependent upon the attributes or experience of the investigator. It comes from the consistent application of a rigorous and apposite methodology and is measured by the contribution to the advancement of the body of safety knowledge.

The potential breadth of research into the role of the accident investigator is vast. Given the integral part the investigator plays within the accident investigation process, it is almost impossible to separate one from the other to study in isolation. A 'successful' investigation is not solely predicated upon the skills and knowledge of the investigator but their contribution is obviously irrefutable. The scope of this particular research project was purposefully limited to those aspects of the investigator's behaviour that were deemed 'effective' in the investigation process; behaviour referring, of course, to something that could be demonstrated.

Thankfully, within the UK the fatality rate associated with aviation, marine and rail accidents is relatively low. As suggested during the introduction to this thesis, when compared with the number of deaths incurred on the roads, the expenditure versus benefit argument remains debatable. Philosophically, and perhaps morally, the need for accident investigation and therefore accident investigators is unlikely to diminish. The public comfort derived from their work is immeasurable.

As Braithwaite (2004) stated "Investigation is a discipline in evolution: as technologies and techniques become more advanced, so too the demands on the investigator will increase." This constant change or evolution is echoed in this comment: "Whatever competence means today, we can be sure its meaning will have changed by tomorrow. The foundation for future professional

competence seems to be the capacity to learn how to learn." (Argyris and Shön, 1974). There is a call for the AIBs to be "future focused" in all aspects of recruitment, succession planning and training; ensuring that the competences and indeed competencies required going forward are adequately provided for.

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8.0 Conclusions and further considerations

This research sought to determine the requisite skills, qualities and behaviours in an effective accident investigator. This was undertaken through a multiphased approach using semistructured interviews, Repertory Grid interviews and rated behavioural indicators qualified in terms of selection, training and ability to distinguish superior behaviour.

The research focused upon the perceptions of the Inspectors of Accident at the UK Accident Investigation Branches for marine, aviation and rail. Job incumbents are thought to be able to infer the knowledge, skills, abilities and other characteristics required for the role with some degree of accuracy (Brannick and Levine, 2002).

The literature regarding the field of accident investigation showed that even operating within a prescribed legal framework, variation in terms of organizational philosophy and function exist which can have an impact upon the investigation process and outcome. The investigation process is observed to be unlike scientific research, with recognized quality controls. There is more latitude for flexibility and more reliance upon expert opinion as opposed to a pursuit of reproducible outcomes. This is demonstrated by the variety of accident analysis methodologies on offer: availability, however, does not necessarily lead to consistent employment.

A preference in organizations for adopting competency frameworks as a method of measuring and enhancing performance was found although a degree of confusion was said to exist regarding the most appropriate use of the terms competency and competence. Whilst there is a tendency to conflate the terms, the researcher found that this was more than a question of semantics and that there were fundamental differences in focus and purpose. For this research, competence was seen as a minimum standard of acceptable performance whereas competency referred to the behaviours by which this standard was achieved.

Individualism and variability characterized the findings of the Phase 1 semistructured interviews which also illustrated the role of the Principal Inspector in the overall effectiveness of the investigation. Individualism refers to the proclivity of many Inspectors, particularly at the AAIB, for being self-reliant and opposing external interferences with regards to how their work is conducted, which has implications for effective teamwork. Variability points to the lack of clearly defined standards with regards to analysis activity that was noted to be based more on experience and intuition than a structured process leading to reproducible results.

The Branches are encouraged to consider their stance with regards to individualism and variability as their structure, philosophy and leadership style will influence both considerably. The individualistic nature is present and prized

and it must be determined whether its strengths outweigh its potential weaknesses. Standardizing an approach to analysis should not serve to constrain, but to guide thinking and promote transparency.

The Principal Inspector, although having the notional dual role of man-manager and investigator-in-charge of allocated accidents, was found to spend an increasing amount of time fulfilling the role of report editor, in terms of both style and content, which was met with disapprobation. Inconsistencies in styles and expectations with respect to the accident report added to the perceived frustration for both the Principal Inspectors and Inspectors alike. The researcher would advocate more use of dedicated publications resource to generate more consistency.

The role of the Principal Inspector was found to take many forms, none of which appeared to be wholly satisfactory. The researcher found that there were many opportunities for learning and sharing best practice that could be afforded by the extension of the collaborative principles of the Board of Transport Accident Investigators down to the Principal Inspector, if not below, and would encourage the Branches to capitalize on the expertise and experience of the Principal Inspectors in a more productive manner.

Analysis of the Repertory Grid interviews conducted with Principal Inspectors in Phase 2 of the research established a competency framework with associated positive and negative behavioural indicators and revealed five main competency themes: interpersonal and communication skills; work activity management; personal attributes; cognitive abilities; and technical abilities. These were consistent with other frameworks considered in the literature review, in particular, Rankin (2004), Robinson et al (2005) and the CIPD (2007).

The majority of behavioural indicators fell into one of two competency groups (interpersonal and communication skills and personal attributes) indicating to the researcher that of the competencies, these were felt to be most important for the ‘effective’ investigator. Further thematic analysis of the behavioural indicators showed an emphasis on report writing and dealing with people.

Rating of the behavioural indicators in the final phase of the study confirmed that interpersonal and communication skills, personal attributes and cognitive were seen as most important in terms of recruitment. Technical skills, however, were seen as being most amenable to change through training interventions with personal abilities least likely, suggesting that they would be better sought at recruitment. This concurs with Spencer and Spencer’s iceberg model (1993) which found that surface skill and knowledge was relatively easy to identify and develop through training whereas it was better to recruit for the deeper, core personality characteristics as these were less likely to be amenable to interventions. Finally, with regards to distinguishing superior performance, no one competency group was outstanding but thematic analysis of highly rated behavioural indicators showed a propensity towards statements that reflected an ability to deal with people.

These findings have implications for recruitment as, concurring with Robinson et al (2005), the traditional focus on technical skills and knowledge should be taken as a prerequisite and not an aspirational acquisition, and the relative importance of non-technical competencies such as report writing and the ability to deal with people be more prevalent in selection testing and decision-making.

No specific skills or behaviours were found to distinguish a superior investigator from an average one: instead it was thought to require a balance of competencies. With no defining threshold, the researcher proposes that superior performance must be measured “relative to mission” (Collins, 2005) and is more usefully thought of as a continuum rather than an absolute set of discrete skills and behaviours.

The constraints of the research study fall partly to concerns with the length and complexity of the questionnaire used in Phase 3 and partly to the initial issues regarding the management of sponsors’ expectations, compounded by the withdrawal of the RAIB from the research project. The relatively small sample size precluded meaningful quantitative methods but qualitative techniques such as semistructured interviews and Repertory Grid were found to be appropriate for eliciting information from the Inspectorate.

The researcher applied Sekaran’s Eight Hallmarks of Science (2003) to the study as a means of assessing the value of the research and was encouraged to see that despite any weaknesses in the construction of the final questionnaire, overall the study conformed to the required standards.

The ubiquitous drive for performance assessment has manifested itself at the MAIB in terms of their adoption of a competence framework that guides internal accreditation of Inspectors. The RAIB, at the time of their involvement in the research, were pursuing external accreditation as a means of validating vocational competences. The MAIB used the structure of establishing performance criteria with discrete elements, accompanied by requisite knowledge and understanding, following National Occupational Standard (NOS) principles. Whilst it is typical for the NOS to focus primarily upon activities and knowledge, there is the possibility of extending the framework to include values and behaviours. As such the competency aspects of this research, including the behavioural indicators generated in Phase 2, could be used to further strengthen the Professional Standards of Competence in Accident Investigation tool. This answers a call in the literature for more blended approaches to determining competences to be available.

Other potential areas for future work involve reviewing competencies required for team based activities as well as reconsidering the role of the Principal Inspector to involve closer collaboration and increased development opportunities between the Branches. This study primarily involved the UK Accident Investigation Branches with comparative information sought from the US National Transportation Safety Board. Whilst it would be interesting to

repeat the research with other comparable agencies such as the ATSB or the BFU in Germany, it is anticipated that many of the findings would be similar. The transport industry is however, by its nature, a global one. What would be of more value would be to involve non-Western agencies with differing philosophies and cultures and to explore further their impact upon the manner with which investigations are conducted.

Far from identifying an 'identikit' accident investigator, the research has found that in considering effectiveness, an investigator's performance measurement is context dependent. This suggests that if the organizational structure is such that individualism and variability are operational norms, then it should not be surprising that the tendencies of the Inspectorate will follow suit. It is not clear, however, if the organizational structure at the Branches has driven the collective culture and preferred working style of the Inspectorate or vice versa. What is important for the Branches to consider is what their expectations are of the Inspectors, for the philosophy espoused and the leadership shown will impact more than the individual skills and behaviours of the Inspectorate. It is the balance of societal expectation of the transparent, quality-controlled, process-driven investigation with the inscrutable, independent expert that many of the investigators strive to be.

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APPENDIX A: Protocol for Phase 1 semistructured interviews

1. Purpose of interview
   Background to research
   Background of researcher
   Confidentiality assurances

2. Background of interviewee: previous employment; time at Branch; education; discipline and specialty.
   Why they joined
   Difference between groups (eg operations vs engineering; nautical vs engineering; signal engineers vs permanent way experts etc.)

3. Investigation process
   Description of day-to-day activities
   Proportion of time taken with different aspects
   Likes / dislikes
   What Inspectors do well / what they struggle with
   Managing investigations

4. Life at the Branch
   Outward impression
   How it differs from preconceptions
   Strengths / weaknesses
   Missing skill sets
   Rivalries / internal conflicts
   Team vs individualist

5. Training
   Development
   Performance management
   Discipline
   Remuneration
   Competency vs competence

6. First investigation / first time at crash site
   Thoughts / feelings / enduring memories
   Coping strategies
   Subsequent investigations
   Dealing with media / families / coroners

7. Description of effectiveness in investigation
   Converse – what does ineffective look like
   What constitutes superior behaviour

8. Branch within industrial context

World standing
Branch within society
Changes to Branch structure and activities over time
Historical and societal influences
Future of Branch – requisite changes

9. Leadership
Politics
Influence of DfT / Civil Service
Funding
Interaction with other Branches

APPENDIX B: Protocol for Phase 2 Repertory Grid interviews with Principal Inspectors

The purpose of this interview is to find out what you consider to be an effective investigator. You are not required to talk about specific individuals but to look at generalised behaviours that demonstrate effectiveness. Personality judgements are also not required unless they have a direct impact on the quality of the work.

You will be asked to think of three people within the Branch whom you consider to be very good at their job and then three people who you consider to be less effective.

Thinking about the three effective investigators, can you tell me something that makes two of these people more effective than the third in terms of :

i. how they collect evidence
ii. how they analyse evidence
iii. how they liaise with families
iv. how they write reports
v. how they make recommendations.

Thinking about the three less effective investigators, can you tell me something that makes two of these people less effective than the third in terms of :

i. how they collect evidence
ii. how they analyse evidence
iii. how they liaise with families
iv. how they write reports
v. how they make recommendations.

APPENDIX C: Phase 3 median data charts

1.(a) Necessary behaviour in new recruits:

Interpersonal and communication skills		MAIB Mdn	AAIB Mdn	All Mdn
2	Makes things clear on paper	4.5	4	4
3	Makes a powerful case for change	3	4	3
4	Team player	4	5	4
6	Writes an objective and impartial report	3.5	5	4
11	Clear communicator at all levels	4	5	4
16	Manages confrontation successfully	4	5	4
18	Uses social skills adeptly	4	4	4
21	Shares information / time / experience	4	4	4
25	Plays the game with respect to the rules of the organization	4	3	4
26	Treats people with respect	5	5	5
36	Demonstrates trust in colleagues	4	4	4
37	Has good written English	4	5	4
39	Puts together a readable report	4	5	4
40	Understands needs of readership	3	4	4
41	Puts information across succinctly	4	4	4
42	Broad generalizable safety message apparent in reports	3	3.5	3
45	Able to put aside personal differences	4	5	4
46	Succinct and factual with media	3	4	3
47	Thoughtful and understanding with relatives	4	5	4
50	Visible and contactable at all times	3	3	3
52	Takes control of situation	3	4	4
53	Asks searching questions	3	5	4
59	Able to delegate tasks effectively	3	3.5	4
60	Accepts differences and works to strengths	4	3	4
68	Appears approachable	4	4	4
69	Listens well	4.5	4	4
70	Interviewees respond well to their questioning	3	5	4
	Competency median	**4**	**4**	**4**

Work activity management		MAIB Mdn	AAIB Mdn	All Mdn
9	Thorough	4	5	5
12	Plans ahead	4	4	4
20	Productive in output	4	4	4
32	Collects pertinent evidence	4	5	4
38	Not sidetracked by detail	3.5	3	3
43	Files ordered and structured	3	3	3
44	Evidence well documented	3	4	3
48	Researches previous incidents and recommendations thoroughly	3	4	3
49	Paperwork available and up to date	3	3	3
51	Willing to deal with DfT admin	3	3	3
64	Mindful of the cost to the taxpayer	3	3	3
67	Maintains focus in the office as well as when in field	3.5	4	4
	Competency median	**3.25**	**4**	**4**

Personal attributes		MAIB Mdn	AAIB Mdn	All Mdn
5	Shows flexibility in approach	4	4	4
7	Assertive - has needs met	3	4	4
8	Confident - without arrogance	4	4	4
13	Attends to detail	4	5	4
14	Self sufficient	4	5	4
15	Calm under pressure	4	5	4
17	Shows humility	4	4	4
23	Willing to compromise	3	3	3
24	Prepared to learn	5	5	5
27	Dependable	4.5	5	5
28	Uses initiative	4	5	5
29	Diplomatic	4	4	4
31	Recognises privileged public servant position	3	3	3
33	Willing to listen to constructive criticism	4	4	4
57	Excited about making a difference to the industry	4	4	4
58	Emotionally mature	4	4	4
61	Reacts positively to new challenges and ways of working	4	4	4
62	Internally robust	4	4	4
65	Cares about the report with their name on	4	4	4
66	Puts effort into producing almost perfect report	3	4	4
72	Recognizes impact of own behaviour	4	4	4
75	Balances technical and social skills	3.5	4	4
	Competency median	**4**	**4**	**4**

Cognitive abilities		MAIB Mdn	AAIB Mdn	All Mdn
1	Demonstrates an inquisitive nature	5	5	5
10	Clear thought processes	4	5	4
22	Makes realistic recommendations	4	5	4
34	Suggests alternative solutions	3.5	3	4
35	Balances specifics with bigger picture	4	3	4
54	Quick thinker	4	4	4
55	Learns quickly	4	4	4
63	Sees past standard responses	3.5	4	4
71	Produces a structured flow of analysis	3.5	4	4
73	Good at practical problem solving	4	4	4
	Competency median	**4**	**4**	**4**

Technical abilities		MAIB Mdn	AAIB Mdn	All Mdn
19	Understands industry	4	4	4
30	Technically competent	4.5	5	5
56	Knowledgeable about standards/regulations	3	3	3
74	Has detailed technical knowledge	4	3	4
	Competency median	**4**	**3.5**	**4**

1.(b) Necessary to screen out behaviour at interview:

Interpersonal and communication skills		MAIB Mdn	AAIB Mdn	All Mdn
2	Unable to show continuity of argument in report	4	4	4
3	Evidence for recommendations lacking	3	4	4
4	Appears to be an individualist	4	3	3
6	Report is vehicle for own agenda	4	5	5
11	Does not modify style of communication depending on audience	3	4	3
16	Can be belligerent	4	4	4
18	Gets people's backs up	4	5	5
21	Withholds assistance as knowledge is power	5	5	5
25	Think the rules don't apply to them	4	4	4
26	Contemptuous of others	5	5	5
36	Does not trust other colleagues	4	4	4
37	Has poor written English	4	4	4
39	Produces a report that doesn't flow	3	3	3
40	Writes for self, not audience	3	4	3
41	Provides longwinded explanations	3	3	3
42	Makes recommendations too specific	3	3	3
45	Aspects of personality get in the way	3	4	3
46	Statements misinterpreted by media	3	3	3
47	Insensitive to relatives or friends	4	4	4
50	Office never knows where they are	3	4	3
52	Allows others to control situation	3	4	4
53	Uses superficial questioning	3	4	4
59	Overly controlling	4	4	4
60	Dismissive of others' working styles	4	4	4
68	Standoffish / aloof	3.5	4	4
69	Hears what they want to hear	4	4	4
70	Loses cooperation of interviewees	4	5	5
	Competency median	**4**	**4**	**4**

Work activity management		MAIB Mdn	AAIB Mdn	All Mdn
9	Superficial when investigating	4	5	4
12	Unstructured - shoots from the hip	4	5	4
20	Takes too long to produce report	3	3	3
32	Collects information not evidence	3	4	3
38	Gets bogged down in the detail	4	3	4
43	Office / desk is chaotic	2	2	2
44	Lack of transparency in continuity of evidence	3	3	3
48	Does not research previous history of accidents	3	3	3
49	Paperwork never up to date	3	3	3
51	Feel themselves above DfT admin	3	3	3
64	Wasteful with money	4	3	3
67	Loses focus when back in the office	3	3	3
	Competency median	**3**	**3**	**3**

Personal attributes		MAIB Mdn	AAIB Mdn	All Mdn
5	Is unaccommodating	4	4	4
7	Does not have needs met	3	3	3
8	Comes across as arrogant	4	4	4
13	Careless with detail	4	4	4
14	Requires constant hand holding	4	5	4
15	Excitable	3	3	3
17	Acts like a 'know it all'	4	5	4
23	Stubborn when challenged	4	4	4
24	Believes they know everything	4	5	4
27	Unreliable and full of excuses	5	5	5
28	Needs to be told what to do	4	4	4
29	Tactless	4	5	4
31	Overly status driven	4	4	4
33	Too precious about the report	3	3	3
57	Too ready to accept the status quo	3.5	4	4
58	Has had little life experience	4	3	4
61	Likes things to remain the same	3.5	4	4
62	Prone to bouts of doubt	3	2	3
65	Has no ownership for report	3.5	3	3
66	Leaves the tidying up of the report to the PI	3	3	3
72	Oblivious to how they are perceived	3	3	3
75	Prizes technical knowledge above social skills	3	3	3
	Competency median	**4**	**4**	**4**

Cognitive abilities		MAIB Mdn	AAIB Mdn	All Mdn
1	Shows no curiosity	5	5	5
10	Shows muddled thinking	4	5	4
22	Makes impractical recommendations	4	4	4
34	Rigidly fixed on one explanation	4	5	4
35	Investigation proceeds on too broad a front	2.5	3	3
54	Needs too much time to deliberate	3	3	3
55	Slow to grasp new information	4	4	4
63	Accepts what's said at face value	3.5	4	4
71	Analysis does not follow in a logical process	3	4	4
73	Rather too theoretical and academic	3	3	3
	Competency median	**3.75**	**4**	**4**

Technical abilities		MAIB Mdn	AAIB Mdn	All Mdn
19	Has lost touch with real world	5	5	5
30	Lacks basic technical understanding	4	5	4
56	Not up to date with regulatory information	3	3	4
74	Unfamiliar with many aspects of industry	4	3	3
	Competency median	**4**	**4**	**4**

2.(a) Likely that behaviour can be acquired or improved through training:

Interpersonal and communication skills		MAIB Mdn	AAIB Mdn	All Mdn
2	Makes things clear on paper	4	4	4
3	Makes a powerful case for change	4	2	4
4	Team player	3	3	3
6	Writes an objective and impartial report	4	5	4
11	Clear communicator at all levels	4	3	4
16	Manages confrontation successfully	3	3	3
18	Uses social skills adeptly	4	2	2
21	Shares information / time / experience	4	3	3
25	Plays the game with respect to the rules of the organization	4	3	4
26	Treats people with respect	2	2	2
36	Demonstrates trust in colleagues	3	2	2
37	Has good written English	4	4	4
39	Puts together a readable report	4	4	4
40	Understands needs of readership	4	3	4
41	Puts information across succinctly	4	4	4
42	Broad generalizable safety message apparent in reports	4	4	4
45	Able to put aside personal differences	3	3	3
46	Succinct and factual with media	3	4	3
47	Thoughtful and understanding with relatives	4	3	4
50	Visible and contactable at all times	4	3	3
52	Takes control of situation	4	4	4
53	Asks searching questions	4	3	4
59	Able to delegate tasks effectively	4	4	4
60	Accepts differences and works to strengths	3	3	3
68	Appears approachable	2	3	3
69	Listens well	4	3	3
70	Interviewees respond well to their questioning	3	4	3
	Competency median	**4**	**3**	**4**

Work activity management		MAIB Mdn	AAIB Mdn	All Mdn
9	Thorough	3.5	3	3
12	Plans ahead	4	3	3
20	Productive in output	3	3	3
32	Collects pertinent evidence	4	4	4
38	Not sidetracked by detail	3.5	3	3
43	Files ordered and structured	4	4	4
44	Evidence well documented	4	4	4
48	Researches previous incidents and recommendations thoroughly	4	4	4
49	Paperwork available and up to date	3.5	3	3
51	Willing to deal with DfT admin	3	3	3
64	Mindful of the cost to the taxpayer	3.5	3	3
67	Maintains focus in the office as well as when in field	3	3	3
	Competency median	**3.5**	**3**	**3**

Personal attributes		MAIB Mdn	AAIB Mdn	All Mdn
5	Shows flexibility in approach	3	3	3
7	Assertive - has needs met	3	2	3
8	Confident - without arrogance	3	3	3
13	Attends to detail	3	3	3
14	Self sufficient	3	2	3
15	Calm under pressure	2.5	2	2
17	Shows humility	3	2	3
23	Willing to compromise	2.5	3	3
24	Prepared to learn	3	2	3
27	Dependable	2.5	2	2
28	Uses initiative	3	3	3
29	Diplomatic	3	3	3
31	Recognises privileged public servant position	4	3	3
33	Willing to listen to constructive criticism	3	3	3
57	Excited about making a difference to the industry	3	3	3
58	Emotionally mature	2	2	2
61	Reacts positively to new challenges and ways of working	3	2	3
62	Internally robust	2.5	2	2
65	Cares about the report with their name on	3	2	2.5
66	Puts effort into producing almost perfect report	3.5	3	3
72	Recognizes impact of own behaviour	3	3	3
75	Balances technical and social skills	3	3	3
	Competency median	**3**	**3**	**3**

Cognitive abilities		MAIB Mdn	AAIB Mdn	All Mdn
1	Demonstrates an inquisitive nature	2	2	2
10	Clear thought processes	3.5	2	3
22	Makes realistic recommendations	4	4	4
34	Suggests alternative solutions	4	3	3
35	Balances specifics with bigger picture	3.5	3	3
54	Quick thinker	2	2	2
55	Learns quickly	2	2	2
63	Sees past standard responses	4	3	3
71	Produces a structured flow of analysis	4	3	4
73	Good at practical problem solving	3.5	3	3
	Competency median	**3.5**	**3**	**3**

Technical abilities		MAIB Mdn	AAIB Mdn	All Mdn
19	Understands industry	4	4	4
30	Technically competent	4	4	4
56	Knowledgeable about standards/regulations	4	4	4
74	Has detailed technical knowledge	3.5	4	4
	Competency median	**4**	**4**	**4**

2.(b) Likelihood of reduction or removal by training:

Interpersonal and communication skills		MAIB Mdn	AAIB Mdn	All Mdn
2	Unable to show continuity of argument in report	4	4	4
3	Evidence for recommendations lacking	4	4	4
4	Appears to be an individualist	3	2	2
6	Report is vehicle for own agenda	3	2	3
11	Does not modify style of communication depending on audience	3.5	3	3
16	Can be belligerent	2	2	2
18	Gets people's backs up	2	2	2
21	Withholds assistance as knowledge is power	2	2	2
25	Think the rules don't apply to them	2	2	2
26	Contemptuous of others	2	1	2
36	Does not trust other colleagues	3	2	3
37	Has poor written English	3	3	3
39	Produces a report that doesn't flow	4	3	4
40	Writes for self, not audience	4	3	3
41	Provides longwinded explanations	4	3	4
42	Makes recommendations too specific	4	3	4
45	Aspects of personality get in the way	2	2	2
46	Statements misinterpreted by media	4	4	4
47	Insensitive to relatives or friends	4	2	3
50	Office never knows where they are	3.5	3	3
52	Allows others to control situation	4	3	3
53	Uses superficial questioning	4	3	3
59	Overly controlling	2.5	2	2
60	Dismissive of others' working styles	2.5	2	2
68	Standoffish / aloof	2	2	2
69	Hears what they want to hear	3	2	2
70	Loses cooperation of interviewees	3	2	3
	Competency median	**3**	**2**	**3**

Work activity management		MAIB Mdn	AAIB Mdn	All Mdn
9	Superficial when investigating	3.5	2	3
12	Unstructured - shoots from the hip	4	2	3
20	Takes too long to produce report	4	4	4
32	Collects information not evidence	4	3	4
38	Gets bogged down in the detail	4	3	3
43	Office / desk is chaotic	3	2	3
44	Lack of transparency in continuity of evidence	4	3	4
48	Does not research previous history of accidents	4	3	4
49	Paperwork never up to date	3	2	3
51	Feel themselves above DfT admin	3	2	3
64	Wasteful with money	3	3	3
67	Loses focus when back in the office	3	2	3
	Competency median	**3.75**	**2.5**	**3**

Personal attributes		MAIB Mdn	AAIB Mdn	All Mdn
5	Is unaccommodating	2	2	2
7	Does not have needs met	2.5	2	2
8	Comes across as arrogant	2	2	2
13	Careless with detail	3.5	2	3
14	Requires constant hand holding	3	2	3
15	Excitable	3	2	2
17	Acts like a 'know it all'	2	2	2
23	Stubborn when challenged	3	2	3
24	Believes they know everything	2	2	2
27	Unreliable and full of excuses	2	1	2
28	Needs to be told what to do	3	2	3
29	Tactless	3	2	3
31	Overly status driven	3	2	2
33	Too precious about the report	4	3	3
57	Too ready to accept the status quo	3	3	3
58	Has had little life experience	2	3	2.5
61	Likes things to remain the same	2.5	2	2
62	Prone to bouts of doubt	3	2	3
65	Has no ownership for report	4	3	3
66	Leaves the tidying up of the report to the PI	4	3	3
72	Oblivious to how they are perceived	2	2	2
75	Prizes technical knowledge above social skills	3	3	3
	Competency median	**3**	**2**	**2.75**

Cognitive abilities		MAIB Mdn	AAIB Mdn	All Mdn
1	Shows no curiosity	2	1	2
10	Shows muddled thinking	3	2	3
22	Makes impractical recommendations	4	3	3
34	Rigidly fixed on one explanation	4	3	3
35	Investigation proceeds on too broad a front	4	3	4
54	Needs too much time to deliberate	3	3	3
55	Slow to grasp new information	3	2	3
63	Accepts what's said at face value	3	2	3
71	Analysis does not follow in a logical process	4	3	4
73	Rather too theoretical and academic	2.5	3	3
	Competency median	**3**	**3**	**3**

Technical abilities		MAIB Mdn	AAIB Mdn	All Mdn
19	Has lost touch with real world	2	2	2
30	Lacks basic technical understanding	3.5	4	4
56	Not up to date with regulatory information	4	4	4
74	Unfamiliar with many aspects of industry	3	4	3
	Competency median	**3.25**	**4**	**3.5**

3.(a) Demonstration of behaviour distinguishes a superior investigator from an average one:

Interpersonal and communication skills		MAIB Mdn	AAIB Mdn	All Mdn
2	Makes things clear on paper	4	4	4
3	Makes a powerful case for change	4	4	4
4	Team player	4	4	4
6	Writes an objective and impartial report	4	4	4
11	Clear communicator at all levels	4	4	4
16	Manages confrontation successfully	4	4	4
18	Uses social skills adeptly	3.5	4	4
21	Shares information / time / experience	4	4	4
25	Plays the game with respect to the rules of the organization	4	3	4
26	Treats people with respect	4.5	5	5
36	Demonstrates trust in colleagues	4	4	4
37	Has good written English	4	4	4
39	Puts together a readable report	4.5	4	4
40	Understands needs of readership	4	4	4
41	Puts information across succinctly	4	4	4
42	Broad generalizable safety message apparent in reports	4	4	4
45	Able to put aside personal differences	4	4	4
46	Succinct and factual with media	3.5	4	4
47	Thoughtful and understanding with relatives	4	5	4
50	Visible and contactable at all times	4	4	4
52	Takes control of situation	4.5	5	5
53	Asks searching questions	5	5	5
59	Able to delegate tasks effectively	3	4	4
60	Accepts differences and works to strengths	4	4	4
68	Appears approachable	4	4	4
69	Listens well	4.5	5	5
70	Interviewees respond well to their questioning	4	5	4
	Competency median	**4**	**4**	**4**

Work activity management		MAIB Mdn	AAIB Mdn	All Mdn
9	Thorough	4	4	4
12	Plans ahead	4	3	4
20	Productive in output	4	4	4
32	Collects pertinent evidence	4.5	5	5
38	Not sidetracked by detail	4	4	4
43	Files ordered and structured	3	3	3
44	Evidence well documented	4	4	4
48	Researches previous incidents and recommendations thoroughly	4	4	4
49	Paperwork available and up to date	4	3	4
51	Willing to deal with DfT admin	3	3	3
64	Mindful of the cost to the taxpayer	3	4	3
67	Maintains focus in the office as well as when in field	4	4	4
	Competency median	**4**	**4**	**4**

Personal attributes		MAIB Mdn	AAIB Mdn	All Mdn
5	Shows flexibility in approach	4	4	4
7	Assertive - has needs met	3	3	3
8	Confident - without arrogance	4	4	4
13	Attends to detail	4	5	4
14	Self sufficient	4	4	4
15	Calm under pressure	4	4	4
17	Shows humility	4	4	4
23	Willing to compromise	3	3	3
24	Prepared to learn	4	5	4
27	Dependable	4	5	4
28	Uses initiative	4	5	4
29	Diplomatic	4	4	4
31	Recognises privileged public servant position	4	3	3
33	Willing to listen to constructive criticism	4	4	4
57	Excited about making a difference to the industry	4	4	4
58	Emotionally mature	4	4	4
61	Reacts positively to new challenges and ways of working	4	3	4
62	Internally robust	4	4	4
65	Cares about the report with their name on	4	4	4
66	Puts effort into producing almost perfect report	4	4	4
72	Recognizes impact of own behaviour	4	4	4
75	Balances technical and social skills	4	4	4
	Competency median	**4**	**4**	**4**

Cognitive abilities		MAIB Mdn	AAIB Mdn	All Mdn
1	Demonstrates an inquisitive nature	4	4	4
10	Clear thought processes	4	4	4
22	Makes realistic recommendations	4	4	4
34	Suggests alternative solutions	4	4	4
35	Balances specifics with bigger picture	4	4	4
54	Quick thinker	4	4	4
55	Learns quickly	4	5	4
63	Sees past standard responses	4	4	4
71	Produces a structured flow of analysis	5	5	5
73	Good at practical problem solving	4	5	4
	Competency median	**4**	**4**	**4**

Technical abilities		MAIB Mdn	AAIB Mdn	All Mdn
19	Understands industry	4	4	4
30	Technically competent	4	5	4
56	Knowledgeable about standards/regulations	4	4	4
74	Has detailed technical knowledge	4	5	4
	Competency median	**4**	**4.5**	**4**

3.(b) Demonstration of behaviour distinguishes an ineffective investigator from an average one:

Interpersonal and communication skills		MAIB Mdn	AAIB Mdn	All Mdn
2	Unable to show continuity of argument in report	4	5	4
3	Evidence for recommendations lacking	4	4	4
4	Appears to be an individualist	3	3	3
6	Report is vehicle for own agenda	4	4	4
11	Does not modify style of communication depending on audience	4	4	4
16	Can be belligerent	3	4	4
18	Gets people's backs up	4	4	4
21	Withholds assistance as knowledge is power	4	4	4
25	Think the rules don't apply to them	4	4	4
26	Contemptuous of others	5	4	5
36	Does not trust other colleagues	4	4	4
37	Has poor written English	4	4	4
39	Produces a report that doesn't flow	4	4	4
40	Writes for self, not audience	4	4	4
41	Provides longwinded explanations	4	4	4
42	Makes recommendations too specific	3.5	4	4
45	Aspects of personality get in the way	3	4	3
46	Statements misinterpreted by media	3	4	4
47	Insensitive to relatives or friends	4	5	4
50	Office never knows where they are	4	4	4
52	Allows others to control situation	4	4	4
53	Uses superficial questioning	4	4	4
59	Overly controlling	3.5	4	4
60	Dismissive of others' working styles	4	4	4
68	Standoffish / aloof	3	4	4
69	Hears what they want to hear	4	4	4
70	Loses cooperation of interviewees	4	5	5
	Competency median	**4**	**4**	**4**

Work activity management		MAIB Mdn	AAIB Mdn	All Mdn
9	Superficial when investigating	4	4	4
12	Unstructured - shoots from the hip	4	4	4
20	Takes too long to produce report	3	4	3
32	Collects information not evidence	4	4	4
38	Gets bogged down in the detail	4	3	4
43	Office / desk is chaotic	3	3	3
44	Lack of transparency in continuity of evidence	4	4	4
48	Does not research previous history of accidents	4	4	4
49	Paperwork never up to date	3.5	4	4
51	Feel themselves above DfT admin	3	3	3
64	Wasteful with money	3	3	3
67	Loses focus when back in the office	4	4	4
	Competency median	**4**	**4**	**4**

Personal attributes		MAIB Mdn	AAIB Mdn	All Mdn
5	Is unaccommodating	3.5	4	4
7	Does not have needs met	3	3	3
8	Comes across as arrogant	4	4	4
13	Careless with detail	4	5	4
14	Requires constant hand holding	4	4	4
15	Excitable	3	4	3
17	Acts like a 'know it all'	4	4	4
23	Stubborn when challenged	4	3	4
24	Believes they know everything	4	4	4
27	Unreliable and full of excuses	5	5	5
28	Needs to be told what to do	4	4	4
29	Tactless	4	4	4
31	Overly status driven	3.5	4	4
33	Too precious about the report	4	3	4
57	Too ready to accept the status quo	4	4	4
58	Has had little life experience	4	4	4
61	Likes things to remain the same	4	4	4
62	Prone to bouts of doubt	3	3	3
65	Has no ownership for report	4	4	4
66	Leaves the tidying up of the report to the PI	4	4	4
72	Oblivious to how they are perceived	4	3	4
75	Prizes technical knowledge above social skills	3	3	3
	Competency median	**4**	**4**	**4**

Cognitive abilities		MAIB Mdn	AAIB Mdn	All Mdn
1	Shows no curiosity	5	5	5
10	Shows muddled thinking	4.5	4	4
22	Makes impractical recommendations	4	4	4
34	Rigidly fixed on one explanation	4	4	4
35	Investigation proceeds on too broad a front	4	4	4
54	Needs too much time to deliberate	3.5	3	3
55	Slow to grasp new information	4	4	4
63	Accepts what's said at face value	4	4	4
71	Analysis does not follow in a logical process	4	4	4
73	Rather too theoretical and academic	3.5	4	4
	Competency median	**4**	**4**	**4**

Technical abilities		MAIB Mdn	AAIB Mdn	All Mdn
19	Has lost touch with real world	4	4	4
30	Lacks basic technical understanding	4	5	5
56	Not up to date with regulatory information	4	3	4
74	Unfamiliar with many aspects of industry	4	4	4
	Competency median	**4**	**4**	**4**

APPENDIX D: Phase 3 most admired skills and behaviours

Courteous	MAIB
Knowledgeable	MAIB
Methodical	MAIB
Responsive	MAIB
Literate	MAIB
Industriousness	MAIB
Tenacity	MAIB
Thoroughness	MAIB
Approachable	MAIB
Understanding	MAIB
Technical experience	MAIB
Industry experience	MAIB
Humility	MAIB
Team player	MAIB
Openness	MAIB
Generous with time and knowledge	MAIB
Non judgemental and cooperative	MAIB
Tenacity in investigation	MAIB
Prompt report writing and ability	MAIB
Accuracy of English in report writing	MAIB
High integrity	MAIB
Tolerant	MAIB
Sensitive to other people's feelings	MAIB
Decisive	MAIB
Only speaks when he has something worth saying	MAIB
Strong analytical skills and problem solving	MAIB
Takes control of difficult situations and uses initiative	MAIB
Clear communicator	MAIB
Incisive thinking	MAIB
Investigative enthusiasm and drive	MAIB
Open minded	MAIB
Determined – not put off	MAIB
Inquisitive	MAIB
Skilled report writing	MAIB
Knowledgeable	MAIB
Adapt questions to the witness/ship type	MAIB
Able to remember many facets of a case	MAIB
Writing ability	MAIB
Ability to communicate with others	MAIB
Organisation of services (diving/underwater survey)	MAIB
Knowledgeable	MAIB
Friendly	MAIB
Humour	MAIB
Good memory	MAIB
Attention to detail	MAIB

Integrity	MAIB
Honesty	MAIB
Reliability	MAIB
Professional standards	MAIB
Ability to produce a report respected by the industry	MAIB
Team player	MAIB
Leadership	MAIB
Sharing information	MAIB
Open frank discussion	MAIB
Accepting of constructive criticism	MAIB
Ability to work quickly yet thoroughly	MAIB
Good interpersonal skills	MAIB
Good analytical skills	MAIB
Focused on task	MAIB
Respects others	MAIB
Focus	MAIB
Drive	MAIB
General interest	MAIB
Work ethic	MAIB
Reliability	MAIB
Experience - lifeskills/investigation/industry/commercial	MAIB
“Knowing they don’t know” and seeking knowledge / advice	MAIB
Tolerance/openmindedness of clients and colleagues	MAIB
Willingness to help and pass on knowledge	MAIB
Calmness under pressure and decisiveness	MAIB
Motivates others	MAIB
Leads by example	MAIB
Communicates up and down	MAIB
Listens	MAIB
Firm but fair	MAIB
Pleasant	MAIB
Careful listener	MAIB
Not sarcastic	MAIB
Can understand diversity	MAIB
Good sense of humour	MAIB
Doggedness and persistence	AAIB
Flying ability	AAIB
Well ordered with paperwork/information	AAIB
Not afraid to speak out	AAIB
Good sense of humour	AAIB
Not ambitious for promotion	AAIB
Extremely technically competent	AAIB
Does not keep harping back to some perceived slight 10 years ago	AAIB
Takes the investigation forward at his pace	AAIB
Still finds time to offer constructive advice	AAIB
Very observant	AAIB
Ability to visualise impact sequence and match to impact marks	AAIB
Very patient	AAIB

Honest about what they know	AAIB
Team worker	AAIB
Those that share experience and knowledge	AAIB
Approachable and friendly	AAIB
Those that are not afraid to question anything or anyone	AAIB
Respect for everyone regardless of status or experience	AAIB
Technical competence	AAIB
Good interpersonal skills	AAIB
Ability to progress investigation	AAIB
Flexibility	AAIB
Good presenter of information	AAIB
Fast learners	AAIB
Open minded	AAIB
Articulate	AAIB
High attention to detail	AAIB
Approachable	AAIB
Tenacity	AAIB
Courtesy/diplomacy	AAIB
Technical knowledge	AAIB
Relaxed style	AAIB
Unflappable	AAIB
Professional	AAIB
Polite	AAIB
Good written skills	AAIB
Good oral skills	AAIB
Intelligent	AAIB
Inquisitive attitude	AAIB
Objectivity	AAIB
Persistence	AAIB
Thoroughness	AAIB
Logical thought	AAIB
Willingness to try/push new methods	AAIB
Thorough	AAIB
Listening	AAIB
Sharing	AAIB
Confident	AAIB
Prepared to listen	AAIB
Good readable writing style	AAIB
Wide knowledge/skills base (general and aviation)	AAIB
IT skills above the norm (CAD for example)	AAIB
Understand the importance of producing reports/safety recommendations in appropriate time scales	AAIB
Clear logical thinker	AAIB
Keeps colleagues in picture – good team player	AAIB
Keeps aim in view – doesn’t get distracted	AAIB
Inquisitive	AAIB
Open to new ideas	AAIB
Integrity	AAIB

Thoroughness	AAIB
Knowledge	AAIB
Report writing skills	AAIB
Approachability	AAIB
Objective, open minded approach	AAIB
Thorough documentation of evidence	AAIB
Extensive and broad technical knowledge	AAIB
Ability to write reports that flow logically	AAIB
Attention to detail	AAIB

APPENDIX E: Phase 3 least admired skills and behaviours

Unreliable	MAIB
Plays the system	MAIB
Poor literacy	MAIB
Lack of focus	MAIB
Poor technical knowledge	MAIB
Single mindedness	MAIB
Lack of commitment	MAIB
Inability to prioritise	MAIB
Indecisiveness	MAIB
Laziness	MAIB
No technical experience	MAIB
No industrial experience	MAIB
Lack of humility	MAIB
No respect for all (including those involved in accidents)	MAIB
Lack of compassion	MAIB
Cluttered thought process during investigation	MAIB
Poor interview technique	MAIB
Ineffective report writing	MAIB
Weak presentation skills	MAIB
Poor analysis technique	MAIB
Arrogant	MAIB
Loud	MAIB
Lazy	MAIB
Unhelpful	MAIB
Snobbish	MAIB
Lack of decisiveness and too much time needed to deliberate	MAIB
Arrogance and “know it all” tendency	MAIB
Full of excuses	MAIB
Lack of enthusiasm	MAIB
Unstructured – shoots from the hip	MAIB
Resistance to challenge of theories	MAIB
Dismissive	MAIB
Illogical	MAIB
Ambivalent	MAIB
Bored with subject matter	MAIB
Poor interviewing skills	MAIB
Overkeen to volunteer others	MAIB
Correction of reports	MAIB
Aloof	MAIB
Arrogant	MAIB
Dismissive	MAIB
Sloppy	MAIB
Unwilling to share information	MAIB
Sloppy approach	MAIB

Lack of commitment	MAIB
Professional knowledge out of date	MAIB
Lack of attention to detail	MAIB
Poor investigator/interviewee interface	MAIB
Arrogant	MAIB
Not accepting of discussion	MAIB
Unprepared to share information – knowledge is power	MAIB
Reactive rather than proactive	MAIB
No leadership/management skills	MAIB
Loud and judgemental	MAIB
Lacks subtlety	MAIB
Insensitive to others in room	MAIB
Inexperienced in modern methods in industry	MAIB
Lack of focus on task in hand	MAIB
Superficial knowledge of the job	MAIB
Careless	MAIB
Arrogant	MAIB
Does not listen to advice	MAIB
Does not recognise own shortfalls	MAIB
Dithering indecisiveness	MAIB
Lack of “presence” – lack of respect from peers	MAIB
Lack of detailed technical knowledge of their specialism	MAIB
“Information is power” – unwillingness to help newbies and others	MAIB
Lack of broad experience – only know one way to do things, so that way is the right way	MAIB
Autocratic	MAIB
Unreasonable	MAIB
Focus on procedures rather than outcomes	MAIB
Focus on quantity rather than quality	MAIB
Lack of commitment	MAIB
Impatient with people from other backgrounds	MAIB
Overly critical	MAIB
Interrupts conversation	MAIB
Arrogant attitude	MAIB
Deviousness – looking out for themselves	MAIB
Arrogance	AAIB
No ‘esprit de corps’	AAIB
Over ambitious	AAIB
Moodiness	AAIB
Cannot work as part of a team	AAIB
Over ambitious	AAIB
Over critical of other, generally younger, inspectors	AAIB
Lazy	AAIB
Never have the time to help newer colleagues	AAIB
A degree of arrogance	AAIB
Poor team player	AAIB
Poor report writing skills	AAIB
Arrogance	AAIB

Belief they are above others and do not provide assistance to others	AAIB
Abruptness and lack of respect	AAIB
Expectation that others will do the small stuff eg admin	AAIB
Lack of communication, does things without discussion with the team	AAIB
Not always truthful	AAIB
Poor communication within team	AAIB
Jump to conclusions	AAIB
Put other people's backs up	AAIB
Non production of reports	AAIB
Poor communicators	AAIB
Information hoarders	AAIB
Individualist	AAIB
Not willing to canvass opinion	AAIB
Judgemental	AAIB
Micro management	AAIB
Superficiality esp technically	AAIB
Dismissive attitude	AAIB
Inability to see other perspectives	AAIB
Abrupt	AAIB
Indecisive	AAIB
Rude	AAIB
Arrogant	AAIB
Dismissive	AAIB
Lazy	AAIB
Superficial – prepared to jump to conclusions	AAIB
Illogical – lazy and / or don't care	AAIB
Arrogant – stuck on transmit	AAIB
Bullying	AAIB
Poor writing skills	AAIB
Presumptuous	AAIB
Too confident too early	AAIB
Inconsiderate	AAIB
Rude	AAIB
Too much time talking over coffee on inconsequential matters	AAIB
No sense of urgency on **all** investigations	AAIB
The inability to progress multiple investigations (time mgt issues)	AAIB
General timekeeping (long not short term)	AAIB
Not 'mixing in' with colleagues	AAIB
Self interest	AAIB
Lack of communication	AAIB
Lack of basic management skills	AAIB
Superficial	AAIB
Lack of consistency	AAIB
Laziness	AAIB
Unwilling to improve performance	AAIB
Dishonesty	AAIB
Lack of appreciation of others' time	AAIB
Poorly written reports	AAIB

Ambiguous, wordy use of written English	AAIB
Poor IT skills	AAIB
Occasionally poor interpersonal skills	AAIB
Proclivity to make longwinded presentations	AAIB
Reluctance of some senior inspectors to pass on technical expertise to others	AAIB

APPENDIX F: Phase 3 comments

Skills related comments

A good inspector requires to be: practical; understanding; thorough; technically sound; logical and a good communicator, both written and verbally.

Acceptance that accident investigation is an exact science; and poor investigation / report is due to inability of inspector to ask correct questions or find the evidence.

Consider Ps carry out an accident investigation or at least one PE in the field as part of staff development

I am surprised to apparently see no references to 'diversity' or similar - guess this area is covered under general openmindedness? Ability/experience of dealing with those from different cultures is a valuable skill from the diverse industry of shipping

Experience in an office environment; social conscience; environmental awareness.

An inspector needs to be a good communicator at all levels and shouldn't be afraid to talk to a high ranking official or to a member of the public and shouldn't be afraid of being in the media spotlight. To obtain you need to give, ineffective communication can lead to ineffective results.

Sustained desire to improve flight safety; lateral thinking - prepared to tackle status quo and address basic causes: both essential; distinctly lacking in some areas of the AIBs that I have come across.

Need to have a sense of humour

Inspectors ideally should possess the widest range of knowledge and experiences but not wholly limited to aviation matters. Question 4.1 is most important: "should demonstrate an inquisitive nature"! And be able to write logically as well!

How well or poorly someone develops as an accident investigator will be influenced by how well they and the organisation are managed. Humour is a vital ingredient. This questionnaire takes a lot longer than 20 minutes.

Questionnaire related comments

Please make future questionnaires more user friendly

This questionnaire is too long

This is not 20 mins long, even though I tried to make it so - it took an hour; time management?

20 minutes was a very poor estimate for completion of this form!

Too many questions and therefore superficial answers. To complete properly would take approx 2 hours. Took, me 40 minutes with little thought at end of questionnaire.

Section B column C is not 100% clear to me eg "shows no curiosity" is marked as a 5 since lacking curiosity will show someone as having the qualities of a poor investigator and will therefore distinguish the ineffective investigator.

APPENDIX G: Phase 3 generic questionnaire