CHAPTER THREE:

LITERATURE STUDY –
THE ADVANCED AIRCRAFT TRAINING CLIMATE

3.1 INTRODUCTION

Education consists mainly of what we have unlearned.
(Mark Twain, 1898, cited in Keane, 2005:204)

Any sufficiently advanced technology is indistinguishable from magic.
(Clarke, 1984:27)

The realm of advanced computing can cause confusion and often uneasiness amongst the general population (Moore, 2003). Linking two very complex areas – advanced technology and training – can therefore be a daunting research task. The purpose of this chapter is to introduce the organisational training climate in the context of advanced automated civilian commercial aircraft. A multidisciplinary approach was therefore adopted to interpret the vast array of literature related to the topic. Evidence was sourced from the field of organisational behaviour (which focuses on multiple levels of analysis) and from contemporary theories originating in clinical and industrial psychology, as well as from literature on aviation human factors, advanced computerisation, aircraft accident investigation principles, and learning and training (educational psychology and sociology). This chapter encapsulates 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 impact of technology on both the latent and overt behaviour of airline pilots has been thoroughly documented, researched and mapped, but only up to a point (Parasuraman & Riley, 1997; Research Integrations Inc., 2007). Thus far, there has been little scientific analysis of the *environment* in which pilots *acquire* and *adapt* new knowledge related to working with advanced automated commercial aircraft.

Science starts with good definitions (Carston, 2002). Difficulties in science arise when what an author intends to say diverges from what is actually understood in a particular context. Problems in research reporting arise where there are differences between the linguistic expression used and the message that is to be communicated. For this, and other similar reasons, it is vital that definitional issues be clarified prior to undertaking any scientific discussion. Thus, definitions of the key terms used in this study are provided for in the literature review to ensure clarity.

The focus of the present study was to explore airline pilots' perceptions of the advanced automated aircraft training climate after developing a valid measurement scale for the construct. The literature review set out in this chapter is useful in understanding, clarifying and defining the constituents of the training climate in the context of training to operate advanced civilian aircraft. Thereafter, the review examines some approaches learners may adopt when acquiring new knowledge. Measuring the psychological components of the training environment is discussed, particularly in respect of the complex aviation sector.

3.2 RESEARCH DELIMITATIONS

The study assesses a psychological climate in terms of its systemic association with advanced automated aircraft pilot training. A systemic organisational environment is described in terms of the external, internal and intermediate spheres of influence that apply in an organisational behaviour context (Leibold, Probst & Gibbert, 2005). The conceptual links emerge from a psychological bond between the organisation (in this case, the airline), the group (here, the instructor-trainee interface) and the individual (here, the trainee), as experienced by qualified advanced automated aircraft airline pilots. In this study, only the psychological processes (individual attributes) of the airline pilot (employee) were considered, whereas those of management were excluded from the scope of the study.

The unit of analysis in this study is therefore the perceptions of a particular group of airline pilots flying (operating or working with) advanced computerised (highly automated) commercial aircraft. These pilots typically occupy various positions at an airline organisation, where they command the aircraft (as captains), or are second-in-command (first officers) or, in some cases, third-in-command (second officers).

To investigate this training climate, the psychological theoretical streams were further limited to those dealing with perceptions, attitudes, and elements of the psychodynamics associated with personality and motivation; or associated with areas of learning, education and training. To gain an understanding of the human-machine system, only theories relevant to the operation of advanced automated aircraft were considered.

To simplify the presentation of definitions, tables were compiled to clarify some primary but complex aviation concepts used in this study. For instance, it was required to clarify early on, in Section 2.2 and 2.3, concise definitions and further explain that an advanced automated aircraft consists of two separate but related parts, namely the flight deck itself, and the airframe and associated mechanical sub-systems. It was necessary to initially differentiate two parts of the advanced aircraft because technological capability is based on the association between basic computerised external aircraft systems and computerised control and display units in the flight deck (Ausink & Marken, 2005; Dole, 1989). Overall, the pilot of an advanced aircraft would rely extensively on computer-based systems in order to control, monitor and manage the aircraft.

3.3 CLARIFICATION OF THE CONSTRUCT - TRAINING CLIMATE

According to Denison (1996), empirical research on phenomena associated with an organisational climate requires quantitative methods, because there is a need to generalise findings across social settings. It was therefore intended that the core components in the measurement scale developed in the course of this study would successfully assess perceptions of the advanced aircraft training climate of the airlines concerned. Hence, further elucidation of the term *training climate* is necessary at this point of the discussion in order to quantify and operationalize the final construct.

3.3.1 Introduction to climates

The literature differentiates between two separate climatic constructs, namely a *psychological* climate and an *organisational* climate (Chung, 1996:35; Denison, 1996:619). The psychological climate refers to making sense cognitively of the organisational environment. In this context, Denison (1996:621) has criticised authors who continually confuse “culture” with “climate”. Denison (1996) points out that an organisational climate refers to individuals’ subjective summated (average) sense made of interpersonal constructs, and their understanding of policies, procedures and structure. By contrast, Schein (2004) refers to the organisational culture as a set of group assumptions created after learning from a number of internal and external difficulties or problems. Climate researchers are “generally less concerned with [social] evolution but more concerned with the impact that organisational systems have on groups and individuals” (Denison, 1996:621).

It can then be established that employees (and in the present case, trainees) will adapt their behaviour based on their perception of the organisational climate (Fishbein & Ajzen, 2001; Tracey & Tews, 2005). For instance, according to Chung (1996), the behavioural characteristics of human beings are moulded by a plethora of simultaneous environments. After closer examination of this proposition, it can be deduced that the simultaneous environments in which human behaviour may occur are similar in nature to the business eco-system posited in Leibold, *et al*. (2005); that is, a business eco-system consists of systemically related environments (psychological, industrial and economic environments) and similar enterprises that fluctuate in unison within their corporate dimension. Therefore it may be conjectured that competiveness stems from the different business eco-systems and not specifically between similar enterprises within such eco-systems. One may conclude from such a proposition that the training of airline pilots by one organisation or company will be beneficial to the entire industry on the whole. However, the climatic construct developed for this research is associated with an individual enterprise (airline company) within the business eco-system. Future research into the perceptions of climates defined in terms of eco-systems may yield new information and possibly enhance industry safety.

For the purposes of the current study, the training climate consists of psychological bonding elements (based on multiple levels of internalised organisational influence, such as structure, management, leadership, corporate values and company strategic objectives). Katz and Khan (1966) argue that the mechanism of psychological bonding involves linkages between the human psyche and the organisational pattern. It has also been suggested that employees unconsciously seek out patterns within an organisation so as to bring about stability from available environmental information (Drucker, 1946). Such seminal arguments support the conclusion that the climate, in terms of the corporate training environment, has a significant psychological influence (exerted by the external environment), and thus exists within the mind of the beholder.

Because the core purpose of this research was to develop a perception measurement instrument of a particular climate, it was posited that the advanced aircraft training climate should consist of both organisational and psychological dimensions. However, this approach did not address the concern raised by Hellreigel and Slocum (1974:256) that there is confusion over whether the term “climate” refers to the attributes of people or the attributes of organisations. The current study adopts Denison’s (1996) view that it would be difficult to define a climate as referring *only* to people.

3.3.2 Airline training climate

A basic definition of the training climate is “all factors in the person, learning and organisation that influence [the] transfer of knowledge to the job function” (Rouiller & Goldstein, 1993:8). The airline training climate was conceptualised in terms of Rouiller and Goldstein’s definition, and two additional components were also included to create a holistic construct: firstly, a theoretical part (technical knowledge on the aircraft) and, secondly, a practical part (flight simulator and route training).

One of the characteristics that distinguish a training climate from a general business climate is the immense breadth and depth of interpersonal organisational behaviour relationships found in a training climate. The organisational behaviour standard model is entrenched in concepts originating from a broad spectrum of behavioural sciences; in particular, from psychology, at the microscopic or individual (person) level; from sociology, at a group or intermediate level; and from anthropology, at a macroscopic (organisational) level (Robbins *et al*., 2004).

Psychology refers to a scientific investigation into the mind of the individual, whereas the role of sociology in the behavioural sciences is to study people in relation to others (Argyris, 1957; Schein, 2004). An umbrella discipline covering the study of communities in the behavioural sciences is anthropology – "much of our current understanding of organisational culture, organisational environments and differences between national cultures, is the result of the work by anthropologists or those using their methodologies" (Robbins *et al*., 2004:10). Leibold *et al*. (2005) describe the interaction of organisational components at these three distinct levels as a kind of systemic choreography, and have classified this interaction as a business eco-system. Leibold *et al*. (2005) clearly demonstrate how the boundaries between human behaviour and business behaviour are somewhat blurred in theory, which implies that building an appropriate construct to measure human perceptions of organisational systems can be tricky.

Katz and Khan (1966) postulate that what they call *psychological bonding* closely links the mechanism of interaction between the layers of an organisational structure. Thus, it is reasonable to argue that a training climate may be described in terms of a business eco-system (Leibold *et al*., 2005), and can therefore be appropriately measured by a perception scale. The primary objective of the study can therefore be accomplished only by accepting the proposition that that perceptual or psychological bonding in human beings occurs when they interact with an organisational eco-system.

The construct of perceptions of the advanced automated aircraft training climate is then defined in terms of the aforementioned organisational behaviour concepts and of psychological bonding theory. It is relevant to associate the behaviour of employees in an organisation with business-related measures, because the current literature calls for an improvement in organisational behaviour research through the use of quantitative methods (Ellis, 2010). For instance, Tracey and Tews (2005:355) propose "strengthening" organisational research by operationalizing specific constructs, particularly with regard to training and education.

3.3.3 Climate constructs associated with the airline organisation

This part of the literature study critiques the paths taken by various researchers in conceptualising factors associated with a generic training climate construct and its influence on the airline organisation.

Leibold *et al*. (2005:55) argue strongly in favour of adopting systemic thinking when attempting to measure constructs of organisational behaviour because "the emphasis on the parts has been called mechanistic, reductionistic, or atomistic; the emphasis on the whole is termed holistic, organismic, or ecological. In modern science, the holistic perspective has become known as *systemic*, as opposed to systematic". This premise was adopted in building an airline-related climatic construct. The intention was thus to develop a systemic measurement construct.

When trainees have a good understanding of the systemic training environment, and this understanding is coupled with other moderating variables, such as previous experience, they are able to cope more effectively with the cognitive and physical demands of airline training (Davis, Fedor, Parsons & Herold, 2000). The self-efficacy gained in the individual, stemming from this closed loop environment (input-output-feedback), is demonstrated in the positive results of a training outcome (Davis *et al*., 2000).

Some other prominent researchers in the aviation training field argue for pursuing an interconnected solution to the problems of measuring perceptions related to an aviation training environment (Telfer & Moore, 1997). However, many of these models do not use contemporary systemic theory (Leibold *et al*., 2005). The aim was therefore to connect contemporary ideas of a training climate construct with that of aviation related human factors.

Table 8 contrasts some of the more important elements that emerged from seminal research. It is believed that such elements may be closely associated with the development of any new organisational training climates. Table 8 furthermore, shows that there are definite layers to any such climatic system, even where these layers are not explicitly commented on. These layers are interconnected and it is accepted that an interaction occurs which dictates the pattern of the perceived training climate. It should be noted from Table 8 that, terms such as *policies*, *supervisory, perceptions* and *individual characteristics* point to the three organisational behaviour dimensions – the macro, meso and micro levels.

Table 8: Chronological list of training climate elements

Chronological literary source	List of associated elements
Kozlowski and Hultz (1987:85)	1. Supervisory and trainer support. 2. Innovation policies. 3. Training job assignments.
James, Jones and Ashe (1990:110)	1. Individual and psychological attributes. 2. Trainee cognitive representation of practices and procedures. 3. Shared perceptions (trainee and trainer). 4. Situational cues that either inhibit or facilitate learning.
Rouiller and Goldstein (1993:45)	1. Consequences from learning or training. 2. Behavioural cues exhibited by supervisors, peers and subordinates. 3. Factors associated with the person, training and instructor and organisation.
Holton, Bates, Seyler and Carvalho (2000:68)	1. Contents of training programme. 2. Design of training programme. 3. Characteristics of the individual. 4. Motivational constructs of the individual. 5. Features associated with the working environment. 6. Preparation of training. 7. Outcomes of learning.
Tracey and Tews (2005:86)	1. Components of transference of learned knowledge and skills. 2. Components of shared and aggregated knowledge.

Tagiuri and Litwin (1968:32) define an organisational climate as "the relatively enduring quality of the total [organisational] environment that (a) is experienced by the occupants, (b) influences their behaviour, and (c) can be described in terms of the values of a particular set of characteristics (or elements) of the environment". This definition suggests that the training climate should in turn also consist of dimensional layers at an organisational, group and individual level. Therefore, the training climate associated with the advanced aircraft was constructed three-dimensionally (that is at a macro, meso and micro levels of analysis).

Hellreigel and Slocum (1974:256) refer to the organisational climate as "a set of attributes which can be perceived about a particular organization and/or its subsystems, and that may be induced from the way that organization and/or its subsystems deal with their members and environment". Hellreigel and Slocum (1974) therefore suggest that the way an employee *perceives* his or her environment should then be connected with a climatic construct. Similarly, Tracey and Tews (2005:355) describe the organisational climate as "a much broader, multidimensional perceptual variable", and point out, "specific dimensions or factor definitions should be determined by a specific criterion or criteria of interest". Therefore it may be expected that an airline pilot who experiences training to operate an advanced aircraft will develop some perception of the climate when meaning (pattern recognition) is associated with the learning that takes place (Neal, Griffin & Hart, 2000).

The goal of any structured learning process is to implement a range of observable behavioural changes in a trainee over a defined length of time. Cattell *et al.*'s (2002) model elegantly hypothesises a link between psychological factors, education and training. This model (see Figure 11) was adapted for the conception of the present research construct to measure an aviation training situation.

When one considers the complexity of a highly structured environment, combined with the interplay of a range of behavioural factors, it is clear that learning to operate an advanced aircraft can be a demanding task for an average person. Furthermore, the sheer complexity of advanced technology obviously requires an inherently structured learning process occurring over time. Because a vector is a function of time, that is, it maintains a relative position in space, one can argue, using Cattell *et* *al.*'s (2002) model; that an airline pilot's structured learning process for operating advanced aircraft includes measuring the rate of behavioural change produced by learning, mediated by factors such as ability, personality, motivation and personal states (see Figure 11). There is an abundance of similar models of the attributes of education and learning in a climatic context, but Catell *et al.*'s (2002) model was preferred in the current study because of the elements of psychology associated with it.

Figure 11: Mathematical relationship between structured learning and flight deck behaviour

1. $\bar{B} = f\left(A.P.M.S\right)$
2. $\bar{B} = f\left(\text{Time}\right)$

<u>Structured airline training for advanced aircraft</u> =

Rate of change in behaviour (B) as a function of:

Ability (A), Personality (P), Motivation (M), Personal State (S)

Source: Own derivation

Likert (1958) suggests that vector changes in behavioural domains similar to that described in Figure 11 allow behaviour to be measured in terms of interactive organisational elements as a function of time. Figure 11 mathematically depicts the variables associated with the demands of a regimented training programme. It also shows that, in a multidimensional system, core changes at the individual level of analysis are likely to occur.

Recently, airline training organisations have begun to identify and accept the critical role that individual factors can play in determining the outcomes of flight training (Abbott, 2010). They are responding to the conclusions of research that attributes as much as a third of aircraft accidents to enduring personality traits (Abbott, 1995; Helmreich, 1987, 2002; NTSB, 2009). In this regard, it is relevant that Figure 11 as derived from Cattell *et al.* (2002) suggests a behavioural prediction equation in line with the complexities associated with a structured learning model such as that which may be expected in a modern airline organisation. Cattell *et al.* (2002) further demonstrates that a structured learning process takes place across the aforementioned vector changes in terms of particular behavioural domains which have been incorporated within the model devised in Figure 11. Specifically, these personal factors tend to associate with intrapersonal psychological constructs such as:

- ability;
- personality;
- motivation; and
- personal state.

These domains were considered in the initial item pool generation and development of the final measurement construct (see Figure 13), so as to achieve the objectives of the current study.

It appears that individual factors play a fundamental role in airline organisations and that these factors in turn have a significant impact on the production of competent advanced aircraft pilots. The research model under investigation thus assumes that ripples in the training environment originate at an individual level to begin with.

3.3.4 Contextualising the advanced aircraft training climate

Social systems such as an organisation, lack the fixed demarcations commonly found in physical or biological systems, and instead consist of a combination of events that are inseparable from the functioning of the organisation (Katz & Khan, 1966). Thus, Katz and Kahn (1966) argue that organisations and societies behave in complex patterns and that the behaviour of each individual within an organisation is based largely on the requirements of the larger pattern. This implies that the outcome of an aviation training instruction effort is the result of the motivation and strategies adopted by the trainee pilot, the instructor’s value system, ability and knowledge, and by the very nature of the managerial pattern (Telfer & Moore, 1997:2). These elements are listed in Table 9. In addition, Table 9 and Figure 12 depict core elements of the advanced automated aircraft training climate, positioned as a systemic model. The structure of the model is largely based on the proposition that social systems exist within patterns of psychological bonding in terms of Katz and Khan’s (1966) seminal proposal, as discussed earlier.

Table 9: Aviation-related psychological elements of a training climate

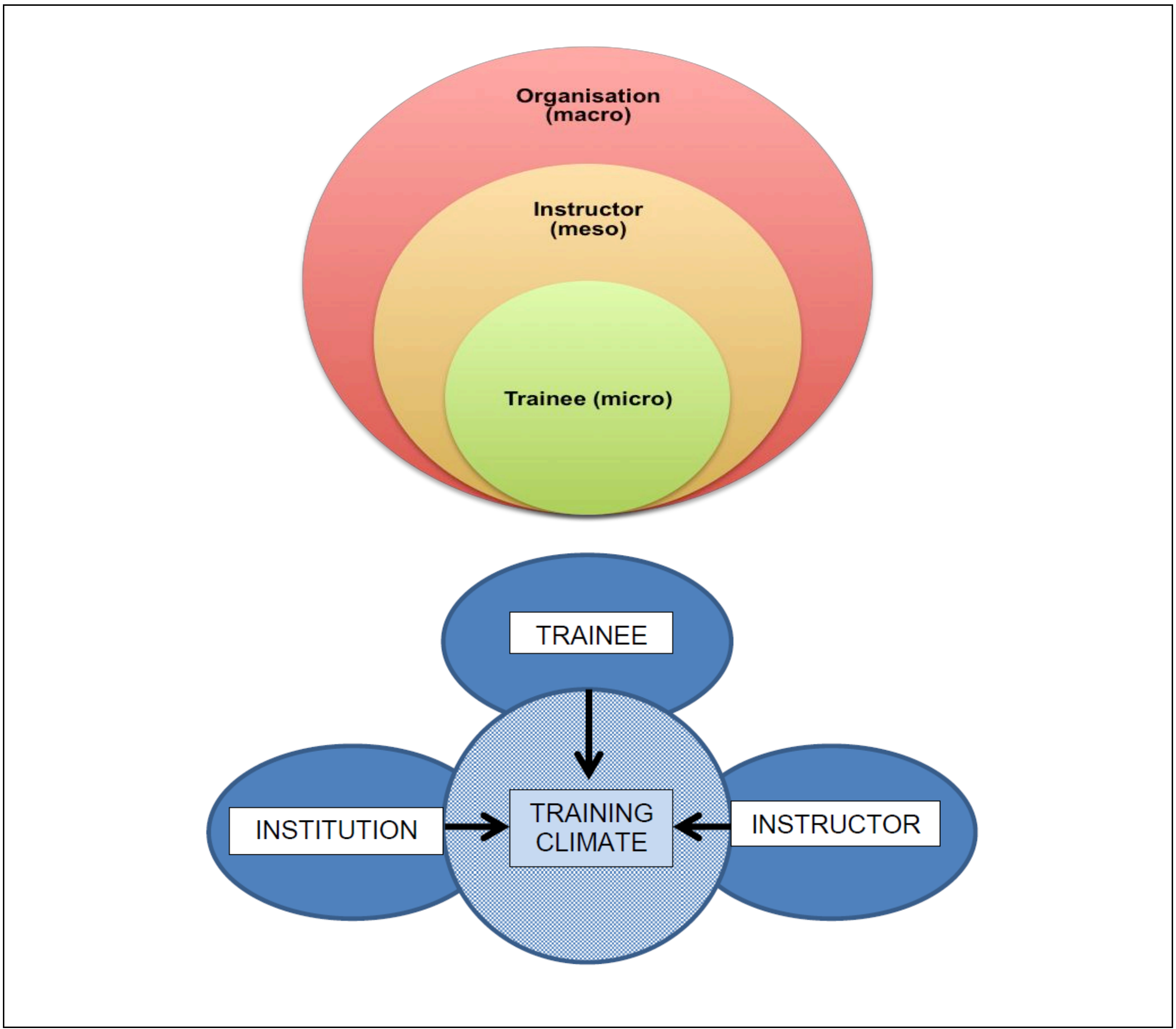
Trainee Pilot (micro sphere)	Perceptions of learning and psychological self (academic, social).
Instructional Group/ Instructor-Trainees (meso sphere)	Perceptions of teaching and interaction with instructor and co-trainee.
Airline Operator (macro sphere)	Perceptions of the organisational training atmosphere, structure, policies, standards and planning.

Source: Adapted from Katz and Khan (1966), Leibold *et al.* (2005), Roff (2005) and Telfer and Moore (1997)

The second diagram in Figure 12 depicts a shaded area envisioned as the airline training climate. In other words, a training climate is shown to be the intersection of three sub-constructs; namely, the institution, the trainee and the instructor or instructional dimension. Face validation of the concept is based on the effect presented in the variable overlap shown. The present research construct was then based on the premise that the *training climate* is an area common to all three independent variables (the trainee, the institution and the instructor). Although Figure 12 clearly shows where the individual instructor is positioned within the main construct, this dimension also refers interchangeably to the instructional domain consisting of the elements associated with an instructor-trainee relationship.

Figure 12 also illustrates and emphasises the importance of congruency between the various organisational levels. Congruency between levels assists the trainee, the instructor and the institution to attain the required degree of flight training success both efficiently and effectively (Tracey & Tews, 2005). According to Telfer and Moore (1997), a lack of congruence between levels will result in dissension amongst the various ranks, in turn weakening the system and contaminating the training climate. By analysing the current systemic situation through a measurement of output perceptions (held by qualified airline pilots), an organisation can attain sufficient knowledge to deal adequately with adverse training variables. Learner frustration and subsequent ineffective training may occur when departments operate in silos – in other words, when there is too little congruence between the goals and objectives in different sections of an organisation (Tracey & Tews, 2005). Moore, Po and Lehrer and Telfer (2001) emphasise the fundamental importance of aligning beliefs across all levels of an organisation, such as the management, teacher and student levels. Figure 12 clearly depicts the alignment and congruence attained within the main research construct. Alignment of independent belief systems is illustrated by the arrows, which emanate from each outer component (the trainee, the institution, and the instructor domain), pointing toward a core or centralised main component (the training climate). The integration of independent belief systems towards an aggregated pattern is summarised in the final hypothesised research construct (see Figure 13). The final measurement construct could only be developed after considering what approaches to learning trainees may adopt.

Figure 12: Representation of a systemic aviation training climate



Source: Adapted from Leibold *et al.* (2005:136), Roff (2005:15) and Telfer and Moore (1997:15)

3.4 APPROACHES TO LEARNING

Confucius (cited in Reynolds, 2001:174) once said: “Learning without thinking is useless; thinking without learning is dangerous.” Rosenow (2003) suggests that the art of thinking involves being mindful of the facts, by mitigating the impact of bias and prejudice with which knowledge is often peppered. An inability to learn is often coupled with an inability to think logically (Aronson, 1991). Most of the reasons generally associated with learning that is hampered are related to personal issues (see also Figure 11). Individual-based problems such as stress, low self-esteem, anger, illness, sleep deprivation, fatigue, laziness, depression and other effects have been cited as significant contributors to dysfunctional learning (Rosenow, 2003:47). This implies that factors originating from an individual or personal level of analysis are an important consideration when one needs to understand how human beings learn in terms of their perception of climate.

Some studies have objectively demonstrated that personality traits play a statistically significant role in influencing each individual’s character and behaviour, and thus the person’s approach to learning (Aronson, 1991; Cattell, 1946; Cattell *et al.*, 2002). From an aviation perspective, some research has shown that approximately one third of aircraft disasters may be directly attributable to individual enduring personality traits (Abbott, 1995; Helmreich, 1987, 2002; NTSB, 2009). Therefore, intuitively, aviation research specifically in terms of training should begin at an individual level. Furthermore Biggs (1987) posits that methods generally adopted by pilots for acquiring specific knowledge and skills to operate aircraft could differ significantly from person to person based on attitude.

Various psychometric scales have been developed and constructed to measure an individual’s capacity for learning, but most of these inventories are based on generic areas of educational research; such as at schooling and tertiary institutions. Adaptations of early education psychology theory, particularly from theory first formulated in the seminal Swedish studies conducted during the 1970s, have led to some of the modern versions of learning inventories and instruments. According to Biggs (1987), Biggs and Moore (1993), Entwistle and McClune (2004) and Ramsden (1992), learners tend to adopt one of two fundamental strategies, namely a surface learning strategy or a deep learning strategy. These broad strategies are characterised as follows:

- *Surface learners*: These students reproduce knowledge through rote memorisation. This phenomenon is further defined as the acceptance of new facts and ideas without much scrutiny (little thinking). Information is acquired at face value and stored in isolation with little or no connectivity. Students who use this strategy may often fail to distinguish principles from examples. A lack of interest in the content and the subject itself and a focus on merely obtaining a qualification characterises surface learners.
- *Deep learners*: These students gain meaning and understanding from knowledge based on a deeper level of acquisition (thinking). By examining additional facts or new ideas critically, deep learners can integrate new knowledge into existing cognitive structures. Focusing on the concepts that are needed to argue through a problem characterises an insightful level of knowledge acquisition.

Lasting individual personality traits, combined with environmental perceptions, can radically influence modern airline pilots' training and learning strategies. Warren (2004) suggests that organisations that encourage a deeper level of understanding should also ensure that subjects apply what was learned effectively. A deep comprehension of concepts is fundamental to integrating early understanding with present application, especially in a technical environment such as engineering, medicine and, in this case, operating advanced automated aircraft (Sherman, 1997; Wilson & Weston, 1989).

The importance of reflective learning is particularly important in an aviation safety context. This requirement was highlighted when airline pilots' training came under intense scrutiny during an air crash investigation (NTSB, 2009) after a Colgan Air Dash-8, Flight 3407, stalled while the airplane was on a final approach, and crashed into a suburb (Pasztor, 2009). The post-accident analysis revealed no mechanical malfunction in the aircraft itself (NTSB, 2009). However, the investigators found that the flight crew lacked a critical and fundamental understanding (trained knowledge) of their aircraft systems. The crew also misunderstood aerodynamic principles and there was substandard crew resource management (CRM), a fatal combination that led to the disaster.

More recently, analysis of the flight data recorders in an Air France Airbus A330 crash in 2009 led the manufacturer to advise pilots about the recommended abnormal and emergency procedures to be followed in case of an unreliable airspeed indication. In other words, Airbus appealed to pilots to reflect on basic aerodynamics and the effects of thrust setting versus actual airplane trajectory, something pilots are generally taught very early in their careers on basic aircraft. “Clearly it pointed to the possibility that mismanaging the plane’s speed had been one step in a cascade of on-board failures, leading to the crash” (Wald, 2009:11). By contrast, high levels of experience, coupled with highly effective training methodologies, averted disaster in a Qantas Airbus A380 incident, which occurred over Western Indonesia (Milmo & Webb, 2010). After severe damage to the aircraft’s number two engine, many fundamental flight systems were cut, resulting in spurious warnings emanating from the computerised monitoring system. The crew of this particular aircraft understood their equipment and the functioning of its related systems very well. Moreover, three of the four crewmembers were instructors for that aircraft type. Through reflective and effective reasoning, the team were able to determine which warnings were authentic, and which warnings were inconsistent with the problem at hand. This level of thinking and reflection enabled the crew to bring the aircraft safely back to the departure airport without any casualties.

The limited availability of academic information in the area of the application of learned theory to effective airline flight operations and supportive flight deck behaviour constitutes a knowledge gap in what is currently understood about the phenomenon. This has made it difficult for the current research to determine what exactly constitutes aviation training antecedents. Lowy (2009) has determined that there may have been some efforts to bridge this knowledge gap by scientifically analysing aircraft accidents and incidents, and also successful outcomes in adverse operational situations. As more data is gathered, it is becoming clear that understanding the role which flight training plays can guide solutions to future effective aircraft operation (Abbott, 1995).

3.4.1 Application of learning in the airline environment

In air crash investigation reports, inadequate transfer of theoretical or learned knowledge (which can only come from a deep conceptual understanding) to practical applications (actually flying an aircraft) is usually castigated as a sign of a lack of pilot *experience* (Pohlman & Fletcher, 1999). Such conclusions appear vague, and fail to pinpoint a root cause. For instance, a review of the most recent aircraft accident statistics reveals that many commuter or smaller airline operator accidents could be attributed to insufficient pilot experience levels (Pasztor, 2009; Patrick, 2002). However, research has also determined that some highly experienced airline pilots flying for large carriers also add to accident statistics. In many cases involving experienced pilots, it appears that insufficient experience in operating complex technology is a major contributor to accidents (Sherman, 1997). By contrast, Howell and Fleishman (1982) earlier pointed out that sufficient training and understanding in complex technology may mitigate or compensate for low levels of experience. Therefore, when examining human factor based aircraft accidents and incidents, a lack of systems understanding rather than actual experience levels should be considered a root cause. Paradoxically, some authorities have found that in an effort to contain costs, many airline operators cut back on some important aspects of pilot training. This has led the FAA in the United States to adopt far stricter oversight policies when it comes to pilot education, flight training and licencing (Moses & Savage, 1989), an example, which is being followed closely by their South African counterpart, the South African Civil Aviation Authority (2011b).

Telfer and Moore (1997) found that pilots exhibit competitive tendencies during training. Biggs's (1999) findings confirm this and suggest that the so-called *achieving* aspect of learning is strong among airline pilots. This construct describes those students who are enthusiastic about doing well in tests and exams (a deep sense of learning) and are competitive. In other words, these candidates are able to apply deep learned theory effectively, and then apply it in a competitive sense, because of their need for achievement. The need to achieve is strongly stimulated by a passion for the profession (Vermeulen, 2009). Thus, the *best pilots* are generally the ones who display a deep-seated passion for their chosen career path.

Moon (2004) contends that the premise that learning takes place in only two distinct dimensions – either in the form of superficial understanding (surface learning) or by truly understanding (deep learning) – may be a somewhat simplistic view of the situation. Moon's (2004) suggestion influenced the construction of the model used in the current research, because Moon demonstrates the existence of *multiple factors* responsible for affecting the approaches adopted by learners. These factors are:

- *Conception* – how a trainee envisions the learning process affects the method or the learning strategy that the trainee adopts.
- *Instructor influence* – teaching and assessment requirements determine the difficulty of the exercise and therefore have an impact on the learning approaches adopted by a trainee.
- *Demands* – a trainee's perception of the level of stress imposed by the process to meet the requirements to succeed influences the trainee's choice of learning approach.
- *Personal factors* – individual aims, goals and outcomes directly influence learning strategies.
- *Experience* – Moon (2004) is of the opinion that a trainee's prior knowledge of a subject, or experience with the subject matter, has an impact on the trainee's decision to adopt certain learning strategies. Familiarity with the current physical and psychological environment plays an equally important role.
- *Self-management* – a trainee's maturity determines the person's emotional orientation in terms of self-management and so has a direct impact on learning.

The proposed domains explicitly categorise the levels of learning strategically (Moon, 2004). It can be inferred that these domains are highly influential in channelling a trainee to adopt one approach rather than another, or in addition to another, for instance, adopting learning strategies with simple surface characteristics, or a strategy that promotes a fundamental and deeper understanding of the subject.

Lawshe's (1975) findings suggest that the psychological domain associated with training is another important factor to consider in understanding what learning strategies a subject may adopt. Higher order psychological variables are involved in learning, such as deductive and inductive reasoning. Moreover, the behavioural nature of the domain in question is characterised by the following factors or attributes (Lawshe, 1975:565):

- directly observable behaviour;
- reportable behaviour; and
- abstract behaviour.

Regulators recognise the various behavioural dimensions of training; for example, it is a subtle factor influencing the requirements for demonstrating competence during tests, evaluation or assessment. According to the Civil Aviation Authority (2011), the civil aviation technical standards (CATs) and the civil aviation regulations (CARs) require that, in order for an applicant to be deemed competent by a flight testing instructor, he or she must have demonstrated both knowledge of aircraft specific technical theory (abstract behaviour) and competent manipulation of the aircraft flight controls (directly observable behaviour). Both components are behaviours that are reportable and can therefore be documented; on the basis of such reports, an appropriate licence can be issued or denied. Lawshe's (1975) model is highly relevant in understanding both the psychological and behavioural aspects of learning.

3.4.2 Literature on airline pilots' learning styles and subsequent organisational impact

McManus, Keeling and Paice (2004) suggest that the ability to complete a job, workplace climate, stress and burnout are very closely linked to an individual's learning style. Personality traits can also play a significant role in the style that a person adopts (Cattell *et al*., 2002). Personality elements are significant in predicting training success (McManus *et al*., 2004). Aspects of personality such as conscientiousness and agreeableness are traits found in those pilots who are more likely to succeed in training (Berliner, 2006). Airline pilot recruitment specialists have capitalised on these theories by looking for specific personality attributes in the individuals whom they eventually hire (Telfer & Moore, 1997).

The early work of Kolb (1976) suggests that some conscious efforts can affect the learning style that a trainee adopts and subsequently have an impact on the success of the outcome of the application of the learned theory. Hence, Kolb's (1976) model presents two orthogonal dimensions (McManus *et al.*, 2004). An orthogonal model is plausible because it combines bipolar dimensions of cognitive growth based on the transformation of experience (from both active behaviour and abstract behaviour). Obtaining a pilot's licence thus requires mastering both orthogonal dimensions (SACAA, 2009). Therefore, the hypothesised measurement construct for the present study was designed by considering orthogonal levels of learning. Items concerning an individual's personal attributes were also considered important for inclusion in the operationalization of the research model.

Because both motivation and personal or individual attributes of all active participants in a training environment (instructors, trainees) play increasingly important antecedent roles in successful or unsuccessful learning styles, broadly structuring learning into a surface or deep process can be problematic in an airline training organisation (Moore *et al.*, 1997). Ashcroft and Foreman-Peck (1994:22) posit that there is a basic challenge in categorising learning styles because "it is easy to induce a surface, reproductive approach by structuring the learning demand, but very difficult to induce a deep approach...it may be possible to promote a deep approach by altering the learning demands for some, but not all students". Deep approaches to learning are promoted and cannot be built into a structure, because this approach stems from an individual level.

Depending on circumstances, in certain instances, a trainee may indeed find the need to adopt a surface learning style, because in aircraft training it may be necessary to memorise specific material (Airbus, 2011b), as some aspects of piloting do require rote memorisation. So, for example, rote memorisation of certain checklists, call-outs and standard operating procedures (SOPs) *verbatim* are an important part of training. This technique may be analogous to the way an actor memorises the lines of a script. For example, a mechanical procedure is required when a landing is aborted. The pilot is required to verbalise and manipulate the aircraft in a precise sequence so as to stabilise the aircraft's trajectory after such a manoeuvre.

Rote memorisation of procedures is limited mainly to aspects of flying that require immediate and deliberate action from the pilot. This is why the basic philosophy of advanced aircraft manufacturers is based on the premise that pilots should have as few memorised action items to deal with as possible. Airbus, for instance, requires a pilot to perform manoeuvres by memory for only seven non-normal operations (Airbus, 2011a) in an automated aircraft, in contrast to the operation of older analogue-type large commercial jets, which required a pilot to memorise almost three times that number of items (Degani *et al*., 1995). This discussion therefore suggests that pilots who are successful in training have the ability both to memorise and to understand topics related to flying.

The difficulty in finding good theory related to airline pilots' learning styles and approaches is similar to the complexity of probing learning in other technical professions, such as the learning styles adopted by medical doctor trainees. These two groups of learners share some similarities: a study conducted by Wilson and Weston (1989) found that the working hours of junior anaesthetic doctors were comparable to those of airline pilots. Both jobs include intense episodes that make high physical and cognitive demands, coupled with significant periods that involve simple monitoring. McManus *et al.* (2004) refined the categorisation of so-called surface learners after analysing medical students undergoing training. Classing the surface learners as either surface-disorganised or surface-rational subcategorised the surface or rote-learning group. A surface-disorganised student is predicted by factors relating to high scores on neuroticism (emotionally unstable) and lower levels of conscientiousness (carelessness or haphazard traits), when described in terms of the Big-5 personality models.

Although a number of contemporary psychological theories describe personality models, the theories are mainly derived from an earlier Big-5 model of personality. According to Cattell (1946) and Costa and McCrae (1992), five significant factors can account for the majority of the variability in all personality types. Generally, these factors with underlying correlated trait variables were labelled as follows (Cattell, 1946; Costa & McCrae, 1992):

- *openness to experiences*, with a trait scale ranging from consistent or cautious at the lower end, to inventive or curious at the upper end;
- *conscientiousness*, with a trait scale ranging from over-easiness or carelessness at the lower end to efficiency and being organised at the upper end;
- *extroversion*, with a trait scale ranging from solitary or reserved at the lower end, to extroverted, outgoing or energetic at the upper end;
- *agreeableness*, with a trait scale ranging from unkind, aloof or cold at the lower end, to compassionate and friendly at the upper end; and
- *neuroticism*, with a trait scale ranging from emotionally unstable, sensitive and nervous at the lower end, to emotionally stable, secure and confident at the upper end of the scale.

The general personality models can be linked to various assumptions of learning. For instance, Rogers and Skinner (1956) propose that learning essentially takes place in three dimensions. Firstly, learning can be observed as a change in behaviour. Similarly, a personality type is manifested in overt behaviour. For example, a person displaying low levels of conscientiousness may appear disorganised and haphazard. It can be assumed that these characteristics are an indication of inherent traits within the individual (Cattell, 1946). Secondly, the environment is an important antecedent of education and thus shapes learning. This implies that the training climate plays a significant role in learned operant behaviourism. Thirdly, the contiguity of events determines the level of conditioning and ultimately the success of the learning. Therefore, personality types that are strong on the conscientiousness scale are more consistent or controlled; and their level of organisation results in stronger bonds being forged, that is, in better conditioning (Costa & McCrae, 1992). In terms of the learning strategies possibly adopted by trainee pilots, surface-rational students are characterised by strategic learning during their early years of study. The early learning experience is generally coupled with far less openness to experiences (a more cautious approach); however, later on, it is linked to higher levels of conscientiousness. During the initial stages of learning, this kind of trainee attempts to gain as much knowledge as possible using minimum cognitive effort, with the aim of passing exams and tests (a surface or rote memorisation method is then usually adopted). After obtaining specific qualifications and reaching a level characterised by stability and less stress, these trainees may then focus on gaining a deeper understanding of their subject. Conscientious trainees are able to link the reward of receiving praise and admiration for their knowledge with many other reinforcements, which can greatly increase the likelihood that the trainee will continue to behave in this manner on subsequent training courses. According to Rogers and Skinner (1956), the operation of a learner's behaviour within the environment is shaped by reward and punishment. In addition, the changes in a trainee's behaviour are measurable in terms of both successes and failures in actual flying and written examinations. In part of a study that analysed new pilots undergoing conversion training at a large airline company, Telfer *et al*. (1996) found that these participants scored above the mean for the *achieving* factor than was the societal norm. Although it was concluded that airline pilots appeared to be very competitive in their chosen learning strategies, they did seem to use a substantial amount of rote (surface) methods during the early stages of their training (Telfer *et al*., 1996), very similar to the medical students mentioned by McManus *et al*. (2004). This appears to be in line with the theory that students strategically use the memorisation of material to pass specific assessment levels during initial training. Regrettably, in analysing aviation learning strategies, Telfer *et al*. (1996) did not go any further in defining or splicing the surface dimension in their particular study, unlike the study on the medical students conducted by McManus *et al*. (2004). Therefore, the results are inconclusive regarding why pilots adopt a surface learning technique. Furthermore, the comparison of the medical students group with the pilot trainee group is hypothetical. No quantitative statistical comparative analysis has been conducted to verify the significance of the hypothesis. Nonetheless, the data provided by the research on the medical students served as a guide in developing the present research construct. Most of the literature on learning approaches favours a dichotomous view and does not offer a formal definition, but rather describes the nature and attributes of learning styles within specific organisational contexts. The role played by the organisation has caught the attention of educational researchers exploring the factors that influence students' learning approaches (Schaap, 2000). In an organisational behaviour context, authors prefer to describe the interaction in the learning environment according to the elements of the macro, meso and micro spheres (Ashcroft & Foreman-Peck, 1994; Berliner, 2006). Table 10 lists some of the elements associated with such levels of analysis.

Table 10: A synthesis of the elements affecting learning at different levels of analysis

	ELEMENT		
Source	Airline Operator (macro sphere)	Instructor-trainee group (meso sphere)	Student (micro sphere)
Ashcroft and Foreman-Peck (1994)	Bureaucratic requirements. The type of assessment systems in place. Nature of the environment, either caring or distanced.	The approachability of the instructor. Teaching style and method. Conact with the trainee. Size of the group being taught.	Style of the student. Personal goals and values. Social expectations. Interest in the subject being taught. Emotional well-being.
Berliner (2006)	Socio-cultural history. Social class. Status of the organisation.	Level of 'parental' education offered. Characteristics of the instructor or teacher. Intelligence of the instructor. Ethnicity of the instructor. Sociability of the instructor. Interactions between instructor and student. Media type used for instruction.	Intellectual ability of the student. Personal values. Motivation to learn the subject being taught.

3.5 MEASURING LEARNING

"The work of education is to make changes in human minds and bodies. To control these changes we need knowledge of the causes which bring them to pass" (Thorndike, 2007:3). Early attempts to describe how human beings approach learning and their eventual methods to acquire the skills to complete complex tasks typically focused on why people selected dichotomous cognitive strategies (Moon, 2004). As already indicted in Section 3.4, according to Ashcroft and Foreman-Peck (1994), early research demonstrated two ways in which adults approached learning, namely *surface learning* and *deep learning*. These two concepts are still often the basis for measurement when researchers attempt to measure perceptions of learning.

The evolution of educational research has produced many inventories to explain and measure how learners acquire knowledge (Biggs, 1987; Moon, 2004; Pololi & Price, 2000), for instance, the Study Process Questionnaire (SPQ) developed by Biggs (1987). These inventories have been adapted by researchers, and in most cases, have been used in the measurement of college and medical students' approaches to learning. The literature reveals that students' and adults perceptions of their learning environments have been diagnosed with the use of several complementary and conflicting inventories over the past decade, from the primary through to the tertiary education levels. However, a review of the available resources also shows that accurately measuring airline pilots' perceptions would require the development of a new inventory.

Both qualitative (Denzin & Lincoln, 2005a, 2005b; Seabrook, 2004) and a multitude of quantitative methodologies (Schaap, 2000) have been used to analyse the educational environment. However, an extensive search of leading academic electronic databases (EBSCOHost, Emerald, Google Scholar, Proquest, ScienceDirect, Informaworld) and various hardcopy library resources suggested that very limited information is available regarding research in the last five years into learning measurements related to the educational environments of trainees in the aviation industry. Furthermore, within the last two decades, very few researchers have attempted to analyse, describe and publish results of an analysis of the learning environments of airline pilots, particularly those operating advanced aircraft (Sherman, 1997; Smith & Dismukes, 2000; Telfer & Moore, 1997). Most adult learning measures reviewed were developed in the medical and tertiary education fields – little attention has been paid to the perceptions of airline pilots operating highly advanced equipment. Nevertheless, the current study relied on models conceptualised from earlier generic learning research results. These were used as a platform for developing a measure to assess airline pilots' perceptions of the training climate associated with their training on advanced aircraft. The domains of previous measures, from other industries, were also part of the framework used to determine what constitutes a learning environment and thus a training climate. Based on this tentative framework, appropriate items were then generated to construct an assessment questionnaire used to assess content validity of the main construct (see Tables 19 to 21). The learning measures consulted for the construction of a working framework, which guided the present study, are summarised in Table 11.

Table 11: A chronological synthesis of some important learning inventories

Source	Instrument used for reference
Rothman (1970)	Medical School Environment Index
Levy (1973)	Learning Environment Questionnaire
Kolb (1976)	Learning Style Inventory
Marshall (1978)	Medical Schools Learning Environment Survey
Myers and Briggs (1979)	Myers-Briggs Type Indicator
Honey and Mumford (1982)	Learning Styles Questionnaire
Biggs (1987)	Study Process Questionnaire
Moore, Lehrer and Telfer (1997)	Pilot Learning Processes Questionnaire
Sherman (1997)	University of Texas Aviation Automation Survey
Entwistle (1998)	Approaches to Study Inventory
Pololi and Price (2000)	Learning Environment Survey
Schaap (2000)	Learning Approaches Questionnaire
Roff (2005)	Dundee Ready Education Environment Measure

Table 11 lists some of the learning, training and educational inventories established during the last three decades. These inventories were appropriately consulted in the development of the present scale. It can be observed that only two of these instruments diagnosed aviation-related educational environments *per se*, namely the Pilot Learning Processes Questionnaire developed by Moore *et al.* (1997) and Sherman's (1997) University of Texas Aviation Automation Survey. Only Sherman's (1997) survey contained an analysis of advanced flight deck automation training. However, Sherman's (1997) study did not address the learning environment or training climate *per se,* leaving many questions unanswered. Moore *et al.*'s (1997) Pilot Learning Processes Questionnaire explored the perceptions of pilots who operated older generation analogue-type aircraft. The study by Moore *et al.* (1997) does, however, provide a systems framework for the analysis of airline pilots' organisational behaviour, aspects of which were used in the framework to develop the theoretical model proposed in the current study. A review of these inventories thus revealed the need for new research. Additionally, combining the ideas from the two aviation-related surveys and the generic learning inventories developed over the last thirty years provided some constructive guidance for the construction of the new measurement tool developed in this study.

3.6 HYPOTHESISING AN EXPLANATORY MODEL OF THE RESEARCH CONSTRUCT

The alignment of beliefs (organisational pattern generation) in an advanced automated aircraft training environment ensures that a well-maintained system is in place to generate competent pilots during transition training (Bent, 1996). The challenge of measuring trainees' perceptions of this system provided the seed for the development of a hypothetical measurement model. By synthesising the information gleaned from the scholarly literature review, a conceptual theoretical model to measure perceptions of the advanced automated aircraft training climate was constructed. Figure 13 depicts the core theoretical model used in the operationalization of the construct and development of the final measurement scale. The goal of this part of the research was to measure the extent to which the theoretical model provides adequate coverage of the investigative objectives and propositions. Based on the mechanisms for psychological bonding (Cattell *et al.,* 2002; Katz & Khan, 1966), the research model was also based on three levels of fundamental analysis:

- the organisation;
- the group; and
- the individual.

Throughout the literature, a so-called open systems concept was a common finding in describing successful aviation training organisations (Andrews & Thurman, 2000). Adopting a systemic approach also allowed the final research construct to use seminal theory as a conduit (in other words, arriving at the unknown from the known). A total of 17 critical measurement domains, encapsulated in three fundamental dimensions, were ultimately hypothesised for the research theoretical construct. These three dimensions are the following:

- Dimension 1: The micro sphere, derived from *psychology* – the measurement domains were
    - Learning for technology (Le);
    - Motivation to train (Mo);
    - Personality (Per);
    - Training Stress (Sts); and
    - Training decision-making (Dm).
- Dimension 2: The meso sphere, derived from *sociology* – the measurement domains were
    - Training group dynamics (Gd);
    - Intergroup training behaviour (InGB);
    - Simulator training teams (Ste);
    - Training conflict (Co);
    - Power (Pr); and
    - Communication (Com).
- Dimension 3: The macro sphere, derived from *anthropology* – the measurement domains were
    - Training culture (Cu);
    - Knowledge Environment (En);
    - Structure (Str);

- Training Policy (TPol);
- Training standards (Std); and
- Training Planning (TPla).

Table 12 shows a list of the various psychological, behavioural and learning theories that were consulted in developing an operationalization method for the model (see Figure 13). The table listing the theories provides only an overview of the vast amount of work done in the field (an in-depth discussion of these theories was beyond the scope of the current thesis and therefore specific references are not mentioned). In addition, the theories that were assessed here are well known as seminal research in psychology as an academic discipline; such as those of Maslow, Vroom and Schein. In addition an in-depth analysis of these theories at a doctoral level would have been superfluous. The conjectural item pool that had received content validation from a panel of experts (discussed in Chapter 4) was originally created by adapting the root theories listed, and also categorising them at three specific levels of analysis (see Table 12). According to Corsini (2002) in Roeckelein (2006:X), "[a] *theory* is a body of interrelated principles and hypotheses that purport to explain or predict a group of phenomena that have been verified largely by facts or data; *hypothesis* is defined as a testable proposition based on theory, stating an expected empirical outcome that results from specific observable conditions".

The present study's hypothetical concepts and constructs were derived from seminal theory. Additionally, the final construction of an integrated hypothesised main research construct (see Figure 13) was based on the relationships that are believed to exist between these seminal theories from an aviation industry perspective. The model forms the foundation of the current research and depicts the main construct of measurement, namely *Perceptions of the Advanced Automated Aircraft Training Climate*. The rationale of the hypothesised research model stems from fundamental principles found in the organisational behavioural sciences (that is, at three systemic levels of analysis).

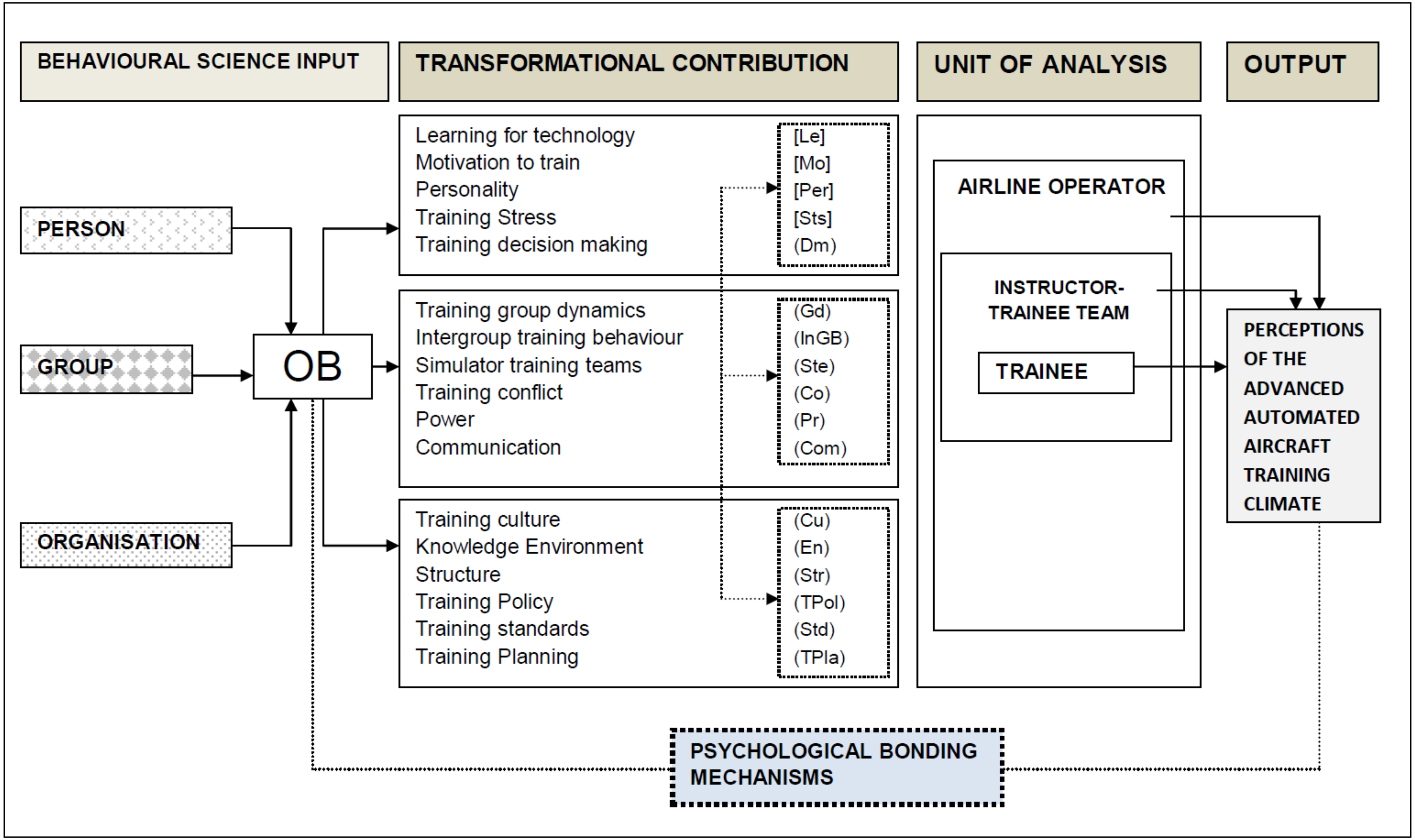
Figure 13 clearly shows that the research construct is multidimensional in nature. According to Cooper and Schindler (2003), multidimensional constructs consist of simpler and more concrete concepts (in this case, 17 such concepts). Such a conceptual model follows from the work supported by Cattell's (1946) theories of mathematical behavioural prediction modelling (also see Figure 11) that show behavioural-learning outcomes or gains, which are modelled from formulae determining the combined effects of intrapersonal psychological variables.

Table 12: Root theories considered in the construction of the theoretical model

Micro sphere	Meso sphere	Macro sphere
Alderfer's (Existence, Relatedness and Growth) ERG theory	McClelland's acquired needs theory	House's path goal theory
Maslow's hierarchy of needs theory	Adam's equity theory	Evan's theory of leadership
Friedman's theory of type A and type B personalities	Vroom's expectancy theory	Schein's theory of culture
Rotter's locus of control theory	Taylor's theory of group dynamics	Deal and Kennedy's organisational behaviour theory of culture
Bandura's social learning theory	West's theory of teams	
Ajzen and Fishbein's theory of reasoned action	Homan's group dynamics theory	
Ajzen's theory of planned behaviour	Brigg and Meyer's group decision making theory	
Roger's and Maslow's humanistic theory	Janis and McCauley's theory of group cohesion	
Cattell's state trait theory		
Allport and Cattell's enduring traits theory		

Source: Adapted from Desler, (2002); Furnham (2008); Roeckelein (2006)

Figure 13: Hypothesised model of the main research construct



Source: Author

3.7 CONCLUSION

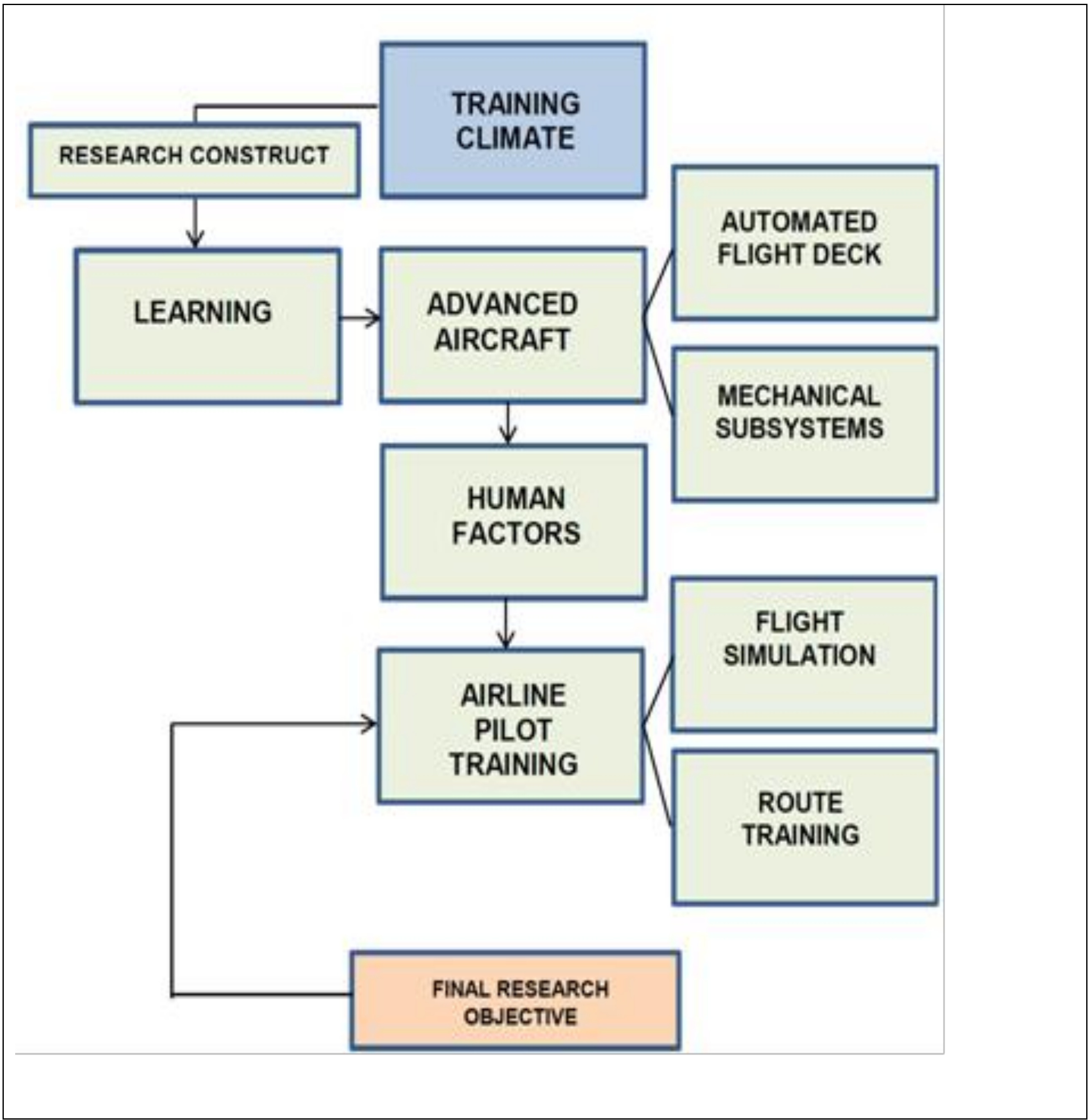
This chapter has focused on education and training, on learning and on the environment in which such learning takes place in an airline training context. The construct of the training climate was discussed, because the training climate played a fundamental role in the design and final construction of the hypothetical measurement model. Theory from the behavioural, social and psychological sciences was examined as antecedents to the current study's objectives. Concepts were borrowed from generic organisational theory to allow for an understanding of learning in an aviation paradigm.

The importance of understanding how learning takes place, and specifically the current and earlier measurement methods adopted by various scholars, were also discussed. This provided a logical build-up to the important literature reviewed in developing the current research's operational model, where the employee refers the pilot at an individual level, while the team refers to the instructor, co-trainee-trainee pilot domain, at a group level; and finally, at an organisational level, the organisation referring to the airline.

Modern airline organisations can only reap the rewards of longer-term safety spin-offs emanating from a clearer understanding of learning with regard to advanced technology aircraft if knowledge of pilots' perceptions regarding the training climate becomes an integral part of their everyday management practices. This will require the adaptation at virtually all levels of the enterprise to accommodate the challenges of the human-advanced-machine learning environment.

Figure 14 presents an integrated summary of the focus of the literature reviewed in Chapters 2 and 3, linking the theory to the design and development of the final hypothetical measurement construct, and leading to the ultimate research objective.

Figure 14: Summary of the focus of the literature review and its integration with the research objective



In the next chapter, the research design and methodology adopted to attain and analyse the relevant data are defended and discussed.