CHAPTER ONE:

INTRODUCTION – THE PROBLEM AND ITS CONTEXT

1.1 INTRODUCTION

On 14 October 1947, a young pilot, Captain Charles E. (“Chuck”) Yeager, broke the sound barrier. Later, he said: “I was always afraid of dying, always. It was my fear that made me learn everything I could about my airplane” (Yeager, cited in Harrison, 2000:96, own emphasis). This statement encapsulates the profound importance of training, even for some of the most famous names in aviation circles. In order to master the machines they fly and so change the course of history, it was critical that these pilots gained a deep understanding and knowledge of their aircraft. Modern airline pilots operating some of the most advanced machinery known to humankind are no exception to this rule.

Today’s successful airline organisations, which operate advanced commercial aircraft employing highly complex automation, have consistently found that well-trained pilots are the cornerstone of their profits and ultimate business survival. The situation is complicated by the fact that, in order to remain competitive in an industry renowned for failure and bankruptcy, airline companies are also obliged to invest in expensive modern and more efficient aircraft. This investment includes training highly competent pilots (Australian Transport Safety Bureau, 2007; Walters, 2002). Although not all training situations are as dramatic as Yeager’s remark implies, training human beings to handle an advanced automated aircraft can be an extremely expensive, challenging and time-consuming exercise (Johnston, Fuller & McDonald, 1995) that require effective organisational practices and structures, dedicated and skilful instructors, and most importantly, motivated learners (Telfer & Moore, 1997).

Air travel in commercial advanced aircraft is currently rated as the safest mode of transportation (Boeing, 2009); however, people still continue to perish as a result of aircraft accidents, and the financial impact of such accidents can close down an airline company (FAA, 1996). The consequences of an aircraft accident are devastating, for not only the company involved, but also the communities that such an event ultimately affects. Alarmingly, the reported probable cause cited in over half of aircraft crash investigations is pilot or human error (Billings, 1997; Cockburn, 2007; NTSB, 2009). Studies have shown that in highly advanced automated aircraft accidents, human factor issues in general, and pilot training in particular, often play a significant role (Ishidi & Kanda, 1999; Kaminski-Morrow, 2009; Rouse & Morris, 1987; Sarter, 1996).

Moreover, O'Hare, Wiggins, Batt and Morrison (1994) have found that, apart from a multitude of variables responsible for a significant portion of the failures in the system, specific attention must be paid to the training received by the pilots who were at the controls of the aircraft. In a quantitative study, Sarter (1996) concluded that a thorough understanding of the training environment can assist researchers in identifying and mitigating at least 40% of the human factor variables associated with aircraft accidents. In a similar study, Machin and Fogarty (2003) found specific interactions between individual variables, training methods and situational factors that influence learning outcomes. These conclusions point to psychological reasons for the root causes of success or failure in a transfer of knowledge. In fact, Telfer and Moore (1997) found that incongruity between the pilots, the machines and the organisation, could explain some of the latent systemic training problems in an airline. Desler (2002) suggests that a systemic nature of a psychological climate, implies aligning three domains of organisational behaviour, that is, at an individual, group and organisational level of analysis.

The aforementioned introduction positions the existence of an ongoing need for further scientific scrutiny to determine the factors that may have an impact on the success or failure of pilot training, related to the safe operation of advanced automated aircraft. Only from scientific analyses and a genuine need to ultimately understand the human-technology dyad, can these human factor issues be effectively uncovered and thereby addressed in the aviation industry (Johnston et al., 1995).

1.2 THE RESEARCH CONTEXT

According to Boeing (2010), the overall volume of commercial air traffic will increase threefold over the next 20 years. However, it is expected that the commercial aircraft accident rate will decrease steadily, in major part due to the exponential advances in technology (Boeing, 2009; CAA, 2011; FAA, 1996). Both regulators and manufacturers are of the opinion that increasing technology in aircraft will reduce human input, with a subsequent reduction in human error, thereby mitigating the total accident rate over time (Bainbridge, 1983; Wald, 2009). The proliferation of highly automated flight decks and the increased use of computer-based heuristics in aircraft have reduced pilots' workload and have, to a degree, eliminated adverse aspects of the human element (Funk & Lyall, 2000). However, some experts in the industry tend to disagree with such assessments of the situation (Barker, 2011; Bent, 1996).

Degani, Shafto and Kirlik (1995) have argued some time ago, that the rapid increase in computer technology predicted for the future, with its subsequent impact on advanced automated aircraft, will have a profoundly negative effect on the human-machine dynamic. Their argument is based on the premise that, the resultant effect of an increase in technological complexity implies that overall, far superior human cognitive effort is required to manage the new technology, thereby increasing the likelihood of human error. More than twenty years ago, Bainbridge (1983) began pointing out a paradox. It was hypothesised that the more complex a system becomes, the more critical or important the contribution by the human operator (Bainbridge, 1983). This paradox has begun manifesting within the last decade, highlighting the need for a deep understanding of technology and its impact on human behaviour (Cockburn, 2007; Hradecky, 2011).

The intense cognitive requirements needed to operate advanced aircraft have resulted in a multitude of automation and computerisation debates (Barker, 2011; Poprawa, 2011; Bent, 1996; Parasuraman & Riley, 1997). Although increased computerisation of aircraft may promise an improvement in their operation (Ausink &

Marken, 2005), Funk and Lyall (2000) have argued that too much automation can also prove disastrous. Hence, the inherent dichotomy between humans and advanced machines implies that an improvement in learning methodologies for new technology may require a paradigm shift in future organisational training activities (Telfer & Moore, 1997). It is therefore increasingly important to research training for the users of technologically advanced systems.

Research conducted in the field of aircraft automation over the last decade has revealed how critical latent training and related safety issues in the human-machine system are (Walters, 2002; Wickens, 2000; Wiener, 1998). A fatal combination of limited technical knowledge and its incorrect application in both normal and emergency situations was found to be a significant contributor in technology-related aircraft accidents (Baum, Gatchel & Schaeffer, 1983), and more recently reported to be a significant contributor to accidents involving the latest technologically advanced commercial aircraft (Cockburn, 2007; Hradecky, 2011).

An illustration of the complexities of aircraft technical know-how and its application is provided by Parasuraman and Riley (1997), who have determined that the intricacy of complex systems (for example, automatic thrust levels, computer mode changes and so forth) in both normal and abnormal flight situations can distract a crew to such an extent that the basic management of the overall aircraft may be jeopardised. These consequences are directly linked to inappropriate usage of the autopilot system (Poprawa, 2011). Operating an advanced aircraft system correctly is necessary so as to harness safety; which was the original intention of the advantages found in technology. For instance, zero visibility landings can only be safely accomplished by automation, and therefore the correct and appropriate use of the autopilot is mandatory in adverse weather conditions and highly recommended whenever visual conditions fall below 1KM (South African Airways, 2007). This is an example of the safety benefits associated with the correct use of automation technology. Researching and understanding why and how the incorrect use of technology can profoundly compromise flight safety is an important requirement in accident prevention and mitigation efforts (Ausink & Marken, 2005).

According to Bent (1996) and Sherman (1997), it is not necessary for a pilot to know all the intricate details of precisely how an aircraft's technology is designed and built in order to operate the aircraft safely. This is one reason why specific licences are stipulated by the aviation regulator for particular facets of aircraft operation (CAA, 2011). For example, an engineer is only qualified to build an aircraft to a certain degree of specification, but may not have the skill to fly it safely with the knowledge acquired in attaining that qualification. Similarly, a pilot is not required to have the technical depth of knowledge of an engineer to operate the aircraft safely. Research can help bridge the gap between the two areas (that is, flying skill versus in depth technical knowledge) to enhance understanding of the nature of accidents related to a breakdown in knowledge between design and operation. For instance, Sherman's (1997) research explored automation training, focusing on airline pilots in the United States, and established significant differences between the ways different categories of respondents view various advanced automated aircraft types. However, his study did not address all the relevant issues – airline pilots' perceptions of the training climate associated with an advanced automated aircraft were not analysed.

Telfer and Moore (1997) diagnosed the training climate associated with the general aviation sector. They deduced that there is an inherent need for aviation organisations to develop more effective learning philosophies and methodologies proactively in order to reduce human training-related incidents, and thereby improve overall flight safety. Flight safety also has a basic financial imperative. The link between flight safety and an improved bottom line is emphasised in a comment such as "safety makes good business sense" (Walters, 2002:110). Investment in flight training efforts, such as research regarding learning to fly new technology aircraft, can thus add value for the organisation as a whole. The benefits of the leveraging effect of training to an airline are immense. Indeed, Abraham (1990:20) posits that the management of aviation safety by systemic improvements is so basic and fundamental that "profit, pride and politics [should] take a back seat to…efforts devoted to safety".

A preliminary review of the scholarly database at the start of the study reported here, suggested that very little empirical research had previously been conducted on the topic covered in the current research topic, namely, the development of a scale to measure perceptions of the climate associated with advanced automated aircraft training. Hence, a gap in the knowledge of aviation human factors was uncovered. Where any prior analyses of how current airline pilots perceive learning for flying technologically advanced aircraft have been conducted, these analyses were inconclusive regarding the psychological attributes of trainee pilots (Ausink & Marken, 2005). An exploration of this subject and the challenges encountered after analysing this specific area, has ultimately led to a deeper understanding of current commercial aviation human factor issues.

In determining empirically the value associated with safety, Gegax, Gerking and Schulze (1991) assert that no monetary saving should be placed above the advancement of safety elements affecting both the organisation and, in particular, the flying public. Their study highlights the importance of more research into both overt and latent aviation safety constructs, and particularly aviation training. Governments, researchers, and economists have found it very difficult to quantify the cost of a commercial aircraft accident, specifically where hundreds of lives are lost (International Civil Aviation Organisation, 2001).

1.3 THE RESEARCH PROBLEM AND ITS SIGNIFICANCE

Creswell (2002) argues that the significance of a study can be assessed by both its scholarly contribution and the improvements it brings about in policy and practice.

There may be some truth in Orben’s quip that “[t]o err is human and to blame it on a computer is even more so” (cited in Zametti, 2008:128). Shifting the blame has long been a common feature of reports on aircraft accidents, and computers have become a new target for blame (Kaminski-Morrow, 2009). As long as manufacturers continue to improve aircraft by designing and installing ever more advanced computer-based systems, there will always be the related human factor issues (Baum *et al*., 1983), even when it seems as if manufacturers are attempting to design out the human factor (Barker, 2011), by limiting the level of control apportioned to the human operator (Wickens, 2000).

Despite ongoing research over the last two decades concerning flight deck automation relating to and affecting safety management systems, problems with training activities related to the implementation of digital automation continue to be reported (Cockburn, 2007; Kaminski-Morrow, 2009; Mitchell, Vermeulen & Naidoo, 2009; Wiener, 1993). Preliminary investigations into the accident in early 2009 involving a Turkish Airlines Boeing 737-800 suggests that (inadequate) pilot training may have contributed significantly to the fatal crash (Dutch Safety Board, 2009). Subsequently, Airbus Industries and the Boeing Company have issued an advisory to all crew operating their aircraft to be vigilant in monitoring automation systems such as auto-thrust, and to maintain control during wing stall situations (a very basic aerodynamic concept taught to pilots at flight school). To rectify various short-term issues, aircraft manufacturers will send out a notice to their customers to implement certain changes to flight operations or modify equipment. A bulletin from Airbus clearly states, “during all phases of flight, flight crew must monitor and crosscheck all primary flight parameters and the FMA” (Airbus, 2011b). The Flight Mode Annunciator or FMA is a primary instrument used by the pilots to monitor the status of the flight control computers. In addition, this specific notice was colour coded red, which indicates a critical requirement. This has served to highlight the fact that manufacturers are becoming more concerned with the recent trend in critical weak areas relating to human factors in the design, monitoring and operation of advanced computerised aircraft. In fact, it was observed that the two operations bulletins found in the Airbus A330-200 Quick Reference Handbook (QRH) on board the flight deck, are both related to flight automation systems.

Scientific interest in a training climate construct associated with the operation of advanced aircraft has arisen as a result of the paradigm shift brought about by the rapid technological advances in aviation (Telfer & Moore, 1997). Transition training (transferring from an analogue aircraft to a digital aircraft) is often cited as a primary concern when analysing human factor issues related to the actual *comprehension* of an advanced digital aircraft system (James, *et al.,* 1991; Naidoo, 2008; Wise, *et al.,* 1994). The systemic nature of flight operations, compounded by a complex environment, leaves room for human operator errors or lapses which may have a catastrophic outcome (Ishida & Kanda, 1999; Parasuraman & Riley, 1997; Sarter, 1996). A review of various analyses of the latent structure of pilots’ perceptions of advanced automated flight decks shows that errors in human behaviour related to training issues can have a significant impact (Naidoo, 2008; Wiener, 1993). Hence, training has played, and will continue to play, a vital role in how airline pilots perceive advanced flight deck automation, which in turn directly influences levels of safety. According to the National Transportation and Safety Board (NTSB, 2009), a significant proportion of accidents involving highly modernised commercial jet airliners can be attributed to poor training. Therefore, efforts to reduce this contributory factor will have a direct and observable impact on safety. Furthermore, Risukhin (2001) suggests that training through higher order learning systems is regarded as an antecedent to a positive perception of advanced technology aircraft computerisation, which can, in turn, enhance the training environment.

Quantitative research into an organisation's *training climate* helps scientists understand the multitude of variables responsible for employees' pedagogical development and the final achievement of the overall learning objectives (Naidoo, 2008; Tracey & Tews, 2005). Collecting data from psychologically measurable variables in terms of the advanced aircraft training climate will effectively create the conduit necessary for developing an accurate construct for the aviation industry. A problem in aviation is the failure to develop accurate and measurable constructs (Sherman, 1997). For instance, Desler (2002) points out that when considering the accuracy of the design of an aviation related training climate construct, it is important to understand details such as the resources, practices and priorities of the organisation in terms of the instructor, facilitator, and more importantly, the attitudes, motivation, strategies and learning styles of the student.

To address the extent of the issue of insufficient measurable constructs within the aviation industry, previous theory, case studies and reports were consulted. Constructs and concepts from organisational behaviour have been operationalized in this research in order to link up with training-related attitudes and outcomes. The premise is that only effective training methodology can significantly influence flight safety from a learning point of view. Singh, Sharma and Singh (2005) found the empirical evidence to support this statement by showing that longer training periods (M=41.67, SD=5.51) were only marginally better in changing performance than shorter periods were (M=37.82, SD=5.51). Such experiments demonstrate the current research problem practically, by accurately and empirically substantiating the role of quality in the training and learning environment. Quality, and specifically the perception of training quality, can ultimately impact behaviour of pilots in the aircraft itself (Naidoo, 2008).

The theory of planned behaviour surmises that the quality of *learning* can directly influence final or actual outcome behaviour (Fishbein & Ajzen, 2001, Meister, 1999). Therefore, the development of a measurement of this environment potentially makes the current study a significant contributor to the present body of knowledge. A preliminary examination of the literature suggested that a problem in aviation has always been accurately validating reliable measurement constructs related to training and then linking the constructs to the resulting flight deck behaviour (Parasuraman & Riley, 1997).

1.4 PURPOSE OF THE RESEARCH

The argument that pilots learn to fly aircraft in different ways is not new, and has been raised in the literature for some time (Sherman, 1997; Singh *et al.*, 2005; Telfer & Moore, 1997). According to Vermeulen (2009), flight instructors are acutely aware of the fact that some students are deeply motivated to understand their aircraft, while others learn only the bare minimum so as to meet the minimum standards to pass the course. Similar conclusions were reached in a study of general aviation pilots (Telfer & Moore, 1997). Hence, some trainee pilots may be motivated by their instructors, together with trait factors such as a passion for aviation; whilst other students may see training merely as a means to an end. The way airline pilots learn to fly is a combination of their natural love for the activity and the subject of aviation on the one hand, and the learning environment on the other (Sherman, 1997; Tracey & Tews, 2005; Vermeulen, 2009). Only after quantitative measurement of the training environment as perceived by students, can the variables and phenomena responsible for individual behaviour on board the flight deck be thoroughly investigated. Similarly, pilots’ attitudes towards training can also be competently explored only if their perceptions can be measured quantitatively (Naidoo, 2008).

In view of the aforementioned discussion, the main focus of the research was to develop an appropriate instrument to conduct a cross-sectional assessment of airline pilots' perceptions of the climate associated with advanced automated aircraft training at their organisation (airline).

Based on a comprehensive initial literature review, a hypothetical construct was developed which defined perceptions of the advanced aircraft training climate. In the context of the present study, and to meet the research objectives, a training climate was regarded as the prevailing conditions of the person (pilot), the group (instruction) and the organisation (airline) as experienced by the pilot during or after training to operate an advanced automated aircraft in the South African commercial aviation industry.

The primary purpose of the study was *to develop a valid and reliable instrument to measure airline pilots' perceptions of the training climate associated with advanced automated aircraft and to explore related phenomena statistically.* Overall, therefore, the fundamental goal of the study was to operationalise an unobserved hypothetical construct by developing a survey questionnaire (perceptions of the advanced automated aircraft training climate) based on three hypothetical latent sub-constructs (the person, the group and the organisation) that conceptualised the primary construct. The major organisational behaviour literature suggests that constructs are systemically correlated at three fundamental levels, namely at the micro, meso and macro levels of the organisation (Bott & Svyantek, 2004; Desler, 2002; Drucker, 1946). Furthermore, for the initial development of the hypothetical construct, this research study relied substantially on the premises sourced from prior psychology theory and organisational behaviour theory.

In addition, the purpose of the research was to analyse the perceptions of South African airline pilots as a specific unit of investigation, as people qualified to operate advanced technology aircraft for their companies. To fulfil the primary purpose of the study, a number of characteristics about the unit of analysis were then assumed. First, it was assumed that, as airline pilots acquire an increasing amount of industry experience, they move from being a dependent personality to being a self-directing entity. Second, it was decided that the units of analysis would all be current, qualified and fully trained airline pilots. Third, it was assumed that pilots use accumulated industry experience as a resource for learning. In other words, the sample under investigation use experience gained on other aircraft as a basis for learning new technology principles. Fourth, it was assumed that airline pilots' readiness to learn was oriented to the developmental tasks of their flight deck position.

As a secondary purpose, this study sought to explore the underlying structure of the relationship between the variables and attempted to explain the dynamic of the phenomena related to respondents' perceptions of the latent constructs, based on an appropriate level of statistical analysis.

1.5 RATIONALE FOR THE RESEARCH PROJECT

A preliminary analysis of the relevant literature suggested that there was no construct-validated measure of a training climate which was associated with advanced commercial aircraft and which was anchored in an organisational behaviour paradigm, even though it has been claimed that many important constructs in the behavioural sciences are organisation-based (Robbins, Odendaal & Roodt, 2004). Research studies that undertake to analyse the organisational learning environment can only be of value if cognisance is taken of the fact that the training climate is a critical component of resultant behaviour and therefore has a subsequent impact on overall organisational effectiveness. Using well-developed scales for the measurement of individuals' perceptions of a particular climate can determine human behaviour within an organisational system and context (Meister, 1999). Early seminal studies point out that individual human behaviour is latent within an enterprise and can significantly influence the overt (observable) aspects of an organisation at a very fundamental level (Likert, 1958). Applying such a theory in the context of the aviation industry could therefore benefit the current body of understanding.

A review of the literature suggests that future research is needed to explore the dyadic nature of a human-technology system in the airline industry. Meister (1999) argues that the measurement of aviation human factors should not be very different from the measurement of any other systems in the psychology environment. Indeed, some authors have suggested that specialised aviation metrics research would have real potential to contribute significantly to improving not only business, but also aviation safety (Funk & Lyall, 2000). One rationale for attempting this study was that analysis of the general understanding of the topic of interest over the past two decades tends to be grounded on fairly little positivist and quantitative research, so that there are vast gaps in what is currently known in both the organisational and psychological literature about climate constructs related to training for advanced aircraft (Funk & Lyall, 2000; Mitchell *et al*., 2009; Parasuraman & Byrne, 2002; Sherman, 1997; Singh *et al*., 2005; Wiener, 1993). For example, one study in this field examined perceptions of glass cockpits over a given period, and found that training aspects affected a significant portion of this perception. However, the authors of the paper acknowledged that the factors involved in airline pilots' perceptions of learning and training were a relatively unknown and new area of exploration (Mitchell *et al*., 2009)

The aim of this research was to explore a relatively new area, marrying the principles of organisational behaviour, aviation training, human factors and advanced technology. This implies a more complex study, making an exploration of relatively unknown phenomena particularly difficult. However, the potential contribution to a scientific understanding of aviation psychology that could accrue from such an undertaking is so valuable that it vindicated the research approach. Moreover, the study investigated and determined the nature and content of a newly developed and empirically derived construct for the airline industry. The clarification of airline pilots' perceptions of the advanced automated aircraft training climate appears unique, because a review of prior research on the advanced automated aircraft training climate revealed little information on any training or learning measurement constructs. Similar constructs are, however, available in the general corporate training arena (Tracey & Tews, 2005). These were reviewed when conceptualising the present research study.

Overall, all searches on the current topic of interest revealed a general dearth of substantive aviation industry data. The fundamental importance of and rationale for this research aimed at airline organisations interested in aviation psychology is that new knowledge of the training climate can be used to develop adequate interventions. Such interventions include altering, modifying or enhancing current training methodology and paradigms, thereby improving organisational effectiveness, efficiency, competence and overall corporate competitiveness.

1.6 SCOPE OF THE STUDY

1.6.1 General scope

A review of relevant journals showed that research into aviation automation training had not yet produced the extensive empirical data necessary to bring about significant policy and regulatory change (Parasuraman & Byrne, 2002; Pohlman & Fletcher, 1999). Only one prior study has touched on advanced technology pilot training, namely that by Sherman, Helmreich and Hines (1995). However, these authors examined automation training only by specifically focusing on pilots' experiences with automated aircraft, using a previously developed framework by Wiener (1998). To date, the theoretical body of knowledge dealing with aircraft automation has been limited and has focused only on pilots' attitudes toward aircraft automation in general (Funk & Lyall, 2000; James *et al.*, 1991; Naidoo, 2008; Sherman *et al.,* 1995; Risukhin, 2001; Wiener, 1998) and not on aspects related to training.

It was found that very little new information is available, particularly in the last five years. In fact, the bulk of the psychology and behavioural literature available on flight deck automation research spans only the last decade. Furthermore, no study has developed any specific instrument to critically assess or measure constructs associated with the training climate related to advanced automated aircraft grounded in organisational behaviour theory. The questions of *what* strategies airline pilots adopt and *why* airline pilots adopt certain pedagogical motives and strategies with regard to advanced automated aircraft have not really been asked thus far. The complex interplay of airline pilots' intentions in learning, the approaches they may choose, and the outcomes of their training, has not been empirically examined, creating a theoretical gap in aviation human factors research. The testing of new methods and procedures that measure perceptions accurately should be undertaken systemically – an argument championed by many renowned psychology scholars

(Cattell, Boyle & Chant, 2002). It has been emphasised in the literature that doctoral research in this specific area is appropriate and very necessary; so as to achieve the required levels of depth needed to make organisational changes (Sherman, *et al.*, 1995). Although the literature shows that the training of airline pilots contributes significantly to their perceptions of new technology aircraft (James *et al.,* 1991; Johnston, Fuller & McDonald, 1995; Naidoo, 2008; Wiener, 1998)*,* the measurement of perceptions relating to training and learning has not, to date, formed the basis for any study in this field*.* The scope of the current research was therefore based on the premise that an instrument should be developed empirically, starting from a sound theoretical foundation. However, it is a limitation on the scope of this research that such an approach has not been used in other research of this nature before, so that there is nothing to compare it to, resulting in highly exploratory methodologies.

1.6.2 Theoretical scope

How people see their learning environment is a fundamental antecedent to influencing the knowledge-gaining opportunities in, and effectiveness of, the training process (Schaap, 2000). Biggs's (1987) 3-P model of learning suggests that there are distinct issues regarding the strategic selection of either a deep, surface or achieving method of acquiring relevant knowledge for pilots learning to fly an aircraft. However, how *advanced automated* aircraft airline pilots perceive their learning environment has not yet been scrutinized using this framework.

Understanding general behaviour in a highly computerised flight deck has not necessarily improved safety in these aircraft (Mouloua, Gilson & Koonce, 1997). Furthermore, Mouloua *et al.* (1997) postulate that a pilot's perception of his or her comprehending advanced aircraft systems may be highly correlated with situational factors such as the subject's experience and the level of automation employed in the aircraft. However, a focus on specific behavioural traits, such as training or learning, should contribute to the body of knowledge and could have a significant impact on flight safety. An examination of perceptions of the training climate as experienced by the operators and dividing the research sample into specific demographic categorisations would result in the level of specificity required. Hence, the current theoretical scope of the study attempted to address more detailed issues by means of a thorough exploration.

The exploratory method used in this study relied on prior empirically derived theory. For example, based on Schaap's (2000) analysis of adult learning approaches, it was deemed important to ensure that the hypothetical measurement construct included concepts related to individuals' abilities to examine and reflect critically on their own learning process, because a quantitative link has been found between learning reflection and continued or sustainable effectiveness in a knowledge economy. To understand the effectiveness of airline pilots in their organisations, this method of theoretical reasoning was extrapolated. For instance, the theory may suggest that pilots who are not cognitively reflective of a higher order climate may not be capable of acquiring the relevant information to fly safely. This notion was combined with evidence presented by Telfer and Moore (1997), who reported that a lack of critical aviation-based knowledge significantly increased the probability that an individual would be the root cause of a serious incident or accident.

Correct reflection on learning processes will invariably promote an airline pilot's ability to handle new and complex situations. *Reflection* in this context and in terms of the theoretical scope used in the current study is then defined as the ability to integrate past learning experiences and apply this knowledge to new problems – an ability that has been shown to indicate a higher level of mastery in an acquired skill. Schaap (2000:xxvi) explains that the "way an individual views the process of learning influences the learner's approach to a learning opportunity and the effectiveness of the learning process concerned".

Some important psychoanalytical concepts are often neglected in examining organisational training. The scope of the current study therefore also included many principles taken from the fields of psychology and the behavioural sciences. For example, Aronson (1991) raises the following critical issues:

- the relationship between learning (training) and the stages of development (in this case, the levels of experience of airline pilots), which could emphasise one or more modes of learning;

- the role of values, goals and ideals in learning strategies;
- the relationship between personality, the self and the organisation in the learning process; and
- the psychodynamics of thinking, in other words, motivation theories and both primary and secondary processes which contribute to theory building in the fields of thinking and learning.

The prevailing training climate (trainees' intentions, approaches and outcomes) as perceived by advanced automated aircraft pilots was explored as a human factor issue in the current study, following on from suggestions derived from important field research by James *et al*. (1991) and Naidoo (2008). It is necessary to measure perceptions in order to reduce the human factors knowledge gap in aviation psychology and also to enhance academic understanding of the related phenomena, which are significant for flight safety.

Inspired by Schaap's (2000) model, which showed distinct systemic linkages between learning approaches, learning environmental factors, personal factors and learning outcomes, the theoretical scope of the research was expanded to include systemic models. According to Drucker (1946), an organisation is a social entity and a repository of knowledge; furthermore, one must regard this entity as interdisciplinary and as displaying some philosophical sophistication. The mechanisms operating between aviation-related learning components and systemic organisational behaviour were examined further in the literature study. This approach guided an understanding of the psyche of an airline pilot (who has been trained to fly an advanced automated aircraft) and the development of a fundamental psychological measurement instrument. The phenomenological components that were identified as encapsulating the knowledge environment of a modern airline pilot were derived from this theoretical scope.

1.7 RESEARCH OBJECTIVES

The research problem and objectives of the study were finalised only after a comprehensive and non-exhaustive preliminary literature review, which revealed a need for the development of an assessment instrument containing the dimensions of the particular construct of *perceptions of the advanced automated aircraft training climate*.

The primary objective of the study was therefore to obtain an empirical estimate of the hypothesised construct by constructing a multi-dimensional questionnaire in order to develop a valid and reliable measurement scale. The following research objectives were generated to guide the study:

- to identify from the literature which organisational behaviour attributes apply to the main and sub-constructs;
- to develop a hypothetical multivariate psychological systems model (founded in empirically grounded theory) from which criteria for the construct of *perceptions of the advanced automated aircraft training climate* could be identified and tested in an quantitative study involving a cross-organisational sample of airline pilots from South Africa;
- to generate a tentative pool of scale items based on a model of the construct;
- to validate the items of the hypothesised construct statistically, by quantitatively examining the judgements gained from subject matter experts and using Lawshe’s (1975) content validity ratio technique;
- to obtain sufficient empirical data to explore the nature of the latent factors of the main research construct and to develop an understanding of their relationships to the surface attributes and to each other;
- to statistically develop a valid and reliable measurement scale based on the main research construct; and
- to explore the statistical relationship between respondent variables and the latent factors of the construct.

1.8 OUTLINE OF THE STUDY

The study is organised as follows:

Chapter 1 has introduced the study by demonstrating the current gap in the knowledge in the aviation industry and providing an orientation regarding the research purpose, scope, objectives and focus of the research.

Chapter 2 sets out a comprehensive literature review in terms of the human-machine interface. Firstly, important terms are defined. Secondly, in order to maintain a relatively logical flow, the literature review was structured around the following key themes: advanced aircraft technology and its impact on human behaviour and *vice-versa*, learning measurement and the theoretical approaches adopted by trainees, examining the training climate construct based on organisational behaviour and relevant psychology theory; which then leads into a discussion of the advanced automated aircraft climate and relevant specific training aspects for this unique work environment. The literature on these themes was synthesised with the aim of providing an integrated theoretical understanding and critique of the topic.

The aforementioned review is comprehensive, but far from exhaustive – only pertinent and relevant theories (arguments) were selected for this critical evaluation of the current body of knowledge. The literature review supports the conceptual development of the main hypothetical construct, and thus forms the core foundational phase of this research.

Chapter 3 links the literature from Chapter 2 in terms of advanced aircraft technology and training. In addition, this chapter critiques the work from the existing body of knowledge to underpin and contextualise the development of a tool to measure perceptions of the advanced aircraft training climate. The chapter also states the delimitations of the present study and seeks to clarify the research construct for statistical analyses in Chapter 4 and Chapter 5.

Chapter 4 describes the research and statistical methodology followed, which includes the steps taken in the final scale design and development. A discussion of the logic of the sampling technique, surveying method, questionnaire construction, factor analysis, reliability and item analysis forms a major part of this chapter. Furthermore, Chapter 4 discusses the initial statistical examination of the main research construct. The results of the Lawshe (1975) technique is discussed and presented after thoroughly examining judgements from subject matter experts. Therefore, Chapter 4 discusses and finalises the operationalization of the main hypothesised research construct.

Methodological depth is achieved within this section, because the chapter also attempts to defend and substantiate the choices made regarding the use of parametric and non-parametric statistics from a theoretical perspective. In addition, effect sizes and practical significance, as relevant to Chapter 5 are summarily discussed.

Chapter 5 explores the results of the study by examining the outcomes of the item, factor analyses and logistic regression analysis. The chapter sets out in detail the analyses and results on the total data set by examining the effects between selected demographic variables and the latent factors of perceptions of the advanced aircraft training climate construct, by using descriptive, comparative and associational statistical methods.

Chapter 6 revisits the research objectives, methodology and limitations of the study in light of the final results. The main components of the research construct are summarised and the managerial impact of the demographic variables on the outcome factors are reviewed. The chapter also proposes recommendations for future research.