A methodology to categorise candidate helicopter pilots: a flight safety approach

CAA UK

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DECLARATION OF AUTHENTICITY

I declare that the research project, *A methodology to categorise candidate helicopter pilots: a flight safety approach*, is my own work and that each source of information used has been acknowledged by means of a complete reference. This thesis has not been submitted before for any other research project, degree or examination at any university.

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DEDICATION

This thesis is dedicated to my two girls, Milla and Tina for their unconditional love and infinite patience and support.

ABSTRACT

Aviation Safety, as the prime operational and management imperative at the researched company, precipitated this research project and emergent thesis.

The author is the chief executive officer and chief pilot at the company. This responsibility, together with potential culpability, compounded the necessity for this research, and the concomitant development of a model with which the safety culture habits of candidate pilots can be identified and expanded to assess latent pilot vulnerability and to either initiate or terminate further flight training. Chief Pilots are typically employed to manage pilots and aircraft in order to sustain safety, reliability and profitability. However, an interesting dimension developed at the company, and perhaps the rest of the local aviation industry, whereby the management of egos became apparent.

The research problem was defined as the development of a methodology for measuring the accurate and reliable categorisation of the safety culture habits of candidate helicopter pilots. The research domain was limited to the researched company's flight school and involved pilots of varying experience levels.

An observed inherent safety culture problem at the company was detected specifically in the phase of a private pilot's flying career after obtaining a private pilot's licence. Hire-and-fly operations singularly posed the highest incidence of all incidents and accidents at the flight school (Henley Air flight safety office statistics, 2012). This was attributed to the fact that the safety culture habits of candidate or existing helicopter pilot students had never been formally assessed. A methodology was proposed to prove that the safety culture habits of candidate helicopter pilots could reliably be measured in order to optimise *ab initio* flight training. This model would complement and enhance the internationally accepted implementation of a Safety Management System that focuses on preventative/predictive methodologies by employing a continuous process of hazard reporting, risk assessment matrices and subjective collation and analysis of aviation risk factors.

The thesis construct followed a typical systems engineering process of **Conceiving, Designing, Implementing and Operating** the research problem. A comprehensive literature review of existing international research was conducted by Hunter, among others, whose work focuses primarily on military and naval aviators. Pertinent aviation human risk factors relating to candidate civilian helicopter pilots were researched prior to proceeding with both quantitative and qualitative methodologies in specifically designing a questionnaire for a population of 20 helicopter Designated Flight Examiners (DFEs). Significant correlations and effect sizes were identified and utilised to optimise and verify appurtenant questions towards constructing a further IAQ. Shadowmatch™ software was introduced in parallel with 33 Instructor Assessments and further statistical analysis ensued.

Little correlation emerged from the comparative data, however, significant effect sizes were revealed with high internal consistency. Validation was achieved through a two-pronged approach into four case studies pertaining to major helicopter accidents at the company. Strong correlations were identified for Critical Match habits, namely *resilience, confidence and change management*.

Findings, recommendations and conclusions of the research were recorded in the final chapter. Notable recommendations were postulated for the active pursuit of Continuous Private Pilot Development, developing and expanding on the existing Shadowmatch™ Personal Development Programmes to fully incorporate a genuine aviation context, and pursuing the role of the Civil Aviation Authority to reinforce its oversight mandate of acting as gatekeeper for all flight training activities and flight safety matters.

The original contribution to the body of knowledge is founded in the commercial application of this categorisation model. The latent potential for expansion into other spheres of the aviation industry as a financially viable model was identified and ratified by the developers of the Shadowmatch™ software package. This categorisation model is unique in its construct and simplicity of implementation at flight schools.

Identified limitations of the research include the small sample size and range restriction of the pilot population, military versus civilian aviation pilot characteristics and the propensity to instability and change-over-time in the helicopter industry.

It is expressly noted that the author is not a psychologist or behavioural scientist. All testing was conducted under the supervision of and in consultation with a registered aviation psychologist. No persons were coerced or paid to participate in any testing carried out during this research project. All testing was conducted on a voluntary basis and no details of any participants were presented to any authority or third party.

"*Aviation is essentially not about flying; it is fundamentally about landing.*"

J.J.L Coetzee (1998)

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AHP	Analytical Hierarchy Process
ATPL	Airline Transport Pilot Licence
AAI	Aviation Authenticity Inventory
BARS	Basic Aviation Risk Standard
BBN	Bayesian Belief Network
CAA	Civil Aviation Authority
CPL	Commercial Pilot Licence
DFE	Designated Flight Examiner
D-K	Dunning-Kruger effect
ERA	Ego Related Accident
FTSSA	Flight Test Society of South Africa
IA	Instructor Assessment
IATA	International Association of Travel Agents
ICAO	International Civil Aviation Organisation
LOC	Locus of Control
OPC	Operator Proficiency Check
PPL	Private Pilot Licence
RCA	Root Cause Analysis
SA	Situational Awareness
SAAF	South African Air Force
SART	Situational Awareness Rating Technique
SOP	Standard Operating Procedure
TA	Transactional Analysis

CHAPTER 1: INTRODUCTORY PERSPECTIVES AND PREAMBLE

1.1 INTRODUCTION AND BUSINESS VALUE PROPOSITION

This thesis was initiated by the author's desire to improve the flight safety and business processes of the researched helicopter company in its mission of providing world-class training for helicopter pilots. One of the crucial elements lacking in the company's training process was the inability to assess the innate aptitude and attitude of candidate pilots accurately in terms of flight safety, as constituted by their **safety culture habits** and related to individuals' strength of character (Peterson & Seligman, 2004).

The research objective of this thesis was aimed at conceiving, designing, testing and implementing such an assessment protocol for ultimate implementation into the wider aviation industry. This chapter describes the problem relating to the creation of a reliable methodology to identify the safety culture habits of candidate helicopter pilots.

The direct benefit of this body of research would reside in the scientifically quantifiable methodology to categorise any new candidate helicopter pilot under voluntary circumstances (Hunter, 2010). A successful assessment and categorisation methodology would enhance the safety standing of the helicopter industry, expand the existing safety culture and safety climate, encourage helicopter owners to entrust their aircraft into the care of helicopter operators, and would ultimately lead to reduced insurance premiums. This initiative is deemed proactive and congruent with internationally employed aviation Safety Management Systems (Stols, 2010).

1.2 RESEARCH BACKGROUND

“Flight Safety” has long been pursued as a non-negotiable virtue of the aviation industry. Sadly, this credo has been far from implemented ideally within the South African helicopter industry. The real effect has been evident in the number of (reported) helicopter incidents and accidents from 2005 to 2010 (Clark & Frankel, 2006).

The improvement of safety statistics and the prevention of accidents arising from material or component failure have evolved into a far more mature process than has ever been evident over the past 65 years. However, the ability to identify and correct specific safety related attitudes and aptitudes “in helicopter pilots are still in its infancy” (Fox, 2005:1).

A noted trend in helicopter safety statistics in South Africa (Williams, 2010), the UK (CAP 763, 2005) and the USA (NTSB, 2005) – as published by the respective Civil Aviation Authorities – confirms that more than 70% of all helicopter accidents could be directly attributed to human error. The inherent complexity (Padfield, 1996) of helicopter flight is regarded as a major negative driver, along with pilot behavioural factors. These behaviours could be due to wilful pilot misconduct (ego driven and flagrant disregard for regulations and standard operating procedures (SOPs)) or inadvertent considerations (inexperience, inherent lack of requisite flying skills and inadequate aviation knowledge) (Zuckerman, 2006).

Existing flight training processes make provision for adequate flying skills training under controlled operating conditions. However, the accurate and reliable measurement of flight safety culture habits remains a challenge. This is fundamental to the construct of the research problem (Fick, 2012).

A niche exists in the South African helicopter industry to create, develop and implement a scientifically devised business process to assist in categorising potential behavioural habits that will contribute to elevate the safety standards of helicopter pilots and also to generate consequential future commercial benefits. Such potential commercial benefits would firstly entail a reduction in helicopter insurance costs, secondly provide an attractive and unique training environment at the researched company to prospective students, and thirdly ensure the continued patronage of helicopter owners, as well as limit the damage and loss to equipment.

The original contextualisation of the research problem is founded on operational experience, experiential evidence and auto-ethnographic tales (Sparkes, 2000). The extent of the research problem is based on a relevant operating environment and a suitable research domain (control volume) for defining the typical safety culture habits of a South African candidate helicopter pilot. Similarly, the auto-authenticity and auto-ethnographic status of the researcher is disclosed for purposes of authentication and research relevance and assimilated through recorded auto-ethnographic tales (Dyson, 2007).

The control volume for the purpose of researching the subject matter was confined to the helicopter pilot training industry in South Africa, and based on the helicopter charter operation and flight school at Rand Airport. In order to authenticate the research domain the following information is pertinent and is depicted in Figure 1.1.

Figure 1.1: Helicopter hangar, Rand Airport

Figure 1.1 shows a snapshot of the researched company's hangar at Rand Airport. The company was founded in 1995 and has expanded into one of the largest helicopter operations in Southern Africa. A fleet of 30 helicopters is partly owned, leased and managed in both the charter division and flight training school. The operation completes 7,200–7,500 hours per annum and typically employs on average 40 commercial pilots.

The company's client base includes most of the major mining houses in South Africa. The operation is audited annually against international best practise flight safety standards by, amongst others, Anglo American, BHP Billiton and Impala Platinum. It furthermore implements a successful Safety Management System (Stols, 2010).

A marked change in student profiles has been noticed since the inception of the company in 1995. The current spectrum shows that only 30% of all students pursue recreational flight training and hire-and-fly operations, whereas 70% intend becoming commercial pilots (Henley Air safety office statistics, 2012). The above ratio was historically exactly opposite to the present division. Due to the high cost of flight training, most recreational pilots are wealthy individuals, champions of industry and successful entrepreneurs.

The company was founded at the time of great transition and transformation in South Africa. A drastic change in the local helicopter industry was underway, as the Angolan/Namibian War had officially ended and the South African Air Force (SAAF) had literally diminished to an Air Wing with limited operational capability. Most conscripted pilots departed from the SAAF in pursuit of a more sustainable civilian flying career (Barker, 2012).

Although the theatre of research is centered around the researched company alone, the general aviation industry at large would also stand to benefit from the research findings.

1.3 KEY CONSTRUCTS

The key constructs observed and considered during the research process included the accurate measurement of flight safety culture habits (Peterson & Seligman, 2004). Habits were identified during both the quantitative and qualitative phases of the research by developing an accurate and scientifically founded method of identifying, and categorising and classifying all prospective helicopter pilots based on the manifested safety culture habits (Camic, Rhodes & Yardley, 2003).

As with any business model, the entire process must be able to sustain operations through continued profitability. Figure 1.2 shows additional key constructs for the successful operation of an aviation company. Safety is regarded as a paramount consideration in the aviation industry and is pivotal in establishing a reliable air service (Barker, 2102a). However, these considerations are futile if they are regarded in an isolated manner and without a suitable profitability component.

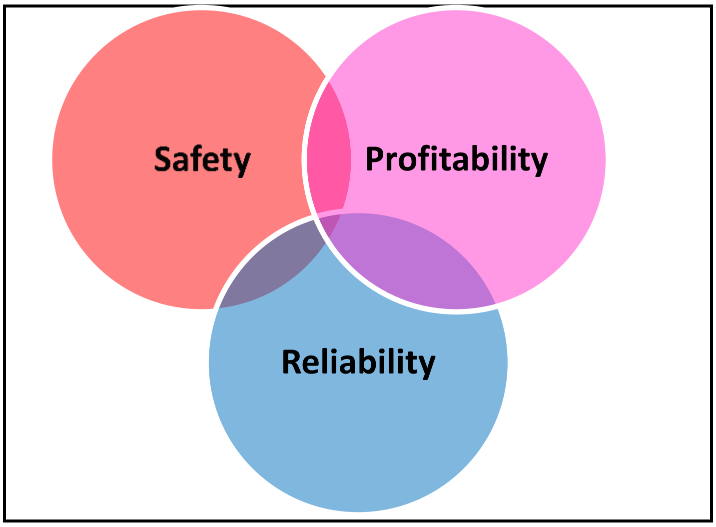

Figure 1.2: Considerations for a categorisation model

Figure 1.2 introduces three considerations pertinent to the successful implementation of this categorisation methodology as it strives to offer students and clients a **Safe** and **Reliable** helicopter service, but also to ensure a **Profitable** outcome for the operating company.

The model for incorporating the key research constructs was based on an integrative process of the philosophy of the Da Vinci Institute in terms of the management of Technology, Innovation, People and Systems (TIPS, 2013). By assimilating the respective TIPS concepts, the researcher endeavoured to convey an innovative methodology of assessing candidate pilots (People) by incorporating computer software (Technology) and using Systems Thinking concepts and pursuing a "how it should be" state within the ambit of aviation safety culture (Marcus, 2007).

1.4 RESEARCH PROBLEM

Figure 1.3 describes the Systems approach to the research model which combines two parallel processes, namely the formal Private Pilot Licence (PPL) training process in conjunction with the Pilot Categorisation process of pilot pre-assessment and identification of safety culture habits. The research project focused mainly on the data-collation and categorisation phase of the business process, but also continued to clearly define the phases that followed until the PPL is ultimately issued.

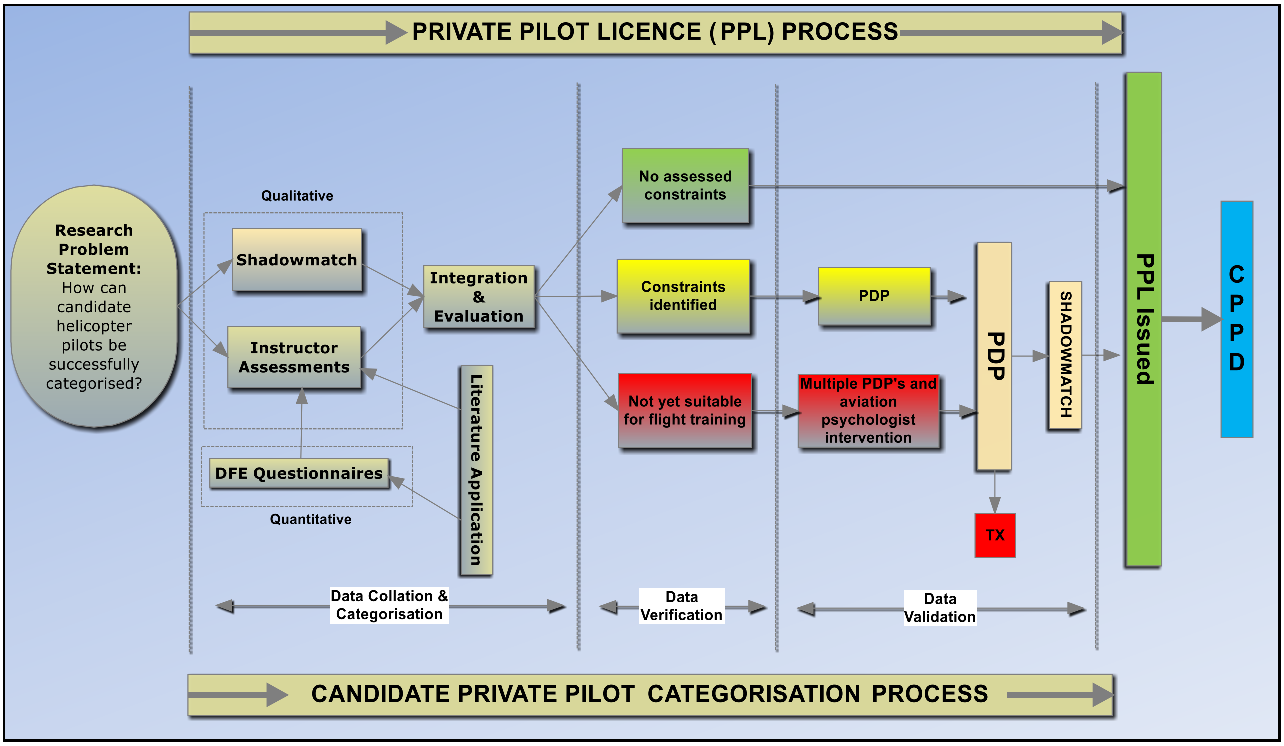

Figure 1.3: Candidate private pilot categorisation process

From Figure 1.3 it is evident that the successful categorisation of the safety culture habits of candidate helicopter pilots firstly requires a needs analysis and the evaluation of probable factors pertaining to the categorisation methodology (quantitative method) (Aliaga & Gunderson, 2000).

Historically, the assessment of private pilots was essentially based on subjective observations by instructor pilot aspects alone and seldom included the physical helicopter handling abilities/skills of candidate pilots (Hunter, 1994), simply because of the high cost of with individual flight tests, specifically in the general aviation domain. Therefore the researcher had to give objective attention to the evaluation criteria such as aviation judgement, general aptitude, attitude and demeanour.

In addition to the noted factors, human behavioural factors which are regarded as conducive to the research problem were also considered (qualitative methods) (Camic *et al.,* 2003; Maxwell, 2005; Merriam, 1998; Macbeth, 2001). Such factors include human behavioural sciences, somatic conditions, normative construct, ergonomics, competency, regulatory compliance, complexity of equipment and ancillary functions such as helicopter handling skill, cognitive workload capacity and arousal. Research conducted by Hunter (2002) highlighted the importance of focusing on a pilot's disposition towards an internal versus an external locus of control at the time of being evaluated as candidate military pilots.

The pursuit of aviator safety excellence and establishment of unique aviation safety culture habits were heralded as an ameliorable industry norm rather than an exception, and more so for helicopter pilot candidates at the researched helicopter company. From the above the formal Research Problem was formulated as follows:

The proposed research methodology to identify and categorise the safety culture habits of candidate helicopter pilots would provide reliable and useful results.

The author's experience and exposure to the South African helicopter industry pre-empted the formal Research Problem. A noted trend was frequently observed at the time when candidate helicopter pilots enrolled at the researched company and a common denominating factor documented a lack of a suitable scientific method to identify, measure and categorise safety culture habits consistent with the company's safety culture and safety climate. Further research and substantiating literature was required to fulfil the requirement of addressing the Research Problem.

1.5 RESEARCH DESIGN METHODOLOGY

In designing a suitable research methodology various research philosophies were considered for the effective collaboration of quantitative and qualitative methods. Varied opinions exist on the academic "correctness" of combining methods. Mouton (2001) opines that the preferred methodology is dictated by the spirit of the research.

Ontology is the philosophy relating to the study of the nature of being, existence or reality (Merriam-Webster, 2013). It also explores the relation of the noted categories and their respective positions in a hierarchy in accordance with distinctive similarities and differences. The interprevistic approach followed in this ontological tradition allows for multiple realities constructed by individuals (Carr & Kemmis, 1986).

Essential ontological dichotomies include among others abstract and concrete objects, essence and existence and substance and accident factors. Ontology is interwoven with Occam's Razor (see Chapter 2). In the instance of this thesis, ontology infers a proactive approach to identifying and categorising the safety culture habits of candidate helicopter pilots within the complex aviation industry (You-yuan, 2011).

Phenomenology relates to the study of structures of consciousness as experienced from the first-person point of view (Stanford, 2008). It focuses on the intentionality as an experience of or about something, and figures prominently in the philosophy of mind. Phenomenology is therefore regarded as the study of phenomena, the appearance of things, or things as they appear in our experience, or the ways in which we experience things.

Phenomenology explores the structure of various types of experiences ranging from perception, thought, memory, imagination, emotion, desire, embodied action and social activity (Stanford, 2008). The author's personal experience embraces the philosophy of phenomenology within the South African helicopter industry and seeks to discover phenomena associated with helicopter pilot egos, aptitude and attitude. The incorporation and integration of human construct within the continued aviation research methodology is considered a valid component by Ferrof, Mavin, Bates and Murray (2012).

Epistemology is the study of knowledge and justified belief. Epistemology entails issues relating to the creation and dissemination of knowledge, in particular areas of inquiry (Stanford, 2005). The interprevistic epistemological knowledge consideration for this thesis was gained through understanding the meaning of the process/experience (Carr & Kemmis, 1986).

The justified beliefs held within the realm of helicopter training include flight discipline, continuous demands for superior performance, diligence towards compliance and conformance with operating procedures, and personal conduct beyond reproach. Rushby (2013:1) argues that "a safety case must resolve concerns of two different kinds: how complete and accurate is our knowledge about aspects of the system" and is congruent with epistemological beliefs due to the "requirement of human experience and insight". Bryman (1984:1) debates the matter of whether it is in fact possible to "establish a clear symmetry between epistemological positions and associated research techniques".

All people, cultures, ethnic groups, organisations and even communities operate in accordance with differing beliefs and expectations (Huss, 2008). Similarly, new pilots will be expected to conform to the belief system espoused by the management, instructor pilots and peers at the company, or any other flight school.

The philosophy of epistemology addresses various kinds of knowledge. Differentiation between traditional versus non-traditional knowledge (TK vs. NTK) is appropriate for discussion, as it assumes certain propositions, and is a formal statement or assertion referring to such a knowledge base (Stanford, 2005). By definition, the aviation industry is inclined to embrace the notion of continuous knowledge expansion, proficiency training and a proactive approach (Coetzee, 2008). This notion can only be achieved successfully through a clearly defined statement of compliance within the aviation organisation such as manuals of procedure, training syllabi and standard operating procedures (Henley Air Safety Management System, 2012).

Absolute compliance will provide for a developmental framework within which the requisite pilot safety culture habits, knowledge and beliefs can be engendered. This is required for safe flight operations (Barker, 2012b).

1.5.1 Mixed methods research

The thesis incorporated a mixed methods typology by combining quantitative and qualitative research methods. Creswell, Plano Clark, Gutmann and Hanson (2003:3) describe mixed methods as “the collection or analysis of both quantitative and/or qualitative data in a single study in which the data are collected concurrently or sequentially, are given a priority and involve the integration of the data at various stages”.

Johnson and Onwuegbuzie (2007:1) recognise mixed methods as “the third major approach or research paradigm” along with the classical quantitative and qualitative methods. Denzin and Lincoln (2005) denote mixed methods designs as direct descendants of classical experimentalism. Quantitative methods are still regarded as top in the hierarchical consideration of research methods and qualitative methods are reduced to a mere ancillary role (Denzin & Lincoln, 2005).

The research design was extended by employing a convergent parallel mixed method whereby the researcher aims to:

- Collect quantitative and qualitative data concurrently
- Analyse the two data sets separately

- Mix the two databases by merging the results during interpretation or analysis (Nova, 2013).

The convergent parallel mixed method aimed to produce a more complete understanding of the two databases, corroborate the results from the quantitative and qualitative databases, and allow a justified comparison of multiple levels within the research system (Nova, 2013). Figure 1.4 depicts the design flow of the convergent parallel mixed method.

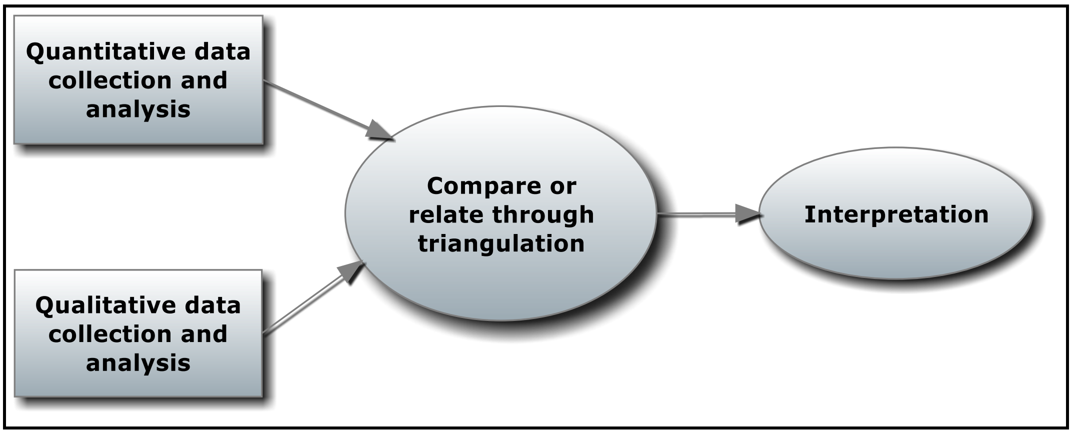

Figure 1.4: Convergent parallel design method (Source: Nova, 2013)

From Figure 1.4 it can be deduced that a parallelised approach to the research methodology of combining quantitative and qualitative methods as well as by comparing and relating the collated data through triangulation (Jick, 1979), provided sufficient construct substance for successful data interpretation. Typical challenges encountered with such a study include the requirement for substantial effort and expertise, correctly and accurately defining the sample sizes, difficulties in converging the two data sets, and the ability to resolve discrepant results. This method does however allow the effective incorporation of intuition; it is an efficient way of combining research methods and makes provision for teamwork (Nova, 2013; Creswell *et al*., 2003).

Figure 1.5 over page depicts the analysis and synthesis of the convergent parallel mixed method research process, as aligned with the process of categorising the PPL and safety culture habits of candidate helicopter pilots.

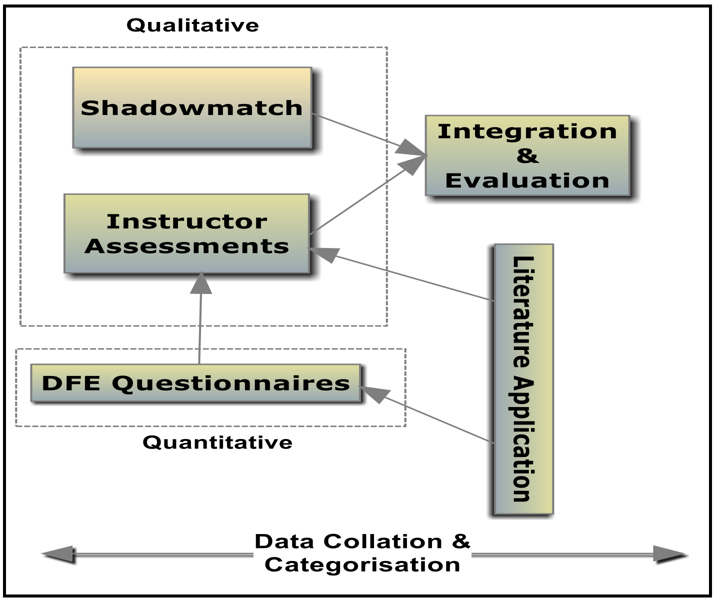

Figure 1.5: Mixed methods research process

It is evident from Figure 1.5 that the convergent parallel mixed method research process provided the researcher with a suitable methodology of incorporating both quantitative and qualitative methods. The ensuing paragraphs describe and expand on the definition, implementation and integration of the two methods, along with the application of suitable literature.

1.5.2 Sampling and analysis

Sampling was firstly obtained and restricted (n = 20) by constructing a questionnaire for completion by DFEs[1]. The guidance material for the questionnaire was collated from a comprehensive research literature application (Chapter 2) which focused and encapsulated the human and helicopter handling factors relevant to this thesis. The results of the DFE questionnaire were interpreted and tested for statistical significance. Questions that revealed suitable effect sizes were employed for the second questionnaire in assessing candidate helicopter pilots and were adopted as the IAQ. The DFE questionnaire served as initial verification of the research data (see Annexure A).

[1] Designated Flight Examiners are civilian instructor pilots appointed annually by the South African Civil Aviation Authority. DFEs are authorised to conduct flight skills tests on behalf of the CAA and are considered as the top flight instructors within the industry. Appointment is subject to rigorous compliance requirements stipulated by the CARs.

The IAQ is a derivative of the DFE questionnaire. The IAQ was used to assess new candidate pilots through further sampling (n = 33) and provided the basis for qualitative research. Flight instructors rated candidate pilots on a 5-point Likert scale. The scores were collated and a statistical interpretation provided as a confirmatory qualitative iteration (see Annexure F). Shadowmatch™ software was integrated into the categorisation methodology as a further qualitative component of the mixed methods research model and further sampling methods were followed (n = 106).

Both qualitative and quantitative approaches were integrated and implemented to establish industry related benchmarks and to ensure a scientific underpinning of the captured data (Bryman, 1984). Both approaches relied on critical literature reviews and the application of literature (Maxwell, 2005) by assimilating the identified factors relevant to this thesis. These factors are defined within the original control volume and depicted by Table 1.1:

Table 1.1: Description of research steps and methodology

METHODOLOGY	PURPOSE	DATA GATHERING	DATA ANALYSIS
Quantitative	To establish and obtain field expert benchmark data	DFE questionnaire	Questionnaire development NWU Statistical Consultation Service (STATISTICA software)
Qualitative	To provide context for research	Case studies	Phenomenology
	To provide context for research	Auto-ethnographic tales	Content analysis
	To identify pertinent Safety Culture Habits (SCH)	Shadowmatch™	Literature application Content analysis
	To explore identified SCH	Self-assessment/360° evaluation	Content analysis Internal audits
	To interpret further assessment statistics	Instructor Assessment/Peer review	Descriptive statistics
	To understand expert observations, experience and analysis	In-depth interviews with field experts	Delphi method
	To assimilate aviation industry values and expectations	Interviews with flight instructors	Focus groups

Table 1.1 presents a concise overview of the research steps utilised during the mixed methods process. A brief overview discussion of the various aspects follows in the paragraphs below and a full content analysis and discussion is presented in Chapter 3.

1.5.3 Quantitative research methodology

Quantitative research is described as an explanation of phenomena by collecting numerical data that is analysed using mathematically based methods and statistics in particular (Aliaga & Gunderson, 2000).

As per Table 1.1 and after a suitable **sampling** population was established, the **data-gathering process** in satisfying the quantitative phenomenon entailed applying the DFE questionnaire to Grade I helicopter instructor pilots (n = 20) with (ideally) at least 10,000 flying hours in order to establish a convincing and authoritative industry benchmark. The questionnaire was developed in consultation, and with the assistance of an aviation psychologist (Coetzee, 2008). As part of the quantitative research process, the draft questionnaire was submitted to the following persons and received feedback on specific topics and questions relating to the question bank. The Delphi technique was adopted in order to achieve a workable consensus within the time constraints of the research process (Stuter, 2013):

(a)	Prof Johann Coetzee	Industrial- and aviation psychologist
(b)	Dr Johan Engelbrecht	Psychologist
(c)	Dr Joel Hughes	Behaviourist and root cause analyst
(d)	Dr Arvid Huss	Behaviourist
(e)	Dr Nicholas Cooke	Helicopter DFE and risk culture specialist
(f)	Mrs Suzelle du Plessis	Registered industrial psychologist
(g)	Professor Johan Fick	Dean of Engineering Faculty –NWU

A further in-depth discussion with Professor P. Stoker (NWU) addressed specific approaches of the proposed research methodology and the intent of each question, in order to reduce any perceived anomalies or ambiguity when answering the questionnaire, and to ensure the correct interpretation of each question.

Data analysis was conducted by an external academic entity through empirical interpretation and statistical reliability computations (NWU Statistical Consultation Service, 2011; Ellis, 2011). The qualitative data was analysed through **content analysis**. Descriptive statistics was used to describe trends in the data. The results are published in Annexure C and D.

Data quality was established through triangulation (Bulsara, n.d.), verification and validation (RDQA, 2008) and is documented in Chapter 5. For the quantitative data, validity and reliability (Creswell, 2009) were determined. For the qualitative data authenticity, relevance, modifiability and fit were used. Further quality assurance techniques involved analysis against case study data (qualitative method) (EPA QA/G-9R, 2006) and comparing the respective dataset values (Chapter 5).

1.5.3.1 Research hypothesis

The fundamental research hypothesis was identified as:

H_1: If the safety culture habits of helicopter pilots could be measured reliably, the training process for candidate pilots could be optimised.

The null hypothesis could hence be justified as:

H_0: If the safety culture habits of helicopter pilots could not be measured reliably, the training process for candidate pilots could not be optimised.

The definition, identification, assessment and categorisation of safety culture habits proved to be fundamental in establishing a benchmark for further relevant research questions (DFE questionnaire) and in defining the research aims for the thesis.

1.5.3.2 Aim of the research

The primary aim of the thesis was to determine the habits associated with defining, implementing and sustaining a safety culture within the helicopter flight training environment. This new body of research furthermore aimed to affect a long-term positive result in reducing the incidence of flight incidents and accidents. A further aim was to provide a significant commercial value proposition by providing prospective and existing helicopter pilots, owners and operators with a scientifically founded categorisation model to identify and accurately measure the safety culture habits of candidate helicopter pilots before they commence with formal flight training lessons.

The reality in observing and measuring the envisaged positive result contained within this body of new research resides in the notion that the exact timeframe is undefinable. The net effect will ultimately be witnessed in a reduction in aircraft insurance costs, an increase in aviation industry stature and credibility of flight schools that have adopted this methodology and an agreeable method of evaluating prospective candidate pilots.

1.5.4 Qualitative research methodology

Qualitative research implies an emphasis on the "qualities of entities and on processes and meanings that are not experimentally examined" (Denzin & Lincoln, 2005:10). The research of Johnson and Onwuegbuzie (2004) positioned mixed methods as a paradigm shift towards offering pragmatism as "an attractive philosophical partner". The focus of the qualitative methodology was therefore to gather suitable data once sampling had been achieved within the control volume of the research domain, and further to pursue the notion of accurately measuring the effect of safety culture habits on flight safety aspects at the researched company.

Merriam (1998) describes suitable qualitative data-collection techniques by addressing issues of validity, reliability and ethics as key constructs. Furthermore, qualitative research does not require well-defined variables or causal models (Denzin & Lincoln, 2005), but data should conform to considerations such as: (i) validity; (ii) reliability; (iii) data fit; (iv) transferability; (v) authenticity; (vi) modifiability; and (vii) quality assurance (Camic *et al.,* 2003; Maxwell, 2005; Merriam, 1998; Macbeth, 2001).

The identified and preferred qualitative research approaches used in this thesis are from Shadowmatch™, but are not limited to the following collation techniques.

1.5.4.1 Case studies

The researcher also employed a phenomenological research philosophy (Merriam, 1998) which was based on recollections of actual events pursuant to the initiation of the original thesis construct. The use of case thesis data was congruent with the qualitative methods harnessed in collating in-depth interview data (Yin, 1998). Case studies encountered at the researched company intrinsically corresponded to incidents relating to pilot ego incidents. This phenomenon typically manifested post obtaining a PPL or higher licence, and normally entailed issues of helicopter ownership as well.

The primary focus of the case studies undertaken centered around the analysis of four helicopter accidents at the company. All accidents occurred during routine flight missions and involved flight instructors (Yin, 2002).

1.5.4.2 Auto-ethnographic tales

Neither ethnography nor auto-ethnography philosophies were employed during the thesis, as the primary focus concentrated on a mixed methods approach. The relevance of auto-ethnographic tales (Sparkes, 2002) is significant in the context of the researched helicopter flight school. Auto-ethnographic tales are also presented "to re-inscribe the everyday world of practice into public accounts" (Denshire, 2009:2).

Through content analysis techniques described by Colorado State University Press (2013), the pertinent steps considered in compiling authentic auto-ethnographic tales include: (i) introduction to content analysis; (ii) conceptual analysis; (iii) relational analysis; (iv) commentary; and (v) examples. Notable examples of auto-ethnographic tales from exposure to (predominantly) newly qualified private pilots and helicopter owners were recorded in Chapter 3.

1.5.4.3 Shadowmatch™

The introduction of Shadowmatch™ provided a platform to define and evaluate the 18 habits associated with the software construct. The inter-relationship between Shadowmatch™ habits and pilot safety culture habits were identified and expanded upon through the application of the literature contained in Chapter 2.

1.5.4.4 Instructor assessment, interviews and 360° feedback

Instructor interviews were conducted to assure familiarity with the assessment model. Additional considerations for exposing ten instructors to the primary qualitative evaluation process were to ensure credibility, validity, transferability (between instructor and student) and authenticity of the assessment format (Fleenor & Prince, 1997).

A further qualitative iteration culminated in the use of instructor focus groups for inter-active discussions and by employing descriptive statistics to record the relevant research findings.

1.5.4.5 In-depth interviews with field experts

In-depth interviews with aviation experts among others in the field of human factors using the Delphi-technique (Stuter, 2013) assisted in further validating the qualitative sub-methodologies. Experts were engaged on an individual basis and were verbally requested to assess draft questionnaires for critique and expansion (Coetzee, 2013). Since not all experts were present during individual interviews, workable consensus could be reached quickly and controversial issues addressed and resolved in real time. A synopsis of the interviews is found in section 5.4

1.5.5 Qualitative proposition

The successful identification, assessment and categorisation of the safety culture habits of candidate helicopter pilots presented the challenge to conduct pre-emptive intervention in order to ameliorate desired flight safety culture habits at the time of first contact with new pilots.

Based on the contextual extent of the qualitative research domain wherein the study was conducted – specifically focusing on the safety culture habits of candidate helicopter pilots – a number of further propositions were developed:

Proposition 1: A predictive pilot categorisation methodology does not exist for the South African helicopter industry context, with specific reference to the safety culture habits of candidate helicopter pilots.

Proposition 2: Given the intrinsic high-risk operating ambit, it is realistic and relevant to contemplate the necessity of a methodology to categorise candidate helicopter pilots.

Proposition 3: A pilot categorisation model would have a positive quantifiable consequence on the existing and future flight safety culture habits within the general aviation industry.

Research objectives relating to the qualitative research problem were noted as:

- Compiling a comprehensive study into the factors (safety culture habits) that affect the behaviour and actions of helicopter pilots
- Identifying and quantifying feasibility options for pursuing the development of the pilot categorisation methodology to assess the application of pilot safety culture factors to any flight school
- Proving that the successful identification, assessment and implementation of a categorisation model would have a positive and quantifiable effect on peripheral aviation industries. Such industries include among others financiers, flight schools, helicopter owners, insurers, improved flight safety statistics and reduction in loss of life reduction in morbidity and mortality.

1.5.6 Originality

The originality of the research model resides in the creation of a distinct DFE questionnaire (quantitative) and the further combination with an existing software model (qualitative) in accordance with the adopted convergent parallel mixed method. It is claimed that no such categorisation model of this nature exists within the South African context, and it could therefore serve to satisfy the requirements pertaining to research originality**.**

As depicted in Figure 1.3, the process of candidate helicopter categorisation followed typical engineering process design methods by utilising existing process models (Blanchard, 1992; Lanigan, 1992; Crandall, Klein & Hoffman, 2006). Furthermore, Systems Thinking and engineering factors such as conception, design, implementation and operation were considered throughout.

1.5.7 Delimitations

Delimitations describe "what the thesis is not about" (Wolcott, 2002). In this instance, the thesis:

- Is not a predictive psychological test or instrument
- Does not claim to be an exhaustive assessment tool for the evaluation of candidate pilots
- Is unique to the South African helicopter flight training domain
- Is contemporary and relevant to the South African Civil Aviation Authority, and by implication, ICAO expectation of reducing all helicopters accidents worldwide by 80% by 2015 (IHST, 2005).

1.6 CHAPTER OVERVIEW

This chapter introduced the hypothesis, research problems, propositions and objectives associated with this thesis regarding the successful categorisation of candidate helicopter pilots. Such categorisation will ultimately have to be measured robustly in an accurate and reliable manner by comparing and critiquing existing literature, and by successfully integrating the proposed quantitative and qualitative research methodologies through a mixed methods approach.

The literature application in Chapter 2 addresses specific pilot safety culture habits relevant to this thesis and the successful and reliable assessment methodology of candidate helicopter pilots. Literature was used throughout this thesis in a direct and integrated application manner and was not reviewed as a stand-alone literature study only.

In Chapter 3 the complete research design and methodology is presented and explained. The combined use of quantitative and qualitative methodologies fuses into a mixed methods process and culminates in the convergent parallel research method.

Chapter 4 is devoted to defining the categorisation methodology for candidate helicopter pilots by integrating and comparing quantitative and qualitative data through triangulation and further literature reviews. The chapter also serves to package the acquired knowledge and research literature into a manageable format for ease of reference and future implementation.

In Chapter 5 the author discusses the aspects relating to data verification and validation, along with the research findings. Specific evaluation criteria are presented to categorise candidate pilots before and after completion of the Shadowmatch™ intervention.

Finally, in Chapter 6 the discussion, recommendations and conclusion of the research problem are addressed. The chapter is followed by a list of literature references and annexures.

CHAPTER 2: LITERATURE APPLICATION

"You cannot legislate the poor into freedom by legislating the wealthy out of freedom. What one person receives without working for, another person must work for without receiving. The government cannot give to anybody anything that the government does not first take from somebody else. When half of the people get the idea that they do not have to work because the other half is going to take care of them, and when the other half gets the idea that it does no good to work because somebody else is going to get what they work for, that my dear friend, is about the end of any nation. You cannot multiply wealth by dividing it." Dr. Adrian Rogers, 1931

2.1 INTRODUCTION

Chapter 2 introduces the reader to specific identified safety culture habits and human behavioural constructs relevant to the accurate and reliable assessment of candidate helicopter pilots (Cameron & Spreitzer, 2012). The literature review and application initially focuses on the complexities of helicopter flight training and relevant flight safety aspects (Garland, Wise & Hopkin, 1998) and explores factors relating to physical assessment constraints and the handling qualities of helicopters. A further iteration identifies cognitive factors associated with basic helicopter training. The author adopted a methodology of literature application rather than a classical literature study (Lessem & Schieffer, 2002).

The literature review furthermore addresses a *sensitive* concept, namely aviator egos (Conte & Plutchik, 1995; Bor & Hubbard, 2006), combined with the observed negative effect that ego has on the habits of flight safety culture. Other topics researched in this chapter include helicopter design ergonomics (Padfield, 1996), basic Root Cause Analysis (RCA) theory (Hughes, 2007), Systems Thinking (Marcus, 2007), psychological and physiological considerations (Lopex & Snyder, 2003; Cameron & Spreitzer, 2003) and other research philosophies. The chapter culminates in an overview and integration of these concepts in developing the two unique questionnaires for the data-collation process through quantitative and qualitative mixed methods (Nova, 2013; Denzin & Lincoln, 2005; Johnson & Onwuegbuzie, 2007).

2.2 PILOT SAFETY CULTURE HABITS AND CATEGORISATION METHODOLOGY

Failures of flight discipline can – in a single instant – overcome years of skill development, in-depth systems knowledge and thousands of hours of experience.”

Tony Kern (1998)

Psychologists have been studying pilot behaviour and aviation human factors since World War II (Barker, 2012a) and concluded that particular personality traits are unique to the pilot population (Shaver, 2009). Pilots are generally *intuitive extroverts* (Cornerstone Strategies, 2008), and are more attuned to understanding and forming opinions from received information and stimuli (Wiener & Nagel, 1998). Further inherent traits include a logical approach, a pragmatic stance on most topics and a strong desire for achievement (Garland *et al*., 1998). The publication, Cornerstone Strategies (2008) defines the most prominent character trait of pilots as their “absolute, unwavering faith in themselves”.

A continuous process of implementing and evaluating the research at the researched company and other flight schools ensures constant verification and validation of incident and accident statistics (Global Aviation Consultants, 2011). The definition of pilot safety culture habits firstly requires an overview of the Safety Culture and Safety Climate within high-risk organisations.

The need for an individual safety culture (Cooke, 2012) could well be instilled by the pro-active safety approach derived from the implementation of the categorisation methodology. A well-established Safety Culture forms a distinct part of a Safety Climate within the entire industry (Human Engineering for the Health & Safety Executive, 2005) and is pivotal in encouraging safety culture indicators such as leadership, open communication, constructive engagement, involvement, continuous learning culture and a just culture approach to reduce attitudes of blame (Human Engineering for the Health & Safety Executive, 2005). **Climate is conditional – culture is what causes it.**

The term Safety Culture was first used after the 1986 Chernobyl nuclear disaster (Von Thaden & Gibbons, 2008), after which research in this field increased remarkably. A Safety Culture can be described in colloquial language as “the way we do things around here”. (Smith & Garret, 2006) and refers to specific enduring characteristics of an organisation (Von Thaden & Gibbons, 2008; Heese, 2012). This notion has direct relevance to flight safety and serves as a continuous confirmation of established flight safety values at the researched company.

Safety Climate places greater emphasis on the perceptions of employees (including students) and are subject to changes within the organisation’s nature and conduct, depending on operational circumstances (Von Thaden & Gibbons, 2008). Successful implementation of Safety Climate principles exist, amongst others, in the aviation and nuclear industries (HSE, 2005) and provide distinct methods and parallels for establishing operating conditions that demand extreme levels of safety and regulatory compliance.

The fundamental underlying principle to institute successful Safety Cultures and Safety Climates in a company is a pro-active approach towards entrenching individual and corporate safety commonalities (Cooke, 2012). By introducing and monitoring the researched categorisation methodology as gatekeeper in assessing candidate helicopter student pilots at the company, the priority of determining the potential outcome of students’ progress is raised substantially by employing this pro-active approach (Matthews, Davies, Westerman, & Stammers, 2000). This methodology and assessment process is regarded as direct extensions of the existing Safety Management System (SMS) in use at the company (Stols, 2011).

Safety Culture characteristics include safety leadership, safety as a core value (Heese, 2012), safety accountability, continuous safety learning and that safety is fully integrated into all functions of the organisational conduct (IAEA, 2012). The work of Von Thaden and Gibbons (2008) defines the Safety Culture Indicator Scale Measurement System (SCISMS) and integrates factors such as: (i) organisational commitment; (ii) operating interactions; (iii) formal and informal safety indicators; and (iv) predictable safety behaviours (Von Thaden & Gibbons, 2008). These elements have to be successfully combined to ensure continuity and simplicity in order to maintain the integrity of the categorisation model and SMS integration. Table 2.1 defines existing SMS policies and postulated interventions (*):

Table 2.1: Elements of a safety training programme (Source: IAEA, 2012 *Adapted by author)

ORGANISATIONAL AND CULTURAL CONSIDERATIONS	NUCLEAR INDUSTRY PRACTICES (IAEA)	PROPOSED PRACTICES AT FLIGHT SCHOOL
• Safety culture leadership • Managing potential conflicts between safety, schedule and cost • Safety Culture expectations: why they are important and what the behaviours look like in practice • Open communication and reporting • Questioning attitude • Challenging unsafe conditions • Conservative decision making • Respect and fair treatment • Fit for duty • Due diligence • Managing change	• Nuclear safety principles and terminology • Quality assurance and control • Procedural use and avoidance of workarounds • Effective pre-job briefings that have attributes similar to operating phase briefings in their identification of the safety significance of the planned work • Design specification modifications • Modifications during installation • Accuracy and completeness of documents and records	• Candidate helicopter pilot categorisation methodology* • Senior management commitment to safety training • Policy and objectives focused safety systems • Aviation Safety Office • Flight Safety Review Board • Risk management • Reporting system • Training and education • Quality management • Documentation and forms • Emergency Response Plan • Dangerous goods • Controlled documents • Crew evaluation* • CPPD*

The elements noted in column 3 of Table 2.1 represent key elements of the SMS programme installed at the researched company. The categorisation methodology must be integrated into all facets of the regulatory SMS documentation and incorporated through normal change management and organisational renewal processes (Global Aviation Consultants, 2011). Further perspectives on the theory and nature of safety climate and safety cultures were obtained through the research of Guldenmund, (2000), Flin, Mearns, O'Connor and Bryden (2000) as well as Glendon and Stanton (2000).

An initial method to categorised candidate pilots was examined through an existing algorithm, as developed by Rasmussen (1982) and made certain assumptions regarding an initial evaluation methodology of pilots. It was found unsuited as a sole quantitative method for this thesis of candidate student pilots for the following reasons: (i) it assumes the candidate is already a pilot; (ii) it is difficult, if not impossible to determine the level of experience other than a verbal affirmation; and (iii) no specific indication of an exact data-collation method is described.

Figure 2.1 delineates the Rasmussen algorithm (1982) and introduces the various errors associated with pilot classification:

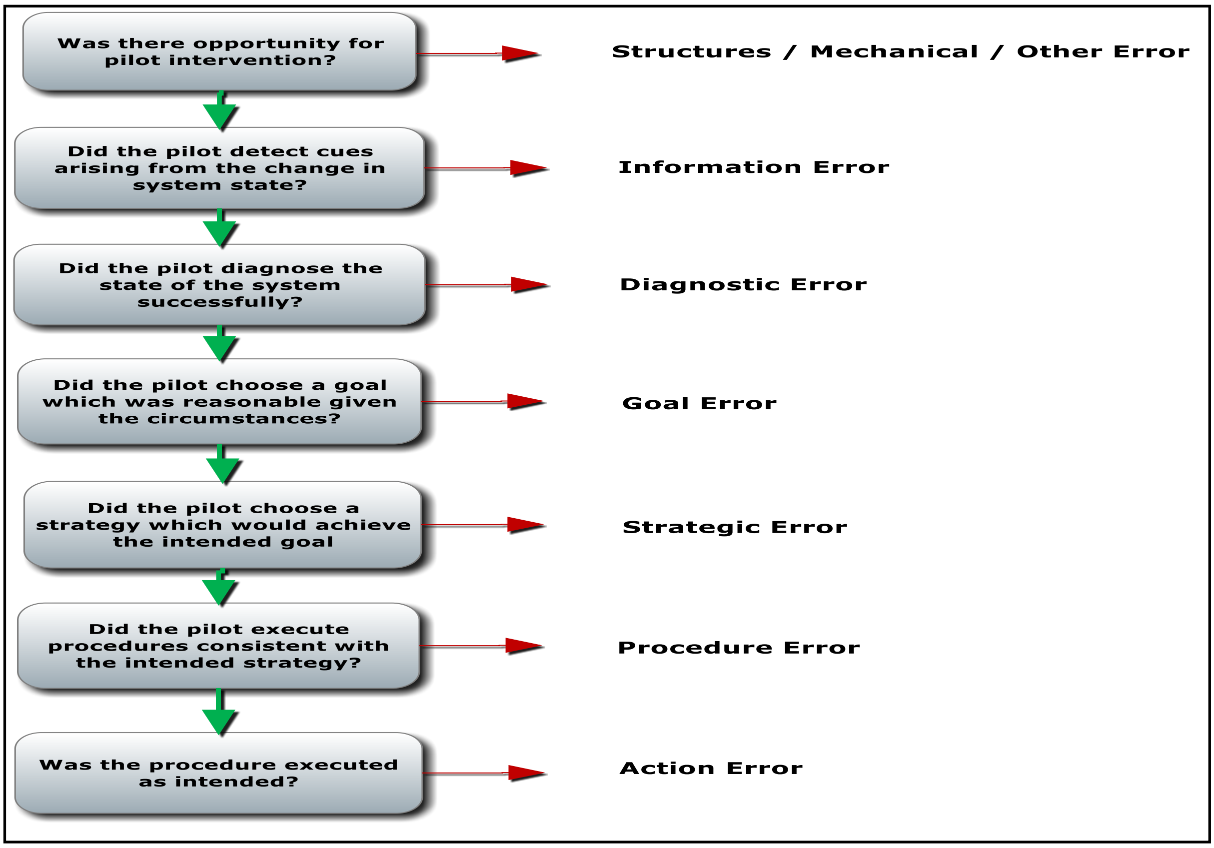

Figure 2.1: Typical Classification Algorythm (Source: Rasmussen, 1982)

It is clear from Figure 2.1 that the algorithm above focuses on pilots that have already attained a previous level of flight proficiency and have similarly been subjected to scrutiny and assessment towards advanced flight training regimes.

2.2.1 Pilot safety culture habits

The evaluation of pilot safety culture habits was briefly addressed in Chapter 1 and is a major driver in the qualitative research process used for the assessment of candidate pilots. A habit is "an action that repeats itself with no (or minimal) conscious planning. It repeats itself when the situation is conducive to such behaviour and the person has a goal of fulfilling his need in some way by doing what he normally does. This action can then become a habit" (De Villiers, 2009:99).

Similarly, pilot behaviour patterns become a habit when such patterns are repeated with no or minimal planning. Hence, habits are learnt behaviour, associated with meaning purpose and typically formed through repetition (De Villiers, 2009). Habits are very predictable and usually extremely difficult to break (Covey, 1989), albeit not all equally well established. Shadowmatch™ identifies and explores the particular habits relating to pilot safety culture. These habits are discussed below.

2.2.1.1 Propensity to own versus propensity to hand-off

These two habits indicate whether the individual takes ownership to solve a problem and handles a challenge him/herself, or whether he prefers an outside agent to solve problems, handle difficulties or even execute tasks (Hunter, 2009). Hand-off refers to the place where the individual places the control and/or task execution, with himself or outside of him/herself. In some jobs a habit of handing-off a task is necessary, in some jobs it is not required. The same applies to keeping the task as a self-execution responsibility (De Villiers, 2009).

2.2.1.2 Simplification

Simplification refers to the habit of breaking complex scenarios down to linear challenges that can be resolved easily. It can be seen as the habit of taking the easy route towards solving complex challenges. The purpose of this habit normally ties up with efficiency whereby an individual has developed the ability to easily find the simple way to resolve challenges/problems (Schutte, 2004). The habit of simplification can develop in tandem with the habit of problem solving. When both these habits are well formed the individual might develop extremely strong behaviours towards effectively solving problems by applying extremely simple ways towards a solution (Cooper & Phillips, 2004).

2.2.1.3 Resilience

Some people tend to give up easily when faced with a challenge {lack of resilience] while others apply themselves relentlessly to solve problems and overcome challenges to complete a task despite difficulties and toughness of the journey (Viljoen, 2008). The habit of [lack of resilience] can also manifest when the specific person tends to disembark from a task not because he experienced the task to be tough, but because he anticipates it to be tough without even trying (Strumpfer, 2003). If this is a habit (giving up without even trying) the individual will also tend to develop a habit of low self-confidence.

2.2.1.4 Propensity to change

Most people find it difficult to adapt to change and to become comfortable with new methods, new ways of doing things, a new environment and new technology (Nel, 2003). Similarly, others advocate change and are always venturing towards new frontiers. The latter are very comfortable with anything new, whether it is a new job, new ways of doing things, new technology and so on. If change is experienced as a significant individual habit, it indicates the behavioural pattern of pushing for change, embracing the new and even invites those around them to participate in a process of changing the world where they work and live (Cox, Jones & Rycraft, 2004).

2.2.1.5 Propensity to handle frustration

This habit indicates an individual's inclination towards applying positive behaviour when dealing with frustrating circumstances (Matthews *et al*., 2000). Frustration occurs when the individual is obstructed from reaching his goal. It is the experience that stems from a situation when obstacles impede one from reaching a goal. A desirable attribute is the capability of handling frustration well (Zuckerman, 2006).

2.2.1.6 Team/individual inclination

This habit signifies whether the individual prefers working as part of a team or as an individual. When these two considerations are very close to each other, it indicates that the individual is equally comfortable working in a team or as an individual.

2.2.1.7 Self-motivation

Some people have the habit of energising themselves whilst others are dependent on external energisers to stay positive, driven and active. Self-motivation denotes the individual's habit towards the capacity to behave with high levels of energy despite the absence of external motivating agents. Self-motivation is the behaviour of continuous positive action towards a desired outcome in the absence of external energisers.

2.2.1.8 Routine

Routine is an indicator of an individual's habit towards structure and repetition, sometimes even mundane activities. It determines whether the individual has a habit of behaving in harmony with an environment of repetition and patterns of the same behaviour. It presents a high propensity towards a positive blend between the individual and an environment where structure and routine results in a reality whereby every day is quite the same as the previous.

2.2.1.9 Problem solving

Problem solving is the habit of engaging with challenges on a conceptual, social and practical level and successfully managing these difficulties/challenges towards resolution. People with a strong embedded habit of problem solving easily become intrigued by challenges and riddles to be resolved. A high habitual manifestation of the inclination towards problem solving signifies that an individual will find it extremely difficult *not* to engage with a challenge to be resolved (BarOn, 1997). The opposite holds true: a low manifestation indicates that the individual will find it easy to bypass or even ignore a problem that needs some effort to be resolved.

2.2.1.10 Responsiveness

Responsiveness indicates the individual's reaction speed, in other words the habit of acting immediately if and when necessary. A low level of responsiveness will merely indicate that an individual does not have the habit of acting immediately, whilst a high level of intensity indicates the habit of acting immediately (Zohar, 1980). Certain tasks do not require quick action from individuals and might necessitate the need to wait and think very thoroughly. Conversely, other tasks might require rapid action. Responsiveness indicates the individual's inclination to respond immediately (Nel, 2003; Viljoen, 2008).

2.2.1.11 Innovation

Innovation indicates the inclination of finding new ways and identifying better processes and methods to improve on current methods of working (Williamson, Fyer, Cairns and Biancotti, 1987). It also indicates the habit of working out-of-the-box and creating new realities. It is regarded as the behaviour of an individual doing things that are new, designing new practical functionalities that improve on the way things are done and even create new realities (Pidgeon, 1998). However, someone with only great ideas but who lacks the skill of bringing these to fruition is not regarded as innovative.

2.2.1.12 People-positive behaviour

People-positive behaviour denotes an individual who has the habit of working with people in a positive way and building positive relationships (De Villiers, 2009). It also tracks the way a person influences people towards a positive and meaningful experience of life. Evaluation of this habit will indicate whether person relates to the characteristics of a natural people-oriented person and somebody not easily frustrated by others.

2.2.1.13 Discipline

Discipline is defined as working under extreme levels of discipline in a highly disciplined working environment where adherence to structure, rules and regulations and time-frames are imperative (Kern, 1998). People with a high degree of discipline will even create structures of discipline for others to adhere to. Individuals with an extremely low score do not easily conform to structure, discipline and strict order.

2.2.1.14 Conceptual capabilities

According to Ashton (2007), the conceptual habit is a measure of how an individual applies his abstract ability. It describes the level to which the individual has developed the habit to apply his mind in working through an abstract problem towards finding the correct solution. This does not indicate whether a person is conceptually strong or weak; it indicates whether the person continuously applies his mind towards solving a problem with an expected successful result (Viljoen, 2008).

2.2.1.15 Conflict handling

Conflict manifests in a situation where people have opposing interests that might unfold with destructive consequences to each other (Steiner, 1974). A high incidence of being able to address conflict in a positive way is desirable and tends facilitate outcomes with no or minimal negative consequences for either party (Berne, 1964). Avoiding conflict is not regarded as a positive way to deal with it.

2.2.1.16 Altruism

Altruism is the belief in or practice of disinterested and selfless concern for the well-being of others (Oxford Dictionary, 2013). This reflects a person's willingness to help others without expecting something back. People that have a strong altruistic habit are relatively free from the 'What's in it for me' approach to helping others. These people do well in service-driven jobs, but a high level of altruism does not always implicate a high score on people-positive behaviour.

2.2.1.17 Self-confidence

Self-confidence indicates the person's ability to act with conviction and remain steadfast once a decision is made. In short, self-confidence is an individual's habit of acting with a high level of trust in individual abilities, qualities and judgement, and being able to understand what he is capable of mentally and physically (Kern, 1998).

A high level of self-confidence indicates that an individual has a habit of acting in a secure and confident manner (Hunter, 2006).

2.2.1.18 Task efficiency

The completion of any task is measured against a certain standard, which in turns presents a level of efficiency unique to the individual. These efficiencies are presented as recurring patterns or habits. They are a combination of how to manage time, how efficient tasks are being executed and how successfully tasks are completed (Viljoen, 2008). Task efficiency furthermore relates to the relative efficiency with which the individual has completed the task. It considers and combines total time, conceptual results and time used for the conceptual questions into a single percentage of relative efficiency.

2.2.1.19 Leadership

De Villiers (2009) defines leadership as “the ability to integrate resilience, discipline, a team-oriented approach, the propensity to act immediately and self-confidence with an attitude of positive involvement”. All these behavioural strengths are harnessed to lead a group of people towards a successful outcome (Covey, 1989).

2.2.1.20 Attitude

Attitude is regarded as the way that people approach life and work through their actions (De Villiers, 2009) and should not be regarded as body language only (Mehrabian, 1981). Attitude in this thesis indicate those actions with which someone approaches the world around them. Four attitude categories are distinguished in Figure 2.2: (i) category 1 constitutes a positive, non-aggressively involved person; (ii) category 2 is a more aggressive but positively involved person; (iii) category 3 is also aggressive but not always positive and not always involved; and (iv) category 4 is a person who is not involved, not aggressive but also not destructive.

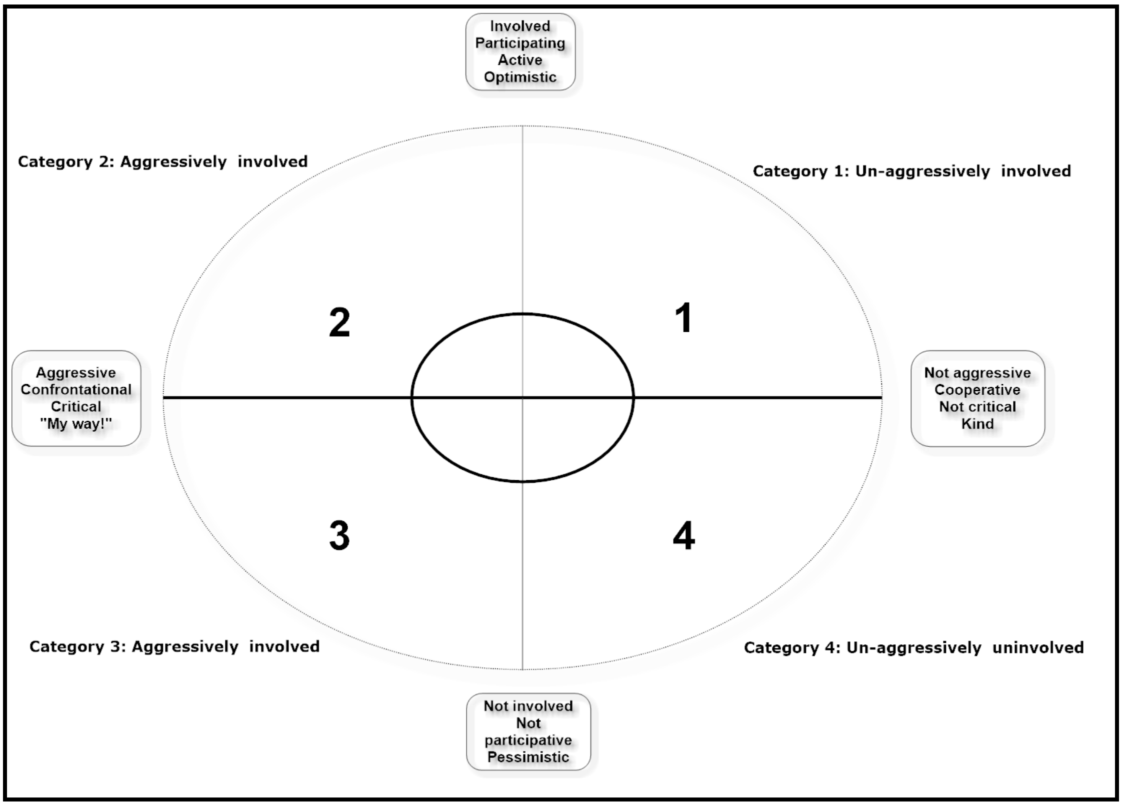

Figure 2.2: Shadowmatch™ attitudinal framework (Source: De Villiers, 2009)

Figure 2.2 confirms that no individual is ever regarded as a category one, two, three or four only, but rather as a combination of the four categories with dominance in one or more of the categories.

2.2.2 Ego State construct

The work of Freud in the early twentieth century describes the personality construction essentially comprising three aspects: the Id, the Ego and the Superego (Structure of the Mind, 2004). A suitable balance between the three noted constructs is required to ensure reasonable/sound mental health and "normal" manifested behaviour. Although Freud's work is notably dated, it is still referred to and applied extensively today.

The Id ("It") function of the human mind equates to the "Child", and relates to the continuous "want" function which is prevalent and exaggerated at birth (both emotional and irrational in construct). It is also commonly associated with primitive minds and contains basic needs and feelings. An overly developed Id is typically immersed in self-gratification and an uncaring approach to others (Berne, 1961).

The Ego ("I") deals with real world principles and ascribes to the reality functions of our lives. The Ego embraces emotions such as compromise and serves to negotiate between the Id and Superego. The Ego section of our minds equates to the "Adult" functions and if the Ego is over-developed, it could lead to rational and efficient behaviour, although the personality tends to manifest as cold and unexciting (Berne, 1961).

The Superego ("Over-I") is the slowest developing portion of human minds, and is the embodiment of our moral values, societal values and parental conduct (Structure of the Mind, 2004). The Superego can be categorised into Ego Ideal and Conscience subsystems. Characteristics such as good behaviour and standards are fundamentals in the Ego Ideal, whilst Conscience dictates the construct of ill behaviour. In extreme cases of over-developed Superegos, the individual might tend to experience a constant feeling of guilt (Berne, 1964).

2.2.3 Characteristics of the distorted ego state of helicopter pilots

It would be a gross generalisation to categorise all candidate and qualified helicopter pilots as being egoistic and distorted in their demeanour. Distortion is described as "a change in form, usually with an impairment of quality" (Oxford Dictionary). The small proportion of helicopter pilots displaying objectionable attributes, regrettably, tends to tarnish the rest of the helicopter ownership fraternity.

Typical characteristics of *distorted egos*, as observed and related by the author, administrative staff, and flight instructors at the researched company, include: delusions of grandeur, pushing the flying envelope (both man and machine), impoliteness and insensitivity towards staff members and insistent, demanding and nagging demeanour (Conte & Plutchik, 1995).

Further distinctions include a notable lack of written correspondence prowess and constant reversion to verbal insinuations rather than committing facts to paper, reluctance to participate in flight school activities, stingy, dismissive of further recurrent flight training requirements and an over-confident approach towards flying. Kern (1998) describes egotism as an idealisation of pilots' perception that their performance is optimal and without further room for improvement.

These pilots tend to also present tendencies to engage in illegal flight manoeuvres such as aerobatics and experimenting with unsupervised charter, game work and night flying. A disturbing behavioural trait is their inclination to engage in conflict situations, rather than embracing potential resolution (Penfield, 1954; Cooke 2012). This may well be a function of male depression, which may include factors such as an evident feeling of apportioning blame on others, irritable behaviour, inflated ego, demanding respect from others and possibly sleep deprivation (HSRC, 2005).

2.2.4 Factors contributing to pilot error accidents

Despite the worldwide outcry for enhanced aviation safety, the continuous demise of man and machine continues annually due to aircraft accidents (Barker, 2012a). However, annual global aviation fatalities are historically still far less than the number of deaths on South African roads during the summer holiday period. In 2006, 777 lives were lost due to aircraft crashes worldwide (Flitedux CRM Presentation, 2007) versus the 1,000 road deaths in South Africa in December 2006 alone. Aviation accidents should therefore be seen and interpreted in context to other transportation accidents (Li, Baker, Grabowski & Rebok, 2001).

The following factors should be considered when addressing the human behavioural elements entailed in pilot error:

(a) Personal discipline and self-management

Evidence of entrenched self-discipline and self-management collaborates to reduce rogue behavioural tendencies in flying, assists with managing stress in the cockpit, aligns both general and flying related attitudes, harbours effective multi-tasking and workload reduction and eliminates factors that cause cognitive overload and concentration/focus breakdown (Sanders & Hoffman, 1975).

(b) Situational awareness

Situational awareness (SA) is the perception of environmental elements within a volume of time and space, the comprehension of their meaning, and the projection of their status into the future (Endsley, 1990; Gawron, 2008). It is also a field of study concerned with perception of the environment, and it is critical to decision-making in complex, dynamic areas such as aviation (Seifert, 2013).

SA cannot be taught. Proposed SA capacity expansion methods are a function of continuous exposure, experiential factors, enhanced lateral thinking and cognitive scenario generation (Padfield, 1996). SA is a fundamental component of flight training and air traffic control. This can clearly be seen during mentally taxing phases of any flight such as take-off, landing and entering congested airspace. Helicopter pilots tend to have more variables to manage during these phases of flight due to the inherent complexity of rotary wing flight (Padfield, 1996).

(c) Complacency

The term complacency refers to a feeling of contentment or self-satisfaction, especially when coupled with not being aware of danger, trouble, or controversy (The Free Dictionary, 2013).

Complacency in flying can undoubtedly result in a sudden realisation that a catastrophic event is imminent. As with most events of a routine or tedious nature, pilots tend to neglect certain “non-negotiable” items as a normal course of action (Rieger, 2011). Pre-flights and fuel checks might become a burden to complete before every flight, checklists are neglected and radio calls become the exception rather than the rule.

Other symptoms of complacency include (Garland, Wise & Hopkins, 1998): (i) a conscious acceptance of lower personal standards; (ii) a distinct reduction in desire to remain proficient through recurrent training programmes; (iii) manifestations of obvious boredom; and (iv) inattention and constant acquiescence of the status quo in the cockpit. Other factors contributing to a complacent disposition are increased feelings of romantic well-being, over-confidence, feelings of invulnerability and selfsublimation and a general preoccupation with any other aspect unrelated to the current flight. The fixation on the mission, rather than the flight is regarded as preferential action and “getting there” at any cost.

2.2.5 Transactional Analysis

A suitable proven theory and model was needed to understand and scientifically quantify the safety culture habits of candidate helicopter pilots. The model needed to analyse the interaction between staff and pilots at the company, serving as a continuous theoretical model, acknowledged behavioural metaphor and manifested adjudicating instrument.

The sudden increase in South African civilian helicopter pilots (Barker, 2012a) during the period of 2005-2008 affected the helicopter industry in a most fortuitous way when the ageing helicopter fleet was revitalised and a new stream of pilots started entering into a relatively stagnant industry. It also brought about certain challenges regarding the question of affordability and ownership. The rapid changes in anticipated individual social stature, initially from *humble* student pilots to sudden private pilot elevation made for demanding interactions between administrators, instructors and the new helicopter pilots.

Transactional Analysis (TA) was founded in the 1960s by Berne and links the internal experiences of individuals with their interpersonal behaviours (Berne, 1964). Berne defined the recognition that one person would give to another as *stroking*, and deemed it essential for both physical and psychological health. The modern day analogy is still found in babies that crave the maternal touch (physical stroking) and adults who yearn for psychological stroking through specific human dynamic interface.

Berne (1964:23) described Ego States as “coherent ways of *thinking*, *feeling* and *behaving* that occur together”. His well-known Ego State Model (Berne, 1961) presents the behaviours, beliefs thoughts and feelings for each alter ego state in Figure 2.3.

The three states can be described in more colloquial terms as **Parent** (the *taught* concepts of our lives), **Adult** (the *thought* concepts of life) and **Child** (the *felt* concepts of life) (Businessballs, 2007).

Berne (1961) continues by defining words with specific reference to the psychoanalytical studies of the ego state and is described by Figure 2.3 in addressing Parent, Adult and Child states:

Exteropsychic:	Identificatory (Parent)
Neopsychic:	Data processing (Adult)
Archeopsychic:	Regressive (Child)

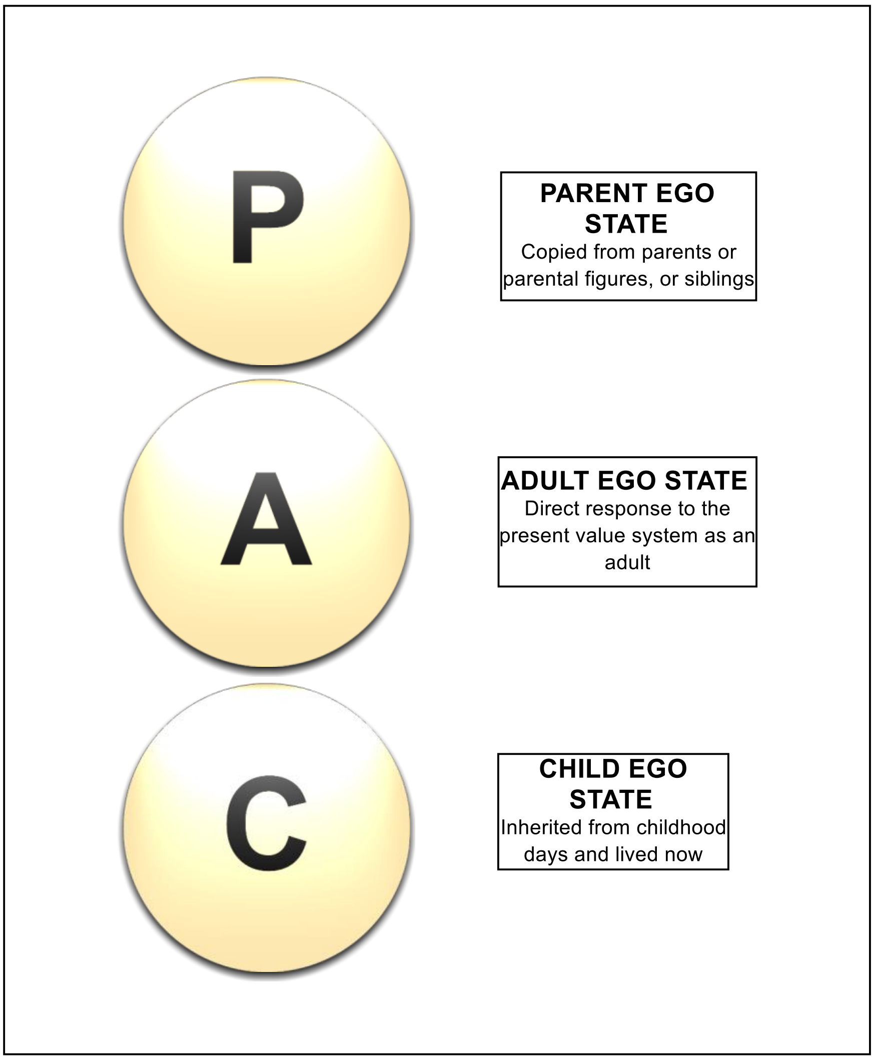

Figure 2.3: The Ego State Model (Adapted, Berne, 1961)

Figure 2.3 depicts the three predominant ego states and their expanded relevance to this thesis. The TA or human interaction between students, owners and flight school staff is a classic example of the daily realities these individuals have to contend with. It is observed that inexperienced, timid students conform to the typical expressions of the Natural Child (positive) behaviour and gradually graduate to the ego state commensurate with the Adaptive Child (negative). The ideal expansion is for all pilots to progress to the Adult ego state.

An observation by Berne showed that the three ego states are in fact real and observable, and indeed manifestations of specific neural networks in the brain (Berne, 1964). These observations are in stark contrast to each transaction or interface between people that consists of a stimulus and response, and which ultimately forms a sequence of events. Such series of numerous events ("strokings") evolve into "games" that people play (Berne, 1964). In addition to strokings, Solomon (2013:20) also describes the influence of "life scripts and early decisions" made at a young age. Certain life decisions are made during the Childhood phase of development and are seldom carried over into adult life.

The structure of the classic P-A-C model has been challenged in recent times with White (1988) postulating a two-state model The essence, however, remains concurrent with the notion that distorted or complex TA results from crossed responses between the Adult stimulus and Child response. The work of Berne (1961 & 1964) proved to be monumental and by most authors in the field of TA studies commonly refers to Berne.

The **Parent** ego state contains attitudes, beliefs and behaviours "absorbed" from external sources, and more specifically from a person's own parents. The manifestation of the Parent is typically seen in a prejudicial, critical or even nurturing behaviour, and tends to influence the inner Child.

The **Adult** ego state is unaffected by or unrelated to age. It deals with the present and effects executive functioning such as problem solving, decision making and cognitive approach. This state is well organised, adaptable, intelligent, logical, can assess probabilities and critical functions, and is useful in cockpit dynamics.

The **Child** ego state is charged by natural childhood behaviour and responses. Functions such as creativity, sense of adventure, spontaneity, curiosity and emotional intensity are common to this state. The Child lives in the first person and contains feelings, wants and needs (Internet-of-the-Mind, 2008).

Non-verbal communication and body language are important means of communication in aviation. Mehrabian's (1981) research shows that only 7% of the meaning is contained in the spoken words, 38% of the meaning is contained in the *way* in which the words are said and 55% facial expression. The further effect of non-verbal communication, and body language, is essential in looking deeper into the aviation games people play.

2.2.6 Constructing an "Aviation Egogram"

Various factors contribute to the socially accepted perception that most pilots are egoistic, wealthy and of superior physical and mental construct. Regrettably, these factors permeate the aviation industry *even before* certain pilots attempt their first flying lesson (Coetzee, 2000).

An Egogram is an "effective, visual depiction of particular strengths and weaknesses within any person" (Dusay, 1977). The characteristics are separated and displayed in a histogram to facilitate interpretation. Egograms are used effectively to promote positive growth within human personalities by measuring the range of *psychological* energy (Dusay, 1977). The indications of the Egogram are by no means inherently "good" or "bad", but merely a visual stimulus of the effect that the respective ego state has on the personality (Berne, 1964).

In constructing an "Aviation Egogram" for helicopter pilots which presents ego state defects, the various personality energies have to be evaluated and plotted. However, no individual should be branded under a single label only or considered unsuitable for any further scrutiny and/or recommendation.

Egograms form a graphical extension to academic TA practices. Referring to Berne's perception of the three adapted ego states, the basic Egogram can be constructed by comparing the *psychological energies* and is depicted in Figure 2.4:

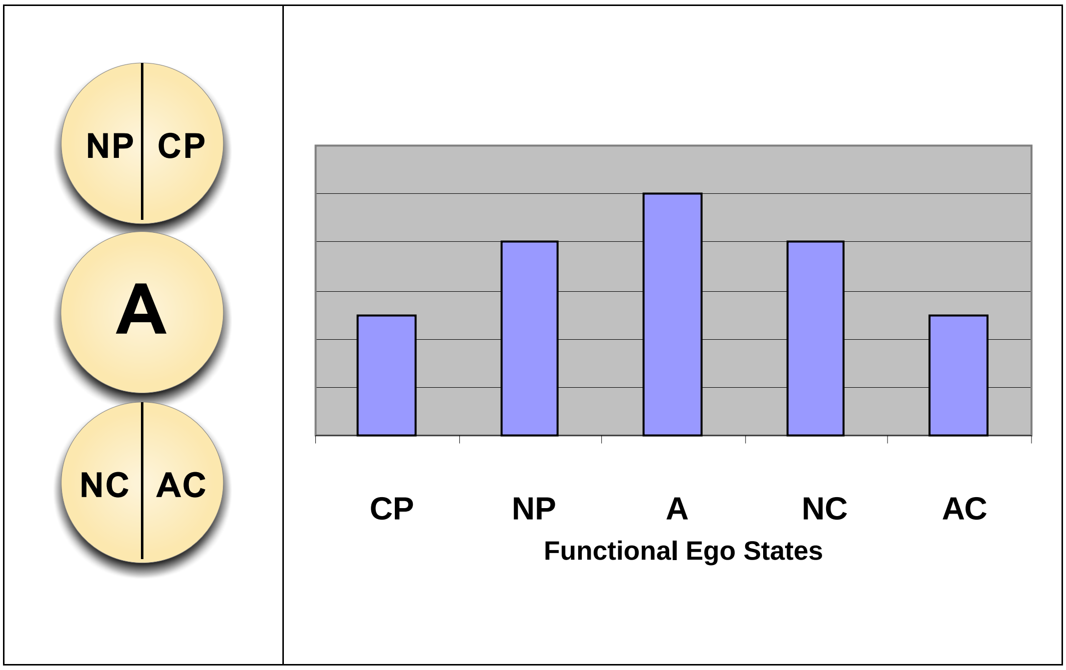

Figure 2.4: Adapted Ego States and normal D-shaped Egogram (Source: Dusay, 1977)

Figure 2.4 provides a graphic display of the Critical Parent (CP) that tends to criticise and find fault, Nurturing Parent (NP) that nurtures and promotes growth, Adult (A) that represents logic and precision, Normal Child (NC) that depicts fun and frivolity, while the Adaptive Child (AC) conforms and compromises.

The author noted that the theory pertaining to TA dates from the 1960s and that little research had been documented with the aviation domain prior to Berne's work. Based on the extensive TA referencing found during this study, the author opines that TA theory has stood the test of time.

Based on the observations noted at the company, helicopter pilot-owners displaying distorted ego state tendencies can be presented in an aviation egogram, as depicted by Figure 2.5.

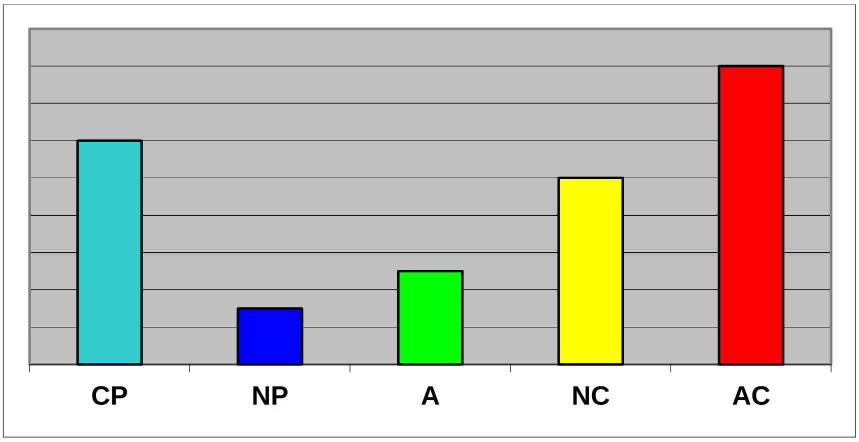

Figure 2.5: Aviation Egogram

The AC in the in Figure 2.5 confirms that pilots with distorted ego state tendencies have clearly defined dependency needs that have to be satisfied. Similarly, they are constantly seeking attention and tend to protest loudly if resisted. Words such as “me” and “I” are predominantly typically used (high CP), and such pilots act in a most inconsiderate manner.

The NC energy is indicative of the pilot’s need to express and “entertain” – clear signs of showmanship and aviation exhibitionism. Regrettably, the A energy level is typically low and not normally adhered to. The low NP value is (probably) not particularly common for the Aviation Egogram, as pilots are typically generous and charitably inclined. This might, however, fall in line with the NC side which serves as encouragement for additional attention seeking and receiving acknowledgement.

Most human Parent behaviour is learnt, and is a function of nurture and protection. NP However, some Parent behaviour is genetically built into people and inherently defines a person (Steiner, 1974). Characteristics such as rogue pilot behaviour, questionable airmanship and persistence to “perform and display” the aircraft at all costs are not indicative of typical Parent conduct.

2.2.7 Aviation enneagrams

The Enneagram Institute™ produced a visual presentation of nine different personality types, namely the reformer, Helper, Achiever, Individualist, Investigator, Loyalist, Enthusiast Challenger and the Peacemaker (Figure 2.6) and how the nine types interact with other related types (Enneagraminstitute.com, 2007).

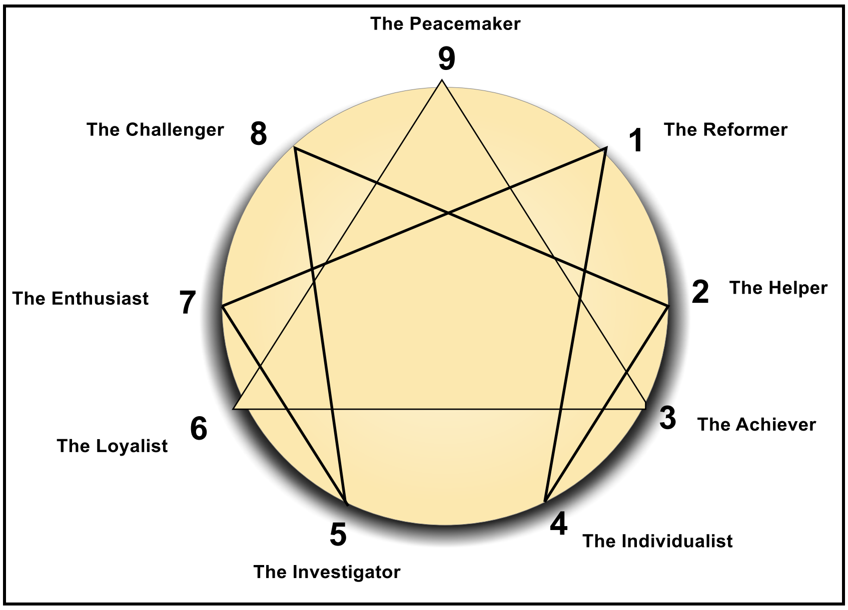

Figure 2.6: Enneagram of personality types

Through years of experience the researcher observed that the average helicopter pilot conforms to the character traits recorded in the domain of The Challenger.

The personality type of the Challenger is characteristically associated with sales people and manifests as being tough on the outside, albeit soft on the inside. Challengers are typically controlling and possessive, tend to adopt maverick behaviour and struggle to maintain healthy relationships (Enneagraminstitute.com, 2007). The Challenger is usually engaged in establishing and running own businesses and more often than not very successful in doing so. They thrive on independence and are constantly looking for a “big break”, in a financial sense. Challengers are positively inclined to exhibit natural strength, insightfulness, innovation and make loyal friends.

Therefore the author deducts that the average helicopter pilot tends to show these character traits.

2.2.8 The Peter Principle

The Peter Principle is a direct enforcement of the fact that people tend to promote (rise) to their ultimate "level of incompetence" within a hierarchical structured (administrative) situation (Peter & Hull, 1977).

The Peter Principle has a direct correlation in this instance. Observed pilots are often "self-promoted" into higher levels of incompetence, not necessarily through any fault of their own, but by way of the financial freedom and power they achieve. Few pilots actually plan to obtain a CPL or higher licence, since their affluence can finance their freedom and lack of further regulated and structured adherence to advanced flight procedures.

This phenomenon concurs with the expectations and reality involved within the various tiers of aviation. The typical structure of a pilot's flying career could present as depicted in Table 2.2:

Table 2.2: Aviation – Life – Education Analogy

AVIATION TERMS	MINIMUM FLYING EXPERIENCE	LIFE ANALOGY	EDUCATION ANALOGY
Student Pilot Enrolment	0 hours	Toddler	Matric Exams completed
Student Pilot Licence	15 hours	Teenager	Enrol at university
Private Pilot Licence	50 hours	Just married	B-degree
Commercial Pilot Licence	200 hours	Parent	M-degree
Airline Transport Pilot Licence	1500 hours	Grand-parent	PhD

The structure of Table 2.2 is based on the author's experience as instructor and Designated Flight Examiner. The various stages of increased flying experience and higher licences correspond with the general perception in the aviation industry anent perception par-value academic prowess.

At this point, *sciolistic* behaviour typically becomes an issue with inexperienced pilots and helicopter owners. Having followed the trend of the Peter Principle within the aviation hierarchy, the owner can easily fall victim to the self-belief of actually being very knowledgeable and competent in their own sphere, albeit that their wealth and distorted perception actually condemns their actions.

Regrettably, the Peter Principle is most apparent when low-time pilots, and more so owners, graduate from SPL to PPL levels. The further effect is evident when owners engage in Commercial flying activities and flaunt their wares with operators, schools, training institutions, events and fellow aviators (Peter Principle, 2008).

2.3 CATEGORISATION AND FILTER MECHANISMS FOR CANDIDATE HELICOPTER PILOTS

> *The words "cheap", "safe" and "aviation" cannot, in my opinion, be used in the same sentence; not unless you add the word "not"!*
>
> John Howse, (1947-2010)

2.3.1 Instructor intuition

The contemporary work and research of Gladwell (2005) sets an example for the inherent sense of *"knowing"* that something or a situation is amiss. Fairechild (2010), a senior international air hostess, describes intuition as "the way people look and behave, plus how we feel in their presence". This certainly holds true for the first encounter between instructor and prospective student. Unsurprisingly, females do have – or at least regard and act on – a higher level of intuition than males do (Bangs, 2004).

Interestingly enough the well-known expression relating to intuition, "by the seat of one's pants", was originally an aviation term meaning to fly without instruments, and thus to be forced to rely upon the instincts acquired through past experience. The sense of "just barely" or "narrowly" would seem to be an extension of this aviation use, since a pilot flying by the seat of his pants is bound to escape disaster by a very narrow margin.

Gladwell (2005) uses various examples to confirm his research into events that urged him to initially trust his instinct rather than only the apparent facts available at the time. He similarly explains that most people possess the inherent ability to make an accurate assessment of others' demeanour within only fifteen seconds of meeting same.

It is, however, of the essence that such decisions about someone else's personality and characteristics should be made through frugal considerations and that only the absolute necessary information is gathered to make such a snap judgement. Excessive information gathering typically leads to over-confidence and may manifest negatively in further interactions with the other person.

The concept of classic "thin slicing" (Gladwell, 2005) is of particular significance when a flight instructor meets a prospective student for the first time. The instructor, or any individual for that matter, would immediately sense and reflect on subtle and fleeting verbal and non-verbal cues to effectively read the student's mind and to formulate a snap judgement.

Humans unknowingly excel at this automatic and impulsive behaviour, and continue to create very specific opinions and first impressions about others, in this case a potential student. Payne (2005) warns against "gross generalisations, prejudice and stereotyping" when using classic thin slicing methods – even if not endorsed or believed by the instructor. The obvious risk is contained in instructor subjectivity and personal preferences, rather than an objective assessment.

The work of Van Aardt (2008) reflects on various research factors such as instinct, cognition and feelings. Her findings infer that intuition is "experienced as guidance, emotion and spiritual".

The adapted flowchart (Figure 2.7) has direct relevance on the initial instructor/student encounter in that it addresses a ***self-regulation*** approach towards the application of intuitive factors (Peterson & Seligman, 2004). By examining Figure 2.7 it becomes evident that the flight instructor is similarly continuously challenged by making observations about the new student and benchmarking same against the intuition factors in the flowchart (Van Aardt, 2008).

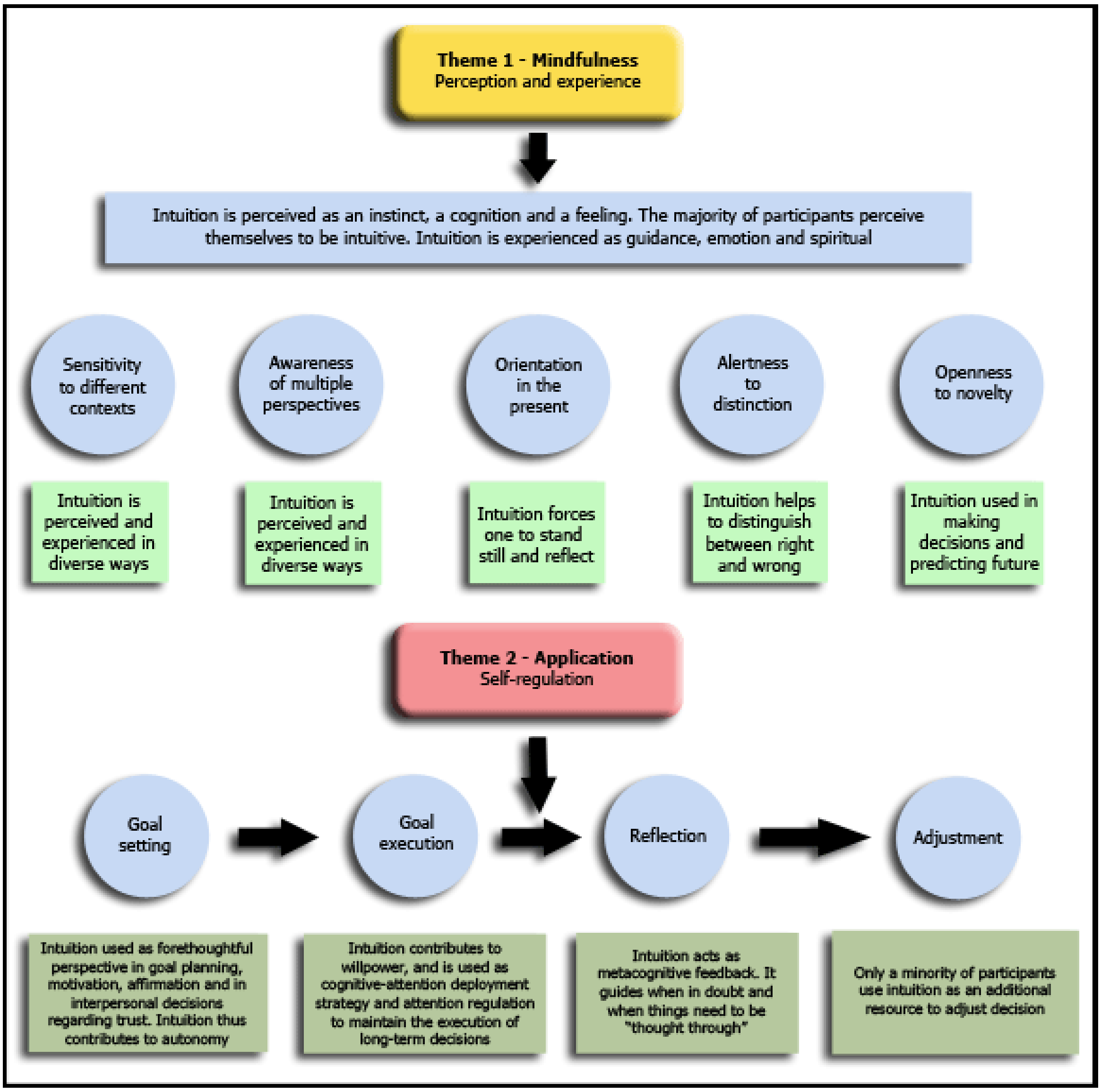

Figure 2.7: Perception, experience and application of intuition in self-regulated decision making (Adapted, Van Aardt, 2008)

Figure 2.7 summarises the perceptions, experience and application of intuition in self-regulated decision making. This factor is regarded as a crucial indicator when considered in an analysis of the safety culture habits of pilots. The original flowchart was adapted to represent the first student/instructor encounter.

Firstly, goal setting and establishing reasonable autonomy in terms of mutual trust is a primary driver. Trust – in both the instructor and the helicopter – is a major consideration for any prospective pilot.

Secondly, goal execution and ensuring that long-term decisions are executed with success form the next tier. The successful completion of the PPL syllabus is an immediate consideration and regarded as significant to the student-instructor relationship.

Reflection is the third logical consideration and regarded as a continuous process – it must be entrenched in the interactive process between student and instructor. Instructors typically mention such stereotyping and perceptions and care should be taken not to potentially negatively influence colleagues. Figure 2.7 presents the various themes associated with the intuition and self-regulation:

2.3.2 Heart versus Head versus *Gut*

In corroborating the intuitive factors noted in paragraph 2.3.1 and relying on more than merely *factual* input, the emotions and perceptions perceived by the five senses (sight, hearing, smell, feeling and taste) are confirmed by a third dimension. When meeting a new student (read: a single dependable first response for immediate use (Hampson, 2005), typical stimuli will emanate from "Head" emotions. This forms the logic and reason aspects that are easiest to quantify scientifically (the five noted senses). Combined with "Heart" emotions and dreams, an individual can instantly contemplate and assess a new acquaintance.

"Gut" options include our intrinsic instincts and intuition, more simply: "the feeling in our bones" (Hampson, 2005). This emotion acts as in the present moment and is immediate, practical and direct.

In the relevant case of meeting a potential student, an instructor will inadvertently rely on all three aspects to make a snap decision of the candidate's demeanour, aptitude and attitude. Physical appearance, attire and personal presentation, self-confidence, interest in the subject matter and general approach are some of the typical factors taken into consideration at the onset of the first encounter (Conte & Plutchik, 1994).

2.3.3 Candidate helicopter pilot demographic factors and aviation wealth-health

Helicopter ownership in South Africa has become “too affordable” (Coetzee, 2000). What was regarded as an elitist, luxury pastime 15 years ago, reserved only for the privileged few that could afford such opulence, helicopter ownership has drastically changed in both population and complexion.

The intrinsic financial burden associated with aviation definitely served as a deterrent when one evaluates the demographics of aviators. The cost of flight training, proficiency maintenance and ultimately ownership of aircraft is exorbitant and, regrettably, typically reserved for people of great financial means. Similarly, because of the exclusivity derived from a superior financial status, certain owner-pilots are simply as successful, speaking in aviation terms, as the amount of money they can allocate towards a potential problem.

Wealth has the potential to create disrespect for rules, prescripts and adherence to fundamentals and rudiments (Coetzee, 2000). This phenomenon permeates through various strata of social sampling and, specifically so in aviation. Regrettably, social stratification is prevalent within the aviation industry. Coetzee (2000) records that one’s wealth and “ability to afford” can easily provide an unconscious “golden glove” of protection for an owner-pilot that displays ego state vices.

2.4 PSYCHO-MOTOR HANDLING SKILLS AND COMPLEXITIES

The flight evaluation process of prospective civilian helicopter pilots has to date been very subjective and reliant on predominantly low-time or inexperienced flight instructors. According to Hunter (2010), the focus of any initial introductory/demonstration flight has historically centered around the instructor exposing the candidate pilot to the unique capabilities of the training helicopter, and more so in the military training environment. This approach is inherently one of noble substance but possibly denies the student a fair evaluation of whether he/she will actually cope with the rigours of flying a helicopter in a solo configuration.

Furthermore, the situation also forces the instructor subconsciously into *colluding* with the flight school management to attract as much potential business as possible (Merrick, 2012). This result is more often than not undesired and potentially flawed in a safety and moral sense. The topic of psycho-motor handling skills and associated complexities covers a broad spectrum of subject matter, introduced below.

2.4.1 NASA Task Load Index (TLX)

The inherent complexity of handling a perfectly unstable platform such as a helicopter, requires above-average psycho-motor skills, attitude and aptitude. The NASA TLX is a contemporary evaluation tool devised by the National Aeronautics and Space Administration (NASA) and is regarded as a multi-dimensional *subjective* work-load rating assessment instrument (Gawron, 2008). As the subjective evaluation will be conducted by (assumed) inexperienced flight instructors, workload factors such as emotional, cognitive and physical responses have to be integrated and weighted by perceptions of the actual task demand.

Critics of the NASA TLX have notably argued that the very construct of the evaluation process and computer-based versus paper versions, add additional workload on the candidate (Noyes & Bruneau, 2007). A significant difference between the workload scores between the two media was found and Noyes & Bruneau (2007) concluded that the computerised version of the TLX incurred a higher workload. In the case of the initial instructor–student encounter, a paper-based evaluation sheet is proposed, as contained in the Instructor Assessment form.

The six typical dimensions that are analysed towards TLX success include: mental demand, physical demand, temporal demand, perceived performance, effort and frustration levels (Gawron, 2008). The manifestation of the six TLX dimensions is of paramount importance in assessing the raw handling capabilities of the prospective novice helicopter student.

The researcher’s experience has shown that younger candidates typically display superior handling and coordination skills when subjectively compared to more mature candidates (50 years and older) on the initial and subsequent flight sorties.

Instructors should take cognisance of the perceived lack (by older students) of their inability to immediately grasp and master basic flight techniques when applying the TLX. A matrix to accurately assess the interpretation of the six TLX dimensions is shown in Table 2.3 and adapted for civilian helicopter pilots. It serves as a scientific scale for rating the definitions:

Table 2.3: NASA TLX Rating Scale Definitions (adapted for civilian helicopter)

	DESCRIPTION	**OUTCOME**	**PROPOSED EXERCISE EXAMPLES**
Mental Demand	How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?	High/Low	Basic understanding of pre-flight and cockpit layout. Spatial orientation as regards airfield layout, location of airfield in relation to notable landmarks, features, etc. Simple arithmetic (feet to metre altimetry conversion, etc.)
Physical Demand	How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?	High/Low	Control manipulation with and without trim control. Ease of performing coordinated control inputs and “feel” for helicopter sensitivity. Rate of reacting to external factors (turbulence, local weather, wind).
Temporal Demand	How much time pressure did the student feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?	High/Low	Persuasion required to convince and encourage student to place all peripherals on flight controls. Reaction time to attitude and power changes (instructor-induced or environmental factors).
Effort	How hard did the student have to work (mentally and physically) to accomplish your level of performance?	High/Low	All items noted in this column.

	DESCRIPTION	OUTCOME	PROPOSED EXERCISE EXAMPLES
Performance	How successful was the student in accomplishing the goals of the task set by the instructor (or him/herself)? How satisfied was the instructor with student performance in accomplishing set goals?	Good/Bad	Grasps/understands basic radio telephony and ATC instructions. Student's apparent sense of achievement/failure/discontent after introductory flight.
Frustration Level	How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did the student appear to feel during the task?	High/Low	Ability to keep helicopter straight and level with first 5 minutes of trying. Ability to hover the helicopter within confines of training hover square

After years of research and experiential data collation, and despite much disagreement about its nature and definition, the NASA TLX and the quantifiable, accurate measurement of workload remain practical and relevant to the aviation community (Hart & Staveland, 1988).

2.4.2 Cooper-Harper scale for helicopter handling and related complexities

Whereas the NASA TLX makes a direct assessment of the specific workload dimensions associated with aircraft (helicopters), the handling scale developed by Cooper and Harper (1969) represents "those qualities or characteristics of an aircraft that govern the ease and precision with which a pilot is able to perform the flying tasks required in support of the aircraft role". In terms of this research domain, flight training is considered the primary aircraft role.

The ultimate achievement is to negotiate a balance between the aircraft's stability and the pilot's capability (Harper & Cooper, 1984). All pilots, whether a new student or experienced campaigner, are products of their individual backgrounds, training (or lack thereof in this instance) and past experience (again, distinctly lacking with new candidates). Incidentally, the pilot selection process whereby candidates are evaluated by using the C-H scale is inherently “anchored in the behavioural realm of any pilot’s action and reflects the differences in performance and workload” (Gawron, 2008). It is fundamentally an algorithm that incorporates adequacy for the task, aircraft characteristics and demands on the pilot to rate handling qualities of aircraft.

Given the level of inexperience of candidate pilots, it can be expected that the overwhelming amount of stimuli on the demonstration flight will have a significant effect on the student pilot (Matthews *et al*., 2000). An accurate, yet simplified, assessment model is thus required for the instructor pilot to make an unbiased and scientific judgement during the demonstration flight. The preferred training helicopter at the researched company is the Robinson R22 Beta II.

Figure 2.8: Robinson R22 Beta II training helicopter

The Robinson R22 Beta II is a small, two-seater training helicopter with a 180 horsepower normally aspirated piston engine which is inherently underpowered for any operations at density altitudes of greater than 8,000 feet. The unfavourable combination of high ambient summer temperatures and elevations exceeding 5,000 feet makes for an intensely demanding operating environment.

The R22 does not escape these adverse factors and are major contributors to the high rate of accidents and incidents on this specific type. It is a well-known industry saying that "if you can fly an R22 at Rand Airport, you can fly any helicopter anywhere in the world" (Bezuidenhout, 1996). Based on the researcher's own exposure and experiential data obtained from other instructors, the Robinson R22 is an extremely demanding helicopter to fly, and indeed to operate safely. To this end, the Cooper-Harper Rating Scale is a significant factor whilst evaluating candidate pilots.

An example of a proposed assessment flowchart, based on the Cooper-Harper Scale (Gawron, 2008) in Figure 2.9 is presented as an adapted template for the purpose of this thesis. A typical student on his/her initial introductory flight will experience and grade the handling qualities of the Robinson R22 in categories 8-10.

Additional research on the advanced reliability prediction of aircraft handling characteristics is contained in the Cranfield Aircraft Handling Qualities Rating Scale (CAHQRS) and incorporates specific dimensions derived from both the NASA TLX and C-H Scale (Harris *et al*., 2000).

Figure 2.9 illustrates the complete Cooper-Harper Rating Scale and the 10 stages that refer to the demands imposed on pilots whilst being subjected to specific tasks or required operations. Rating 1 denotes a pilot that displayed "excellent, highly desirable" handling characteristics and systematically reduces to Rating 10 indicating "major deficiencies". The combination of using both the NASA TLX (assessing workload demand) and the Cooper-Harper rating scale (assessing aircraft handling characteristics) in evaluating and categorising candidate helicopter pilots serves as a scientifically founded combined instrument for any flight instructor to assess any student objectively, at the time of the demonstration flight.

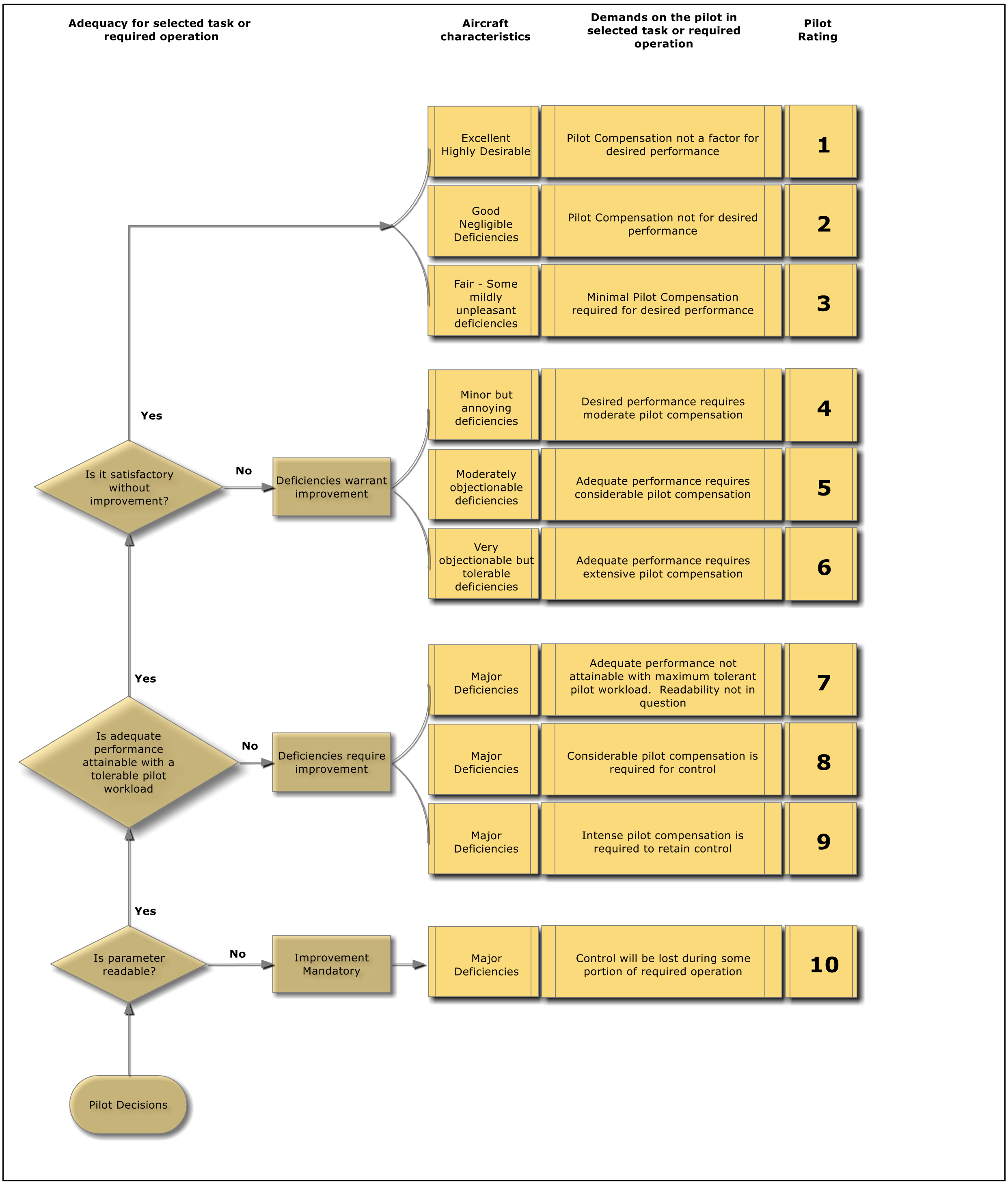

Figure 2.9: Cooper-Harper Rating Scale (Source: Gawron, 2008)

Figure 2.9 indicates the various combinations for aircraft handling characteristics, demands for pilot task selection and the formalised pilot rating scales based on the outcomes derived from the selected tasks.

2.4.3 Procedures and checklists

An intrinsic part of the aviation industry is the non-negotiable adherence to standardised operating procedures and Civil Aviation Regulations. The reality, however, dictates that the sheer volume and complexity of Standard Operating Procedures (SOPs), Minimum Equipment Lists (MEL), legislation and local regulations demand a simplified method of condensing the more pertinent items into a digestible format.

Checklists are an effective method of compressing vital actions and/or memory recall items into a standardised format (Kern, 1998). It furthermore assists in capturing essential routine actions for the safe operation of any helicopter. Airline operations demand a high sense of adherence to checklists for virtually every phase of flight, be it during normal operations or at the time of an emergency event. A simple example of an abbreviated Robinson R22 checklist is found in Table 2.4 [2].

Table 2.4: Robinson R22 Start Checklist

PRE-START-UP CHECKS	
First aid kit	Serviceable
Fire extinguisher	Serviceable and secure
Rotor brake	OFF
Fuel valve	ON
Frictions	OFF
Controls	Full and free travel
Frictions	ON
Carburetor heat	Check linkage
Mixture	Check linkage and set
Trim	Check linkage and push in
Circuit breakers	IN
Radios	OFF
Switches	OFF

[2] Note the concise wording and fluent layout of all the “Pre-flight” checks, “Cockpit & Start-up Checks” actions, as well as “Pre-take off Checks”. The layout conforms to the Original Equipment Manufacturers (OEM) official checklist, as found in the regulatory Rotorcraft Operating Handbook.

PRE-START-UP CHECKS	
Instruments	Check individually
Compass	Check approximate heading
Governor	On (select to the right)
First aid kit	Serviceable
Fire extinguisher	Serviceable and secure
Rotor brake	OFF
Fuel valve	ON
Frictions	OFF
Controls	Full and free travel
Frictions	ON
Carburetor heat	Check linkage
Mixture	Check linkage and set
Trim	Check linkage and push in
Circuit breakers	IN
Radios	OFF
Switches	OFF
Instruments	Check individually
Compass	Check approximate heading
Governor	On (select to the right)
START-UP CHECKS	
Master battery	ON
Strobe	ON
Fuel quantity	Check
Prime	As required
Look out	Clear and verify blade position
Magnetos	Both – then start
Clutch	Engage with no delay
Alternator	ON. Check load and light
Oil pressure	Check pressure rise
RPM	Throttle open to 55%
Main rotor blades	Turning within 6 sec
Oil pressure	In green arc within 30 sec
Clutch light	Out within 90 sec
RPM	Throttle open to 75%
Vne graph	Calculate Vne

START-UP CHECKS	
MAP	Calculate MAP available
Cylinder head temperature	In green arc
RPM	
Governor	Throttle open to 102%
Carburetor heat	Off
Mixture	Out – temperature up – RPM drop
MAP	Out to peak – then set ½ inch richer
Governor	Normal (between 10-12 inches)
Collective	ON
Throttle	Lift ½ inch
Throttle/collective	Slowly close till horn sounds at 97%
Engine	Close/lower (Check needle split)
Throttle	Check idling
START-UP CHECKS	
Magneto check	Set RPM at 75%
Throttle	L/R (Max drop 7% in 2 sec)
	Open to 104% RPM

A more advanced version of the Emergency Checklist is noted in Annexure K and encapsulates the prior notions of checklist discipline in the case of complex systems failures on a twin-engine helicopter. Human memory is inconsistent at the best of times and even more degraded during times of stress and fatigue (Transport Canada, 1989).

During the initial demonstration flight the student will be exposed to the use of a checklist, but not subjected to the full content. This only follows after the formal sign-up and subsequent flight exercises that commence after the introduction and briefing phases. The importance of following checklists and approved procedures should constantly be emphasised and tested by the instructor in order to ensure standardisation and conformity to established safety procedures (Padfield, 1996).

Similarly, student training files must be annotated and expressly noted, should students not conform to the minimum level of proficiency required for safe flight operations as a result of abhorring checklists and procedures.

2.4.4 The Yerkes-Dodson Law of arousal

A further crucial indicator, whilst engaged in the initial introductory flight, is the candidate pilot's ability to cope with sudden initiated (or even involuntary) situations which entail a sense of heightened arousal. It has to be noted that at this point virtually all students are highly excitable and perhaps even tentative in their expectation of the first flight experience. To this end, the Yerkes-Dodson Law of arousal serves as an accurate indicator of performance changes and defining a person's overall state or level of activity (Matthews *et al*., 2000).

The significance of arousal in a flying environment is the absolute necessity for the pilot to react distinctly and immediately in the event of an inflight emergency situation. The relationship between arousal level and pilot performance is expressed as an inverted U-curve (Yerkes & Dodson, 1908) and illustrated by Figure 2.10:

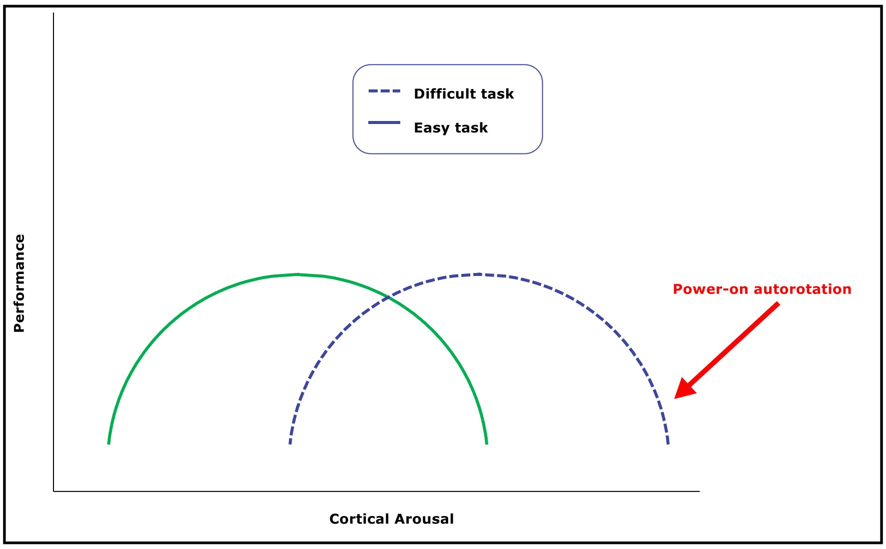

Figure 2.10: Adapted Yerkes-Dodson Law of Arousal (Source: Matthews, 2000)

Figure 2.10 shows that the optimal arousal level for performance ensures maximal performance under a given level of arousal and is typical of individuals who operate under conditions of alertness and awakening (Matthews *et al*., 2000). Similarly, this defined optimal arousal level for performance is inversely proportional to the difficulty of the task being experienced. The level of arousal emanates from signals in the brain circuitry that link the cerebral cortex to structures in the brain-stem and manifests clearly when plotted against the desired performance for a given task (Matthews *et al.*, 2000).

Two causal factors combine significantly when evaluating a prospective student for the first introductory flight. Firstly, apart from the obvious varying levels of anxiety and/or exhilaration, the student will intrinsically be engulfed in a realm of trepidation. This emotion can lead to either a positive or negative outcome in the event of instructor-induced inputs that may be construed as “violent manoeuvres” or even quasi-emergency situations. The instructor should be particularly mindful of the potentially damaging effect an unannounced extreme manoeuvre can have on the student (Gawron, 2008; Matthews *et al*., 2000). Secondly, the instructor must carefully note the extent to which the student reacts when a moderately induced, and correctly recovered flight manoeuvre, is executed. A suggested example of such an episode can be a power-on autorotation manoeuver, fully briefed in advance and expected outcomes well explained.

The level of difficulty associated with the suggested flight manoeuvre on a specific student can hence be recorded scientifically and interpreted. The extent of cortical arousal poses a substantial challenge to any student and a careful assessment of his/her initial reaction to a rushed control input is of importance to a successful flight evaluation (Gawron, 2008). As noted in the paragraph above, the prospect of entering an autorotation in a small underpowered helicopter is extremely daunting and an expected severe level of arousal will occur (see Figure 2.10 above).

Typical physiological signs of arousal include: an increase in heart rate and skin conductance, changes in voice patterns, severe gripping of the flight controls and even complete peripheral (hands and feet) departure from all the flight controls (Matthews *et al*., 2000). Instructors should be well versed and briefed on the effect that arousal has on a new pilot under these circumstances. Personalities differ immensely when challenged – more so, when it is perceived as a life or death encounter.

2.5 HELICOPTER DESIGN ERGONOMICS

The term ergonomics is defined as the study of efficiency of people in their working environments (Oxford Dictionary) and is derived from the Greek meaning "the science of work" (Wiener & Nagel, 1998). Helicopters are described as "perfectly unstable flying platforms" and behave accordingly (Padfield, 1996). Despite the complexity associated with helicopter design and the subsequent evolution since the early design days in the 20th century, the specific handling qualities and control mechanisms have changed very little.

The primary controls remain the cyclic pitch control (manipulated with the right hand and analogous to a joystick in a video game), collective pitch control (raised and lowered by the left hand) and the tail rotor yaw pedals which control the tail rotor pitch.

Figure 2.11: Robinson helicopter flight controls and cockpit layout

The cyclic pitch control effectively changes the attitude of the main rotor disk, when regarded as a solid lift-generating precessional body, rather than two, three or four individual main rotor blades. Displacing the cyclic control forward, for example, would tilt the entire disk forward and cause the lift vector to slant forward of the imaginary vertical thrust line. The body of the helicopter will gradually follow suit and continue to be propelled into the desired direction, as dictated by the displaced cyclic position.

The collective pitch lever controls the vertical changes through the rotating disk's pitch angles. Raising the collective level increases the individual blades' pitch *collectively*, thus in equal amounts on all blades to ensure a uniform lift distribution profile across the entire disk. The requisite action therefore causes the helicopter to climb or descend vertically.

In linear accordance with Newton's Third Law, the equal but opposite effect of the rotating disk is that the airframe tends to rotate (yaw) in the opposite direction. When considering an anti-clockwise blade rotation (as viewed from above), an increase in collective pitch control would cause the helicopter's nose to yaw in a clock-wise direction. The correct pilot intervention entailed applying opposite tail rotor pedal inputs to the direction of yaw. The tail rotor assembly located on the very end of the helicopter's tail boom ensures that sufficient directional control and authority is exerted during all stages of flight. Although the basic control and control input techniques differ very slightly between various helicopter types, the ergonomic layout and suitable orientation is a major factor when considering pilot comfort and workload reduction.

2.5.1 Helicopter pilot workload and effect of cognitive factors

The effect of handling qualities (Cooper-Harper scale) and the actual index of helicopter task loads (NASA TLX) were discussed earlier. The workload experienced by a student with no prior exposure to flying a perfectly unstable platform, is immense. Various scientific measures exist to accurately gauge workload on any pilot (Hansman, 2009). Workload measurement approaches include objective performance approaches, such as primary tasks (including Yerkes-Dodson law of arousal), secondary tasks (slightly more advanced stimuli required) and objective physiological measures such as heart rate variability, eye pupil diameter, EEG, galvanic responses on the skin and specialised imaging methods (Hansman, 2009).

Matthews *et al.* (2000) posits further examples of processing codes applicable to an objective measurement of the cognitive factors associated with the initial introduction flight, such as visual cues (colour, lookout, shapes), spatial (spatial relationships and configuration), acoustic (noise factors, droning, direction of sound projection), speech (articulatory ability and/or impediments) and motor skills (muscle response to stimuli). The cognitive factors mentioned above are included in the initial assessment format for instructors.

Attention span and the lack of division during high workload situations are crucial behavioural considerations for any new pilot. Mental workload is analogous to physical workload (Matthews *et al*., 2000) and by definition demands multitasking capability (Garland *et al*., 1998).

Attention deficiency will compromise multitasking, which undermines constructive pre-planning and entails meta-knowledge about alternative behaviour. To this end, both planning and knowledge develop with experience and confirms the procedural requirement for recurrent training at scheduled intervals.

2.5.2 Systems Thinking for helicopter pilots

The existence and study of Systems Thinking has a distinct relevance to the thinking and planning mind set of candidate helicopter pilots. A systematic approach to the planning and execution of every flight is of paramount importance and serves to stimulate progressive and lateral thinking, culminating in proactive cognisance of potential hazardous conditions (Ackoff, 1995).

Systems Thinking had its origin in the 1940s, primarily through the extensive research and formulations of Ludwig van Bartalanffy. The initial foundation of his research was in the field of mathematics, psychology and sociology, also known as General Systems Theory (Bartalanffy, 1972).

The essence of Systems Thinking pivots around the phenomenon of evaluating the interaction, relationships and arrangements between the respective elements, rather than the properties of its parts. The same holds true for any organism, organisation or system and the focus continually reverts back to the notion of "wholeness" (Heylighen, 1992). Marcus (2007:11) notes that "it is vitally important to be able to identify the root causes of the problems and how to address them".

The author's experience of the South African aviation, and more specific helicopter industry, confirms the need for a Systems Thinking approach to the current and future operations within the helicopter industry, more so, the evaluation of candidate civilian helicopter pilots. A suitable analogy between the flight school and Systems Thinking is aptly cited by Haines (2007:2) as "…getting a '*helicopter view*' of situations, from a height of 5,000 feet, it is much easier to see the bigger picture" (Haines Centre for Strategic Management, 2007). In scrutinising the four distinct phases in the Systems Thinking approach, and more specific consulting the "Da Vinci way" (Marcus, 2007:16), the following observations were recorded during the research process:

(a) Systems Analysis ("As Is" state)

By evaluating the flight school systems, specific problematic processes were highlighted. The following factors constitute the current sub-systems of concern and is certainly not exhaustive or limited to: non-scientific approach to first evaluation of prospective new students, subjective flight performance assessments of pilots on introductory flights, unidentified (problematic) latent personality traits, characteristics and possible pathologies that later manifest in helicopter incidents and accidents if not addressed, and *distorted ego* manifestations, exhibitionism and refusal to adhere to regulations, SOPs and school rules.

(b) Obstruction Analysis ("How it will be" state)

Based on the identified problem areas above, it was imperative to critically and honestly consider the future, based on the likelihood of the process current continuing in similar vein if action was not implemented. An observation was made that the absence of a proper, immediate intervention in terms of the above analysis would potentially result in a chaotic system and cumbersome future management process. Specific points of concern noted as a probable projection of the current business model were: (i) decrease in revenue; (ii) reduction in profitability and sustainability; (iii) diminishing flight safety levels and oversight; (iv) confused student core and charter client base; (v) despondent staff members, owners and insurers, and; (vi) discreditation in the aviation industry.

(c) System Dynamics ("How it should be" state)

Whilst critically analysing the current and future states of the enrolment and evaluation systems at the company, it was also important emphasise that a single unique solution was difficult, if not impossible to find and implement. In doing so, the ideal operating domain would be attained and would include: reliable measurement of candidate pilot categorisation, well-controlled flight safety environment, expansion of the Safety Management System (proactive) and focus on safety RCA (reactive). Further considerations include minimised risk exposure to man and machine, providing a safe and reliable air service to charter clients and flight school students, sustaining the current levels of reputation and standing within the industry, continuing to secure referrals from clients and students to generate further business, and expanding on existing and potential business opportunities and exploiting core strengths.

(d) Mess Formulation

The perceived potential Mess within a system can be defined through factors such as inherently over-regulated aviation industry, severe skills shortage (both qualified and unqualified), Affirmative Action and BEE compliance, marginal operating conditions, unreasonable conduct by, and negotiations with helicopter owners and/or other industry operators and relevance anent actual safety considerations within the aviation industry (Marcus, 2007).

In exploring factual underpinnings relating to flight safety and the considerations akin to enhancing pilot safety culture habits, it is appropriate to examine the expanding effect relating to hazards, incidents and accidents. Figure 2.12 describes Byrd's triangle of hazard analysis and confirms the notion pertaining to the large number of hazards (500-750) leading to incidents (300) leading to minor accidents (30), to serious accidents (10) to a major accident (Borg, 2002).

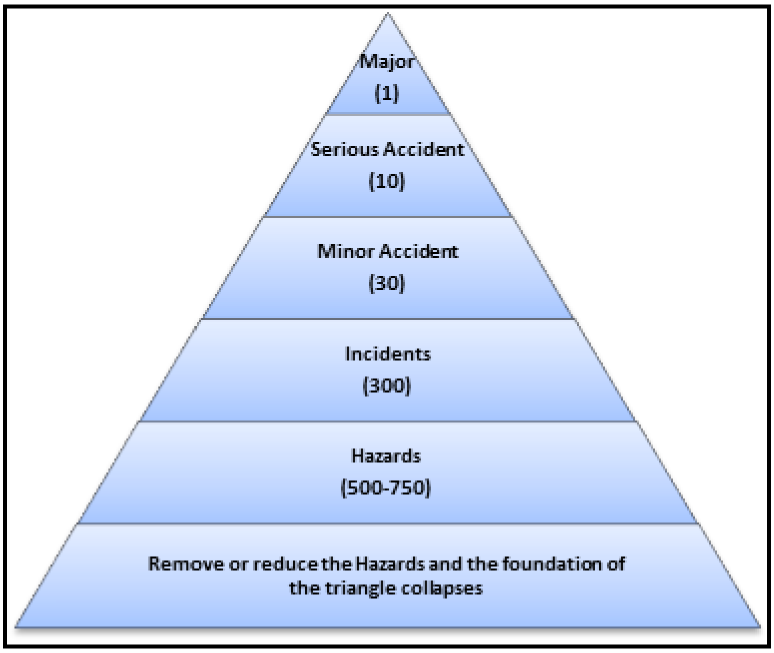

Figure 2.12: Byrd's Triangle of Hazard Analysis (Source: Borg, 2002)

Figure 2.12 typifies the extent to70% which the prevention of hazards will ultimately eradicate the occurrence of several more severe incidents and accidents higher up on the pyramid tiers. Albeit a realistic prevention model, the exact opposite occurred at the researched company in 2010, whereby two serious accidents and one major accident occurred within five days. Incidentally, all three events were from within the flight school and regarded as pure human-factor-related accidents. The quoted example, as compared to the layout of Byrd's Triangle, substantiates the notion of *chaos* within the aviation industry.

(e) Chaos

The aviation industry at large conforms to a rigid set of rules and regulations, with continuous oversight mechanisms in place. Despite the over-regulated nature of the environment and the desired safety stigma that attaches to the aviation tag, incidents and accidents still constantly occur.

Numerous reasons are typically cited in the media, first and foremost always being "pilot error". It has become a simple buzzword to inaptly and incorrectly define any newsworthy aviation related occurrence. More often than not, the exact opposite holds true insofar the actual cause of the mishap is concerned. Several contributing factors should always be considered such as weather, pilot experience, competence, proficiency and knowledge of the aircraft, physiological and psychological factors, mechanical condition of the aircraft, operating environment and terrain and surroundings (Barker, 2012a).

A plethora of variables contribute to most unsafe operations. It has to be said that hard-core chaos theorists are generally looking for "...order masquerading as randomness" (Gleick, 1987:8), and that this postulation conforms to the apparent chaos when considering aviation safety. The contagiousness of chaos permeating through all facets of the industry is an undesirable side effect and needs to be addressed in earnest.

Lorenz is regarded as the father of Chaos Theory and his postulation of the "Butterfly Effect" (Gleick, 1987) reiterates the thinking process whereby even the most meagre of actions have a profound effect further downstream in a given system. The overwhelming reality with regards to the often chaotic appearance is simply a matter of "managing the variables".

A worrying phenomenon in South Africa currently is the obvious inability of the CAA to control, guide, plan and regulate the aviation industry. The imminent effect of chaos can clearly be seen in the simplest of routine safety audits where hapless inspectors parade as seemingly educated officials but, in essence, lack the very foundation for conducting same. By employing the method of a Causal Loops analysis of the stated conditions and mess formulation, a clearer picture of the intrinsic flight school problem(s) are recorded (Marcus, 2007).

Systems Thinking approaches can be implemented very successfully at any organisation. Systems Theory is regarded and employed in a proactive manner, and conforms with internationally accepted aviation Safety Management Systems. Incident and accident investigations have historically been based on Root Cause Analysis (RCA) only and without incorporating formal proactive investigative philosophies (SACAA, 2009).

2.6 REVERSE ENGINEERING ROOT CAUSE ANALYSIS

> ***Lex Parsimoniae: Entia non sunt multiplicanda praetor necessitate.***
> *(When multiple explanations exist, the simplest is usually correct.)*
>
> William of Occam (c. 1287–1347)

2.6.1 Occam's Razor or *The Law of Parsimony*

Introduced by William of Occam (c. 1330), the Law or Parsimony, or more aptly colloquially known as Occam's Razor (it 'shaves the unnecessary untruths away') (Britannica, 2013) states that "when multiple explanations exist, the simplest is usually correct".

A stark reality is that every new law or regulation requires the establishment of a suitable enforcing agency. Man has lost its own ability to understand and appreciate the concept of consequentialism for every one of his actions, with a consequential escalation in legal suits and lawyers' fees.

The author posits that the simplicity of Occam's Razor finds favour when discussing and investigating aviation accidents and incidents. It reduces the number of feasible options to the most correct version.

Seifert (2013) suggests that instructors who evaluate new candidate students should, amongst other things, apply logical thinking, along with intuition and the principle of Occam's Razor when assessing obvious deficiencies and shortcomings on the introductory flight (Hughes, 2007). Instructors should also avoid complicated theories, judgements and external subjectivity whilst evaluating the candidate's ability.

2.6.2 Root Cause Analysis and perspectives

Root Cause Analysis is defined as "a study of the process for identifying the basic or causal factors that underlie variation in performance, including the occurrence or possible occurrence of a sentinel event" (Ghinassi, 2008:3). RCA was originally developed in Japan by Sakichi Toyoda of the Toyota Motor Corporation as part of their manufacturing methodologies and started off by exploring the "Five Why's Method", thus asking at least five "Why" questions (Ghinassi, 2008).

In the context of helicopter flight training and specifically the flight school at the company, sentinel events would include helicopter accidents and incidents. The consequence of a sentinel event would, by implication, mean substantial financial loss to the company, owner or insurers and any form of injury, whether minor, major or fatal.

Direct causes bring about the sentinel event without any other intervening event (Ghinassi, 2008) and are usually in close proximity to the sentinel event. It is important to note that for every effect a unique cause exists. Through the study of consequentialism (Marcus, 2007) it is prudent to note that a fairly long chain of relationships manifest between all causes and effects. Logic dictates that if a primary cause is removed, the original problem will not re-appear.

RCA is always regarded as an iterative process and subject to continuous review and improvement. Basic RCA focuses on a reactive approach to events that have occurred, but can eventually be more of a proactive process after gaining suitable experience in the field (Hughes, 2007). Five commonly used fields for RCA classes are: (i) safety-based; (ii) production-based; (iii) process-based; (iv) failure-based; and (v) systems-based RCA (Ghinassi, 2008).

In the research case for a helicopter flight school, the two most pertinent fields are safety-based and systems-based RCA. Safety-based RCA emanates from accident analysis and occupational health and safety considerations (Hughes, 2007). Systems-based RCA focuses on ideas and theories that comprise change management, risk management and system analysis – all relevant to the researched company. Specific philosophies relating to successful RCA practices include aetiology and the RCA dialectic paragon. These are discussed in greater detail below.

2.6.2.1 Aetiology

Aetiology is defined at the study of causes, their origin and designation (Hughes, 2007). With reference to the paragraph above regarding the definition of the various causes that relate to the aetiology of safety-based and systems-based RCA, the control volume can be limited to the helicopter training fraternity in South Africa. Within the discipline of aetiology, certain holistically defined deficiencies are evident and of specific value to this thesis (Hughes, 2007).

Bionomical performance deficiency describes factors contained in this domain which include procedural, supervisory, response propensity, training (or lack thereof), programmatic considerations, environmental issues and personnel factors. These factors are obviously of a behavioural nature and are at best undesirable when conducting RCA. This behaviour can be attributed to poor cognitive performance and a fundamental lack of knowledge, formal training or experience (Matthews *et al*., 2004).

Technical performance deficiency has relevance to factors that include adherence to systems, processes and components, equipment and the correct configuration thereof, performance deficiency of personnel and equipment (unreliability), improper handling and questionable conduct, system interaction, documentation and environmental interaction (Hughes, 2007).

Conditional factors act as constraints to the aetiology of causes and ultimately RCA include environmental matters, natural disasters and weather, technical issues and human factors. These constraints are typically regarded as being generated by uncontrollable matters of the environment and governed by external factors. They could also include ergonomically induced constraints such as poor man-machine interfaces.

2.6.2.2. Root Cause Analysis dialectic paragon

The work of Hughes (2007:90) addresses the RCA dialectic which examines “the art of investigating the truth of opinions and logical dispute”. It furthermore aims to create and establish a new RCA paragon for aviation and contributes significantly to the body of knowledge relevant to this thesis. Figure 2.13 explains the interaction of the conditional constraints factors mentioned above as precursors to any incident or accident and reveals the exact conditions for the occurrence of such events.

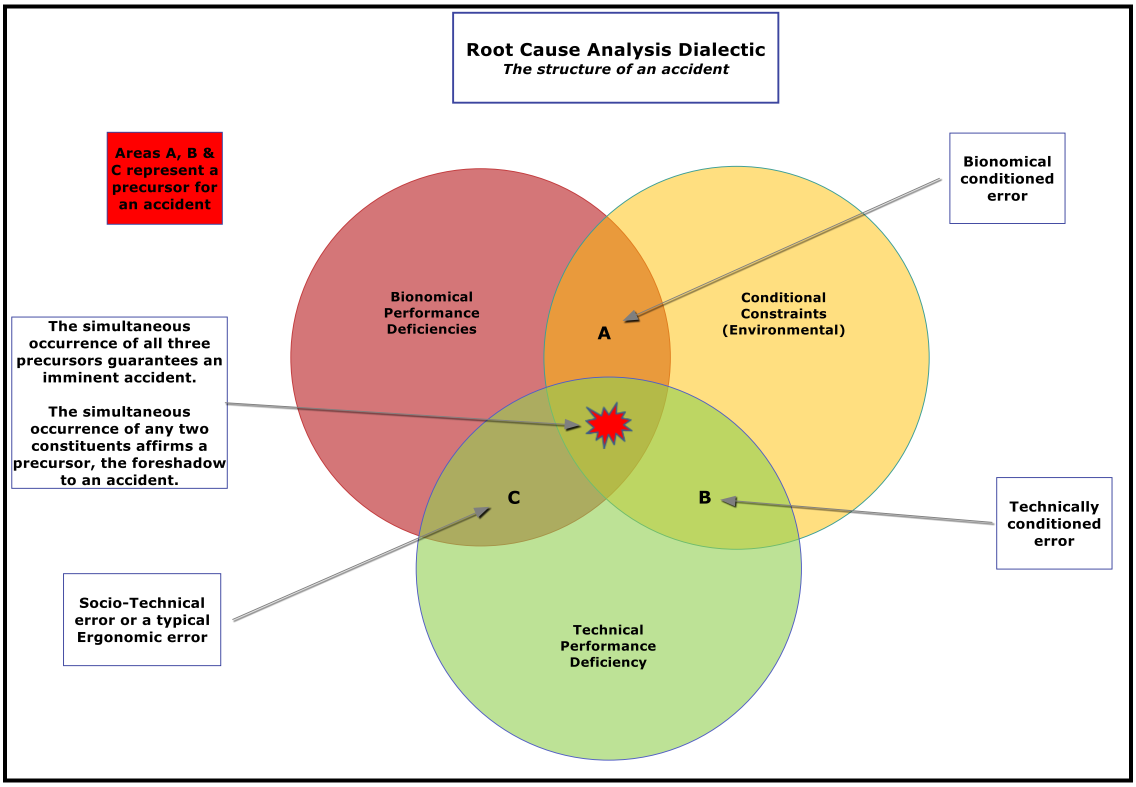

Figure 2.13: Root Cause Analysis dialectic (Source: Hughes, 2007)

By examining Figure 2.13 and defining the factors and conditions relating to the final categorisation process, requires a detailed analysis of the noted precursors. More so, a proactive approach is required for the establishment of a safety culture within the helicopter training industry rather than only reactive RCA conduct. Significantly, the simultaneous occurrence of any two of the above constituents affirms a precursor to an incident or accident (Hughes, 2007). An obvious observation is the overlapping of all three constituents that guarantees an incident or accident.

(a) Bionomical performance

Typical areas of concern for instructors when evaluating new students revolve around immediate perceptions and intuition. By remaining objective in terms of an introductory rather than assessment only approach towards a student, the following postulated bionomical factors should be observed:

1. Procedural factors require specific attention to the student's acceptance and understanding of helicopter procedures, checklists, company operating procedures, administrative requirements and individual document control. Supervision acceptance entails introducing the student to the basic hierarchy of instructors, oversight methods, flight school management, and expectation of the student's general conduct. Challenge/response propensity requires notation of the student's appreciation of in-cockpit procedures when briefed on specific minor tasks, basic commands and expected responses on the introductory flight.
2. Previous exposure to flight training can assist to determine and record any previous exposure to helicopter operations and/or flight instruction. Programmatic considerations ascertain and record the student's ability to accept change management (both on a personal and behavioural level) in coping with aviation discipline doctrines. Similarly, peer pressure is used to diplomatically determine and record the motive for initiating his/her PPL training course.

(b) Technical performance

Consultation with helicopter instructors revealed that a small percentage of pilots (students and PPLs) actually have sufficient technical knowledge of the equipment they fly or will ultimately be flying (Henley Air safety statistics, 2012). Technical performance is thus a major consideration when considering the potential adverse effect it may have on the RCA process after experiencing an incident or accident.

By employing a reverse RCA process in preparation of the categorisation process, prospective students will be adjudicated on pertinent factors such as determining the student's understanding of various helicopter systems, engine and handling controls and location of major components (post basic introductory briefing), flight school processes, as well as and adjudicating the student's ability to discern between safety imperatives and pure internal organisational processes.

Further considerations on a student's technical performance include evaluating the student's ability to make elementary assessments of potential system failings, reliability constraints and areas of probable non-conformance. The instructor should note and record improper helicopter handling or questionable student conduct as blatant inconsistencies insofar as obvious helicopter handling and control issues, exhibitionism, over-confident approach to flying and other relevant safety distortions are concerned.

(c) Conditional constraints

A third constituent when evaluating RCA processes is the investigation of conditional constraints. These constraints are typically regarded as variable and uncontrollable by man. Conditional constraints are related to and governed by external factors. Weather conditions and natural phenomena are self-explanatory and are major drivers in the RCA process when analysing accidents. Accurate weather forecasts and onsite weather briefings are available for virtually every location in the world and pilots should consult these and plan flights accordingly.

Helicopter serviceability, maintenance oversight and quality assurance, cockpit layout and movement constraints and helicopter performance considerations are factors that are regarded as variables and difficult, if not impossible to control fully. Human factors remain the single most important factor in evaluating any incident or accident (Barker, 2012a; Seifert 2013). In the past the predominant concern was focused on pilot error only, but more recently this shifted to maintenance personnel and air traffic controllers among others (Barker, 2012a).

The application of RCA has traditionally been of a reactive nature and sought to locate and confirm direct causes relating to incidents and accidents. Quality assurance systems such as ISO 9002 were developed in the early 1990s and served to activate a more proactive approach to quality management, oversight and ultimately safety (ISO, n.d.). Safety Management Systems served as further iteration for the original ISO Quality Systems and established a predominantly pro-active approach to aviation safety systems. The latest product range includes the Basic Aviation Risk Standard (BARS) which is being implemented at exclusive aviation departments worldwide (BARS, 2008).

The question pertaining to a formal reverse engineering RCA process (read: proactive RCA system) is inherently difficult to define, afford, install and sustain. A suitable proposal for this thesis is the basic exploration of a Bayesian Belief Network (BBN) and is depicted by Figure 2.14. The fishbone layout of the BBN describes the interrelation of the four *Da Vinci Institute* considerations (Management of Systems, Innovation, Technology and People) and the RCA performance factors relevant to the study (bionomical, technical and conditional constraints).

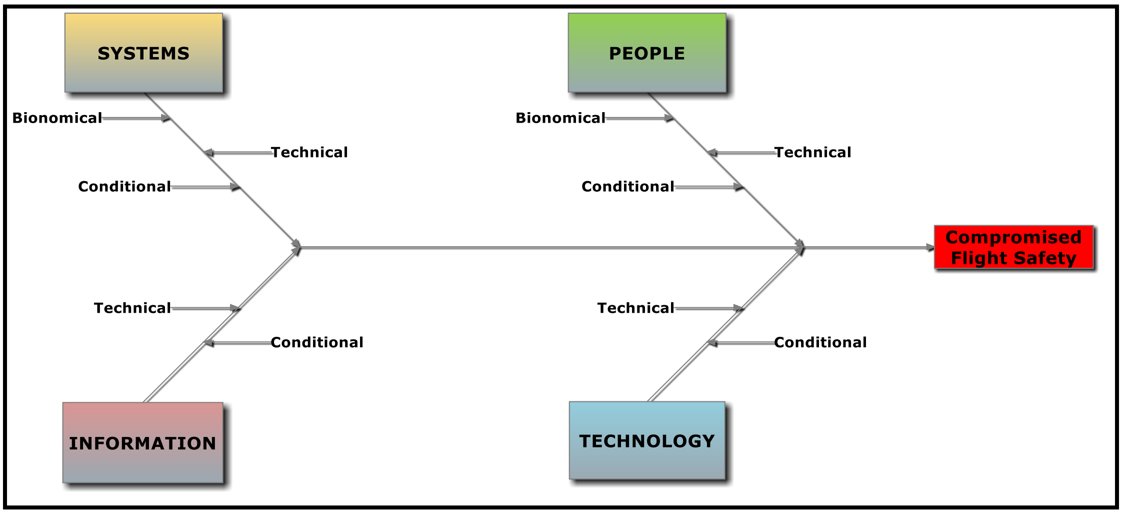

Figure 2.14: Basic Bayesian Belief Network (Source: Hughes, 2007)

The Bayesian belief network layout in Figure 2.14 is a method of examining the effect of an event to determine the original cause through a probabilistic graphical model that represents a set of variables and the probabilistic independencies (Ghinassi, 2008). The validity of RCA can thus be established and verified through factual evidence (Root Cause Analysis, n.d.), as is depicted in Figure 2.14.

Morales-Napoles (2010) addresses the notion of “structured expert judgement” in determining BBNs for aviation safety research, which is particularly relevant to the categorisation nature of this thesis. In reality, certain variables are modelled as continuous quantities rather than merely as *probabilities* (Morales-Napoles, 2010).

2.7 PSYCHOLOGICAL AND PHYSIOLOGICAL FACTORS

"Men (or women) in authority will always think that criticism of their policies is dangerous. They will always equate their policies with patriotism and find criticism subversive."

Henry Steele Commager (1974)

2.7.1 Situational Awareness

This section expands on the notion of Situational Awareness (SA) mentioned in Chapter 1. SA is the ability to asses and process knowledge relevant to the task being performed and can be regarded as an internalised model of the current state of the flight environment (Endsley, 1999; Ek & Arvidsson, 2012). SA has particular relevance in aviation and perhaps even more so with regard to initial helicopter training due to the continuous cognitive- and physical management of complex variables (Hauland, 2008). Typical examples of pressure variables include meteorological conditions, airspace constraints, air traffic control issues and mission profiles. There are essentially four measureable elements to accurately evaluate SA: (i) performance (or query methods); (ii) subjective ratings; (iii) simulation; and (iv) physiological factors (Gawron, 2008) and are scientifically measureable by among others, the Situational Awareness Rating Technique.

It is surmised that a significant correlation exists between a person's ability to assess each and every situation in life (note: not relevant only to aviation), and the published "Dunning-Kruger Effect" (D-K) which hypothesises that unskilled people make poor decisions and reach erroneous conclusions, but their incompetence denies them the metacognitive ability to appreciate their mistakes (Kruger & Dunning, 1999). The research furthermore showed that a distinct cross-cultural variation exists when people from varying cultural backgrounds were exposed to the same test batteries. Candidates from America displayed a tendency to inflate their worth, whereas candidates from East Asia tended to underestimate their abilities (De Angelis, 2003).

The Dunning-Kruger Effect is a major consideration for a large population of student helicopter pilots given the total incompetence (either perceived or actual) whilst busy with their *ab initio* training towards a Private Pilot Licence. The D-K effect interfaces significantly with the Peter Principle discussed earlier.

Other hazardous operating theatres for helicopter pilots include low-level operations, confined and/or slope landing areas and emergency situations. Palmer (2003) surmises that general SA mitigating factors include: cockpit fixation, ambiguity while interpreting instructions, complacency, euphoria (everything is perfect on-board), general situational confusion, unresolved discrepancies in cockpit such as crew gradient and complex seniority structures, distraction, cognitive overload/under-load (boredom), poor communications and information deprivation, failure to meet deadlines or mission requirements, improper following of procedures and a lack of flight related enquiry, command-assertiveness, problem analysis and poor airborne management skills (Palmer, 2003).

2.7.2 Spatial disorientation

Spatial orientation describes the pilot's ability to constantly discern and integrate his position in space relative to other aircraft, geographical landforms, weather and airspace (Vienna Test System, 2012).

Although this definition best describes external orientation aspects, the actual orientation of the pilot inside the cockpit relative to the resources available to him is a crucial function. Internal orientation entails the location and layout of engine and flight instruments, switches and avionics, amenities, lighting and control positions (Garland *et al*., 1998:126).

Disorientation is a complex phenomenon in flight and is the result of interactions of the visual and vestibular systems (Wiener & Nagel, 1988: 280). It furthermore entails the direct interaction between the vestibular system and proprioceptive mechanisms (relating to stimuli that are produced and perceived within an organism, especially those connected with the position and movement of the human body (Gawron, 2008) which detects and process gross movements of the body in a three-dimensional space (Wiener & Nagel, 1998).

The layout of any cockpit, along with the repetitive usage of checklists and procedures, determines situational success and safe flights operations. Spatial disorientation is potentially fatal if encountered in flight – more so under Instrument Meteorological Conditions and the reliance on Instrument Flight Rules.

Basic evaluation of prospective students should include an assessment of the students' navigational and spatial orientation aptitude, location of the airport in relation to easily identifiable landmarks (cities, towns and towers).

2.7.3 Measurement of attention span

Research by Transport Canada (2007) suggests that students start to forget the moment they leave the instructional environment. This phenomenon is more likely in owner pilots, where no operator proficiency checks are required for hire-and-fly purposes at the flight school. Ownership brings about an immediate sense of freedom and regrettably tends to detract from good recurrent training principles.

Contrary to popular belief, the greatest rate of forgetting occurs within the first 24 to 48 hours after the learning episode (Transport Canada, 2007). The ideal learning scenario revolves around a stated schedule of revision, as depicted in Figure 2.15 over page.

Ohio State University has carried out extensive research into the phenomenon of remembering, or perhaps more apt, “forgetting” tutored information. Figure 2.15 shows that the learning and retention curve is initially very steep and that students will remember less than 70% of what was learned in the previous two days. Furthermore, if no further reviewing is undertaken, approximately 40% of the lesson will be remembered.

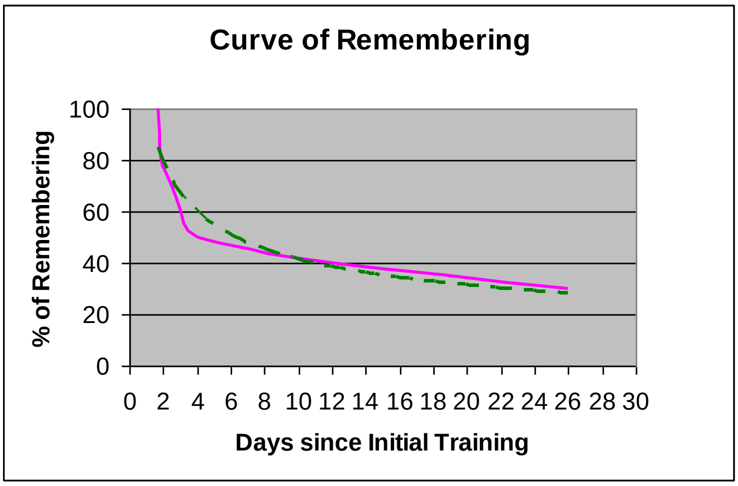

Figure 2.15: Curve of Remembering (Source: Ohio State University & Transport Canada, 2007)

However, in order to maintain a retention level of at least 70%, revision is required within two days of the original lesson, as explained in Figure 2.16. After the second tutorial event the (magenta) curve flattens out rapidly, denoting a greater retention span, and tends to confirm that the 70% retention level is reached after a further seven days. A further intervention ensures a significantly flattened (green) curve and a 70% retention level is maintained for up to 28 days. The yellow arrows indicate the ideal time of recurrent training to sustain a 70% retention level (Transport Canada, 2007).

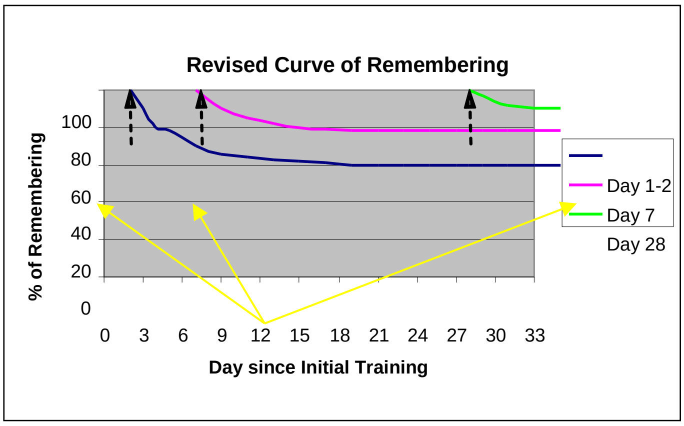

Figure 2.16: Revised Curve of Remembering (Source: Ohio University & Transport Canada, 2007)

The magenta and green lines in Figure 2.16 indicate the positively displaced curves of remembering, for example:

Initial training	➔ 50 minutes
1st review (day 2)	➔ 15 minutes
2nd review (day 7)	➔ 10 minutes
3rd review (day 28)	➔ 5 minutes

The significance found in the two curves and the quoted examples serves to confirm that technical and practical recurrent flight training should be an absolutely non-negotiable feature of recurrent training programmes. This holds true for private pilots, particularly due to the lack of continuous proficiency and maintenance of flying proficiency standards.

2.7.4 Locus of Control inventory

The effect of control functions, whether internalised or externalised, are of major consideration when assessing candidate pilots. Locus of Control (LOC) describes the degree to which a person (pilot) perceives and reacts to outcomes of the unique situations they experience under their control (Hunter, 2002). Pilots with internal LOC generally perceive that they can exert and maintain control over the outcome of specific situations, where as individuals with an external LOC tend to relate and attribute the outcomes to external factors such as luck and the actions of other persons (Hunter, 2002).

Rotter (1966) describes LOC as the representation of how an individual's process of decision-making ability is influenced, primarily on his own (internal) desire or based more on what others desire (external). Males are generally more internally inclined than women and are sometime referred to as "personal control" and "self-determination" (Rotter, 1966).

Additional characteristics of internalised behaviour are: greater protection against submission to authority, higher resistance to external influence, less sympathetic behaviour than "externals", generally known for better behavioural control, typically exhibit more political behaviour control and are more likely to influence other people than externals (Rotter, 1966).

Hunter (2009) intimates that an accurate and factual representation of the perceived personal control and expected behaviour of an aviator (Rotter, 1954) is defined by:

$$BP = f(E \ \& \ RV)$$

where: Behavioural Potential (BP) is expressed as function of Expectancy (E) and Reinforcement Value (RV).

Behaviour potential is the "likelihood of engaging in a particular behaviour in a specific situation" (Mearns, 2013:2). Expectancy is the "subjective probability that a given behaviour will lead to a particular outcome" (Mearns, 2013:2). Expectancies are purely based on past experience and serves as reinforcement of our behaviour.

Reinforcement is another name "for the outcomes of our behaviour" (Mearns, 2013:2). Reinforcement value reiterates the desirability of the expected outcomes (Rotter, 1954). Hunter (2009:14) posits that Expectancy is "a subjective probability that a given behaviour will imply a particular outcome and Reinforcement Value indicates the desirability of that outcome".

The Aviation Safety Locus of Control (ASLOC) was subsequently developed by Hunter (2002) which specifically tested the construct of internality-externality among pilots.

As an example, original research conducted by Hunter (2002) addressed the question whether pilots presented more internal LOC (as a more desirable personality characteristic) with an increase in age or flying hours. A significant ($p < 0.05$) positive correlation manifested between age and internal LOC ($n = 477$, $r = 0.237$) and a negative correlation with external LOC ($n = 477$, $r = -0.213$). The correlation between flying hours and internal LOC ($n = 477$, $r = -0.050$) and external LOC ($n = 477$, $r = -0.012$) had no statistical significance (Hunter, 2002). The work of Stewart (2006) confirms Hunter's statistical analysis and continues to describe LOC “not as a personality orientation, but instead as a set of outcome expectancies acquired through experience”.

Stewart (2006) and Hunter and Burke (1994) consider the following five attitudes pertinent to the Hazardous Attitudes Scale (HAS) and maintain that they correspond directly with differences in LOC: (i) invulnerability (“it won’t happen to me”); (ii) macho (“i can do it”); (iii) resignation (“what’s the use?”); (iv) impulsivity (“do something, quickly”); and (v) anti-authoritative (don’t tell me what to do”). These factors have relevance to this research project and in line with the qualitative research process followed in Chapter 3.

Hunter (2009) furthermore concludes that pilots with higher internal LOC orientation experienced fewer aviation accidents than those with a lower construct. Resignation and command unassertiveness was also found to be associated with accident involvement. Resignation scores indicate the degree to which a pilot elects to choose alternatives indicating a sensation of powerlessness to control events (Hunter, 2002).

The formulation of a Self-Serving Bias by Wichman and Ball (1983) refers to individuals who rate themselves as superior to others, or as being at less risk of experiencing some adverse event. The SSB is based on the original LOC work by Rotter (1954) and was confirmed in the positive by tested pilots that they possessed above average flying skills, were above average safe pilots and their risk profile was above average to other pilots (Hunter & Stewart, 2009). The final analysis of the research showed that “aviators with more experience and exposure developed stronger SSBs and showed higher internal LOC tendencies”. Interestingly, civilian pilots had significantly higher internal ASLOC scores than military pilots and helicopter pilots were significantly different from other pilots (transport and fighter) on both internal and external scores (Hunter & Stewart, 2009).

By developing a model of predicting aircraft pilot-training success through meta-analysis, Hunter and Burke (1994) evaluated 437,258 cases and isolated the following safety predictors, as contained in Table 2.5 over page:

Table 2.5: Aviation Safety Predictors (Source: Hunter & Burke, 1994)

PREDICTOR	NUMBER OF VALIDITIES
General ability	8,071
Verbal ability	22,841
Quantitative ability	46,884
Spatial ability	52,153
Mechanical	42,418
General information	29,951
Aviation information	25,295
Gross dexterity	48,988
Fine dexterity	2,792
Perceptual speed	33,511
Reaction time	10,633
Biodata inventory	27,004
Age	13,810
Education	6,163
Job sample	2,814
Personality	22,486
TOTAL	437,258

The data contained in Table 2.5 assisted with the compilation of the Designated Flight Examiner (DFE) questionnaire developed by the author, and without prior knowledge of the above factors, shows good commonality and relevance to the noted predictors by Hunter (1994).

2.7.5 Mediocrity and diminishing personal standards

The South African political landscape and associated demographics have had a profound effect on the citizens of the nation. Post-1994 thinking, reasoning and personal conduct changed in relation to demographic and socio-economic factors (Barker, 2012b). Regrettably, the very real effect of mediocrity and corrupt actions has become the standard set by an equally mediocre government structure.

The "way of least resistance" and an *instant* solution to virtually every potential problem has permeated into the fibre of a lost generation through a poorly set adult example (Coetzee, 2000).

The researcher noted that the mediocrity associated with such a mentality inevitably leads to an acceptance of such lowered normative, socially accepted and personal standards. Mediocrity, complacency and below average conduct poses a major threat to aviation safety and must be noted at the time of the initial demonstration flight.

2.7.6 Language barriers

Aviation radio telephony (RT) is regarded by the author as a fifth significant control function in helicopter flight. The others are cyclic pitch control, collective pitch control, tail rotor/anti-torque pedals and the engine throttle control.

The InternationalCivil Aviation Organisation (ICAO) has implemented a worldwide initiative to standardise all RT to a common scale, ranging from 1-6. The ICAO Language Proficiency Requirements consist of Operational Level 4 of the ICAO Language Proficiency Rating Scale and a set of Holistic Descriptors of operational language proficiency.

The ICAO Rating Scale delineates six levels of language proficiency ranging from Pre-Elementary Level 1 to Expert Level 6 across six areas of linguistic description: (i) pronunciation; (ii) structure; (iii) vocabulary; (iv) fluency; (v) comprehension; and (vi) interactions (ICAO, 2012).

ICAO expects assessments in English language proficiency in the context of aviation against the criteria contained in the ICAO Language Proficiency Rating Scale and the ICAO Holistic Descriptors. The ICAO Language Proficiency Requirements state that an applicant for a pilot or air traffic controller licence or a licence-holder shall demonstrate, in a manner acceptable to the licensing authority, compliance with the ICAO Operational Level (Level 4) of the ICAO Language Proficiency Rating Scale and the Holistic Descriptors, as denoted in Table 2.6 over page:

Table 2.6 – ICAO Language Proficiency Rating Scale (2012)

<table>
<tr><th colspan="2">ICAO LANGUAGE PROFICIENCY RATING SCALE</th><th>ICAO HOLISTIC DESCRIPTORS OF OPERATIONAL LANGUAGE PROFICIENCY</th></tr>
<tr><td>LEVEL 6</td><td>Expert</td><td rowspan="6">Proficient speakers shall:

Communicate effectively in voice-only (telephone/ radiotelephone) and in face-to-face situations

Communicate on common, concrete and work related topics with accuracy and clarity

Use appropriate communicative strategies to exchange messages and to recognise and resolve misunderstandings (to check, confirm, or clarify information) in a general or work-related context

Handle successfully and with relative ease the linguistic challenges presented by a complication or unexpected turn of events that occurs within the context of a routine work situation or communicative task with which they are otherwise familiar

Use a dialect or accent which is intelligible to the aeronautical community 4</td></tr>
<tr><td>LEVEL 5</td><td>Extended</td></tr>
<tr><td>LEVEL 4</td><td>Operational</td></tr>
<tr><td>LEVEL 3</td><td>Pre-Operational</td></tr>
<tr><td>LEVEL 2</td><td>Elementary</td></tr>
<tr><td>LEVEL 1</td><td>Pre-Elementary</td></tr>
</table>

Table 2.6 depicts the various Language Proficiency Levels relevant to aviation requirements. The number of levels were considered as sufficient to show adequate progression in developing language proficiency without exceeding the number of levels between which people are capable of making meaningful distinctions. This is not an equal interval scale but it does establish a minimum English language proficiency level determined as necessary for aeronautical radio-telephony communications. The set of five Holistic Descriptors of operational language proficiency provide all-embracing characteristics of proficient speakers and establishes some context for communications.

Language barriers within the South African context are, regrettably, well-developed through historical differentiation. The author’s experience with *ab initio* flight training proves that most students suffer from fear of RT, a lack of basic English, or both.

Foreign students, more so from the Middle East and African countries, generally struggle with the correct pronunciation of specialised technical English terms and the immediate interpretation of same. The net effect is profound when considered within the aviation safety context.

When English- and Afrikaans-speaking South Africans have to contend with a “new” language such as aviation RT, the difference in their approach is immense and apparent. New students with Afrikaans as their mother tongue are generally apprehensive and hesitant to use English vocabulary and technical terms freely and with command. This places (invisible) undue pressure on the student and it is directly proportioned to pilot stress in the cockpit. It is a South African Civil Aviation Authority (SACAA) requirement for any student pilot to be in possession of a Restricted Radio Licence prior to going on a first solo flight.

The minimum qualifying standard for a Commercial or higher pilot licence is a General Radio licence. Instructors conducting initial demonstration flights must be aware of the latent apprehension contained in a non-English speaking student and dutifully note such observation on the assessment form.

2.7.7 Moral health

Clark and Frankel (2006) developed the Aviation Authenticity Inventory (AAI) for the pilot population in South Africa. Frankel represents one of the largest general aviation insurance brokerages on the African continent and was able to extract accurate accident data from the SACAA and specialist aviation assessors among others. The AAI was developed to recognise and disseminate accident statistics, and interpret same to elicit honest and relevant responses from accident survivors or witnesses (Clark & Frankel, 2006). Their research focused on moralistic behavioural factors within the aviation insurance sphere which are briefly discussed below:

(a) Compromise: Relates to the notion of elected deviation from acceptable and published procedures at the expense of flight safety considerations. High risk behaviour (Zuckerman, 2006) and sensation seeking inevitably lead to diminishing standards and reluctance to comply with normative and moral conduct.

(b) Disguise: Predispositions within human nature and an inherent adversity to admit personal failure and deficiency permeates into behaviour associated with disguise. The fear of ridicule and embarrassment is particularly relevant to aviation as “failure is not an option”. In fact, failure in any shape or form typical leads to a loss of life or airframe, or both. In the author’s opinion and experience, regardless of a “just culture” or “non-punitive approach” to addressing self-reported hazards and incidents at the researched company, very few pilots and ground crew report such occurrences out of free will and own admission.

(c) Denial: Ariely (2008) describes the effect of arousal on denial of an individual’s prevention, protection, morality and conservatism. This holds particularly true for aviation and the level of arousal derived from flying. Denying the possibility of a very specific level of inadequacy (Kern, 1998) in all pilots’ ability to handle potential emergency situations or other challenges is a fatal flaw in human construct. Kern (1998) furthermore explains that withdrawal from a challenging interaction or confrontation with peers is a clear sign of denial; so is procrastination by delaying and postponing the inevitable with regard to flight discipline and the accurate execution of same.

(d) Disclosure: Whilst researching and addressing the elements of compromise, disguise and denial, Clark and Frankel (2007) aimed to obtain the absolute truth from pilots and witnesses involved with aviation accidents in order to validate submitted insurance claims. Their AAI proved to highlight and enhance the notion that full disclosure is seldom a primary consideration of any insurance claimant and that the involved pilots would typically fabricate evidence suited to the successful settlement of a claim, rather than disclose the full truth.

Other factors associated with establishing a benchmark for moral health in aviation insurance claims submission were extracted from their research (Clark & Frankel, 2007) and recorded. Pilot deceit and Machiavellian conduct was prevalent in most claims. Secondly, the most common form of addiction, smoking and alcohol abuse, manifested in a high percentage of claims. Both substances are associated with the *machismo* attitude of addicted pilots. Addiction can furthermore be extended to the continued use of stimulants and recreational drugs – with dire flight safety results.

High stress levels have a negative impact on flight safety operations and contribute to a severe lack of personal wellness (Coetzee, 2007). Factors affecting stress levels include incompatibility of crew members, seniority gradient in the cockpit, complying with flight duty periods, personal matters such as divorce or death and aircraft technical issues.

Depression could emanates from escalated stress levels, troublesome sleeping habits, changes in energy levels and a myriad of associated personal matters. A lack of sleep and disrupted circadian rhythms could also contribute to an increase in depression.

Life purpose defines the extent to which pilots rate their existence and ambition within the aviation context. Most pilots confided that their sole purpose in aviation remained towards achieving the highest possible monetary gain and that the original passion for flying had diminished. Ego and behaviour were noted as additional factors and addressed earlier in this chapter (section 2.2.2) (Conte & Plutchik, 1994).

Regulatory bodies such as SACAA, the Accident and Incident Investigation Board (AIIB) and ATNS were perceived as victimising and negatively opposed to safe flight operations. Pilots commented that these bodies greatly contribute as stressors for flight operations.

Moral health is not regarded by the author as a personality trait that can be taught or transferred through normal flight instruction. The *effect* of moral health, however, should be gauged by the safety standards achieved by the individual, an aviation company and ultimately the aviation industry. Moralilty, along with flight safety discipline instilled by management, senior pilots, instructors and peers, is congruent with an acceptance of authority and a subservient attitude towards established guidelines and procedures (Barker, 2012b).

2.7.8 Physical health

Physical health and regular medical examinations are intrinsically part of every pilot's annual or even bi-annual licence revalidation routine. Medical examinations vary in severity and regularity in accordance with the type of flying licence held by the individual. Class I medical certificates are assigned to Commercial and Airline Transport Pilots, Class II to Private Pilots and Class III to recreational pilots under a separate operating category.

Somatic conditions relate to corporeal or physical considerations affecting the body, as distinguished from a body part, the mind or the environment. In the case of helicopter flying, the ergonomic considerations relating to physical constraints are profound. The European Aviation Safety Agency (EASA, 2011) implemented a focused approach to somatic conditions relating to the differences in psychological, psychosomatic and somatic stress reactions (NPA2011-16). This publication enforces a specific emphasis on the relevance of such somatic conditions in establishing new safety standards in Europe and is contained in all syllabi and learning objectives pertaining to Personnel Standards.

South Africans are by definition inclined to obesity and rate the highest on the worldwide Body Mass Index (BMI) scales (Morris, 2011). The real effect of this worrying somatic phenomenon is the obvious increase in student's weight and the adverse effect on underpowered training helicopters.

Cardiovascular disease claimed the lives of at least 195 people per day between 1997 and 2004 (Heart disease fact sheet, 2010) and continues to grow daily. Most people underestimate this adverse effect that additional somatic stressors have on an already obese body, smoking, alcohol, stress, deficiency in dietary respects and a lack of regular exercise. Diabetes and insulin-related illnesses are on the increase in

South Africa and pose a major threat to the general public and pilots alike. Pilots are by definition “chair bound” and have to remain so for prolonged periods of time.

The dreaded combination of the noted factors colludes to cause much misery to all pilots during their annual or bi-annual medical examinations. Incidentally, a pilot in possession of an Airline Transport Pilot Licence and over the age of 40 is required to undergo a thorough medical examination every 6 months, as opposed to pilots holding only a Commercial Pilot Licence regardless of age, who are required to have an annual examination.

Class I/Class II medical examination is a standard requirement for the issuance of medical certificate. It provides a comprehensive means of establishing a history of dreaded disease and recurring ailments. Interestingly, only two of the 48 questions relate to mental health aspects and merely skim the surface of acceptable psychological practice (Coetzee, 2007).

The significance of mental health, rather than only somatic conditions when assessing a prospective student, is of paramount importance. Standard practice at flight schools recommends that any prospective student must complete at least a comprehensive Class II flight medical examination prior to commencing helicopter flight training. Regrettably, the psychological assessment process in determining suitability for flight has historically been left untapped (Bor & Hubbard (2006). The Institute for Aviation Psychology, to which the author belongs and subscribes, encourages progressive assessment methods by instilling a proactive engagement process for pilots, rather than merely a reactive counselling service in the event of an incident or accident.

2.7.9 Mental health

“Thus, we arrive at the conclusion that personality is a complex hypothetical construct. It is a hypothetical construct because we develop it – from behavioural observations, of course. It is complex because we assume that it is composed of lesser units – traits, or needs, or id ego, and superego, and so on.”

Baughman & Welsh (1964)

On the SACAA medical examination form (http://www.caa.co.za), it is clearly noted that any inference to mental health is limited to two specific questions only:

1. Have you ever had any mental/psychological disorder?
2. Have you ever had a suicide attempt?

The profundity of the two questions is quite alarming when viewed in isolation from the remainder of the medical questions. In fact, few pilots will willingly surrender such information based on a simple YES/NO answer (Coetzee, 2007).

The extent to which pilots act and perform (Gawron, 2008) during normal, high workload and emergency situations can be described under: (i) behaviour; (ii) normality; (iii) latent pathologies; (iv) personality; (v) attitude; and (vi) aptitude).

(a) Behaviour

Human behaviour is best described as the very manner in which a person acts or performs and provides a crucial research facet to this thesis. These activities, including physical actions, are observed, inferred and interpreted (TheFreeDictionary, 2012) by others within our environment.

“Human Behaviour is the consequence of internalised stimuli, resulting in manifested responses, as influenced by the situation and personality” (Coetzee, 2012). An example of the uniqueness hereof is the fact that some individuals would respond with erratic, irrational and even totally untoward behaviour in a crisis situation, whereas others may remain composed, rational and in control. The intrinsic and extrinsic factors that shape this unique response need to be considered for the appropriate definition of behaviour (Coetzee, 2012).

For the adjudication of behaviour, the principle of individualisation and differentiation needs to apply. This is particularly appropriate when assessing individual pilot conduct within the cockpit domain. The universal and persistent question needs to be asked why a particular pilot would respond in a unique fashion, based on the stimuli provided, both by the instructor and by the instrument/equipment/aircraft. Moreover, how the pilot would react to external factors such as other aircraft, weather and instructions from ATC.

Intuitive responses remain the authentic version of an individual's reactions. This spontaneity that is neither intellectually nor cognitively considered authenticates such behaviour and qualifies for adjudication within the model suggested in Figure 2.17 and the instruments proposed as emergent criteria from the research in general, and the safety templates specifically (Covey, 1998). Figure 2.17 has relevance:

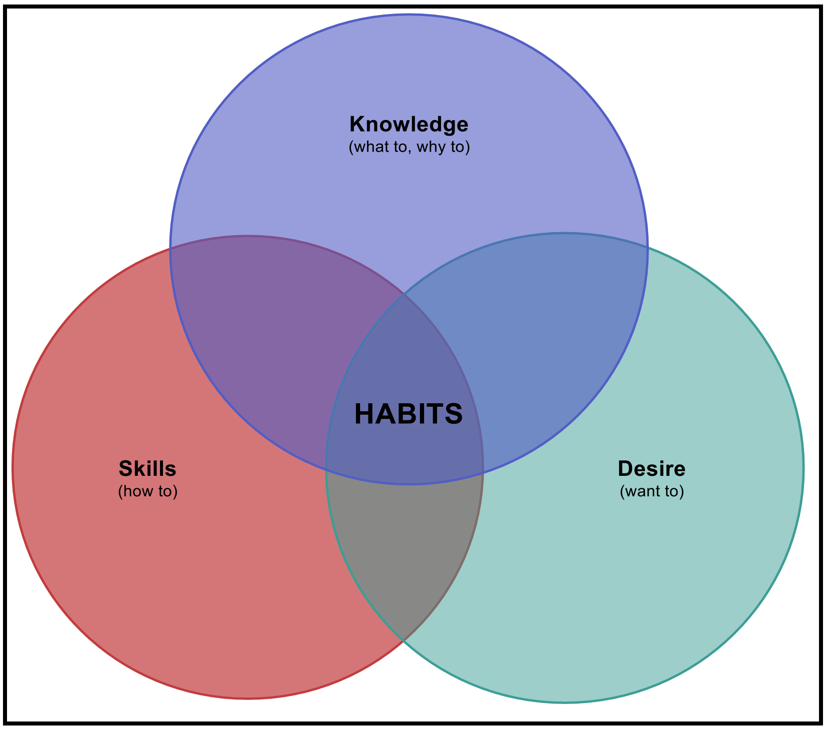

Figure 2.17: Effective habits – Internalised principles and patterns of behaviour (Source: Covey, 1989)

Figure 2.17 integrates the factors noted by Covey (1989) to expose the formation of a habit. Human behaviour is related to our intrinsic *habits* and defines our emotional and intellectual construct. Covey (1989) regards the intersection of knowledge, skills and desire as the definitive culmination in establishing our habits. The profound effect of habits on human conduct will be analysed comprehensively through the Shadowmatch™ software platform in Chapter 3. Research shows that the behaviour of pilots can be modelled mathematically and predicted to a great degree of accuracy using the Padé series and approximations (Szabolcsi, 2007). Various forms of accepted, and questionable, behaviour exist:

Adaptive behaviour describes effective or successful individual interaction with the environment. Adaptive behaviour is of specific concern to a newly acquired cognitive discipline such as helicopter flight training.

Contingent behaviour entails actions that are dependent upon a specific stimulus. The stimulus in this respect will be *flying* itself and of primary concern when compared to flight safety, discipline and a diligent student approach.

(b) Normality

Normality refers to the action and conditions experienced by a group within the context of their surroundings (Coetzee, 2007). For example, the conduct of a defined group at a sports match may be regarded as normal by all participants present, however such behaviour would probably differ significantly from the normality associated with the same group at a Sunday church sermon. The same principle undoubtedly applies to the normal behaviour of student pilots, experienced pilots and ancillary staff within the aviation context. It would be regarded normal for persons associated with aviation to present attitudes such as sophistication, self-discipline, thoroughness, comprehension, planning and self-management (Cooke, 2012).

The manifestations and definitions of normal and abnormal behaviour remain a pressing question in particular, since subjectivity prevails. Therefore, the qualifications of the adjudicating pilot and the proven relevance and operational pertinence of the compiled checklists will remain the definitive interventions and criteria when adjudicating such behaviour.

In this thesis it has been attempted to define such behaviour parameters (safety culture habits) of normality and therefore acceptability, as adjudicated by the proven characteristics of relevant normal behaviour as manifested in human conduct conducive to sustainable safety, and therefore normal behaviour (Jung, 1973). Abnormal behaviour, defined as pathological in nature and therefore deviant, needs to be identified, specified and evaluated timeously, to prevent and ultimately remedy such behaviour (Zuckerman, 2006). Such manifested abnormal behaviour needs to be observed, assessed, defined, interpreted and processed in order to ensure that a pilot who manifests such conduct is not allowed to operate an aircraft. Whilst instructors are not necessarily trained behavioural scientists or psychologists, it is imperative that they do undergo basic training within the context of typically manifested abnormal behaviours.

Typical abnormalities that would feature within this construct include: (i) arrogance; (ii) excessive self-confidence; (iii) superiority; (iv) intimidation of the flight instructor because of excessive self-esteem and importance; (v) self-ridicule and inferiority; and (vi) psychopathic features such as delusions (Zuckerman, 2006). Again, the issue here is not for any instructor to masquerade as a trained or registered behavioural scientist, but indeed to be alert to and trained in basic behaviour observation and assessment skills – all in the interest of safety and training efficacy.

(c) Latent pathologies

As noted in the introduction to the research domain, the author is not a registered psychologist neither does he purport to be one. The identification and discussion of aviation-related human behaviour was conducted under the auspices and sanction of a registered and well-respected South African aviation psychologist.

Notable latent personality disorders and/or pathologies relevant to aviation are congruent with specific behavioural conduct (Berne 1964). Behaviour can be modified or corrected in order to address undesirable conduct by virtue of addressing and changing observable actions (Zuckerman, 2006). It does however require systematic manipulation and modification of environmental and behavioural variables prevalent to the actual behavioural trait that demands modification. This *treatment* process essentially addresses the specific disorder associated with the abnormal behaviour.

Much research on *mood disorders* in aviation has been conducted by the US Aerospace Medical Association and the American Society of Aerospace Medicine Specialists (ASAMS, 2008). A depressed mood disorder (“depression”) is typically defined as five of the following eight symptoms that must occur for most of the day, nearly every day and for at least 14 consecutive days:

- Change in sleep pattern
- Loss of interest
- Thoughts of worthlessness or guilt
- Loss of energy
- Trouble concentrating
- Change in appetite or weight
- Changes in psychomotor activity
- Thoughts about death or suicide (ASAMS, 2008).

The noted symptoms are highly relevant to the aviation industry and would manifest in various direct or masked guises. The rapid onset of depressive symptoms, in combination with financial and/or work related pressures, are potentially fatal factors to consider when evaluating any pilot.

(d) Personality

In the context of this thesis and by specifically examining the source traits characteristically associated with pilots, an individual's personality can be defined as "the combination of all the relatively enduring dimensions of individual differences on which he can be measured" (Byrne, 1996). Contained within any individual's personality (the "mask" that displays during interaction with others), certain Behavioural Triggers are apparent and defined by Coetzee (2007) as depicted in Figure 2.18 over page:

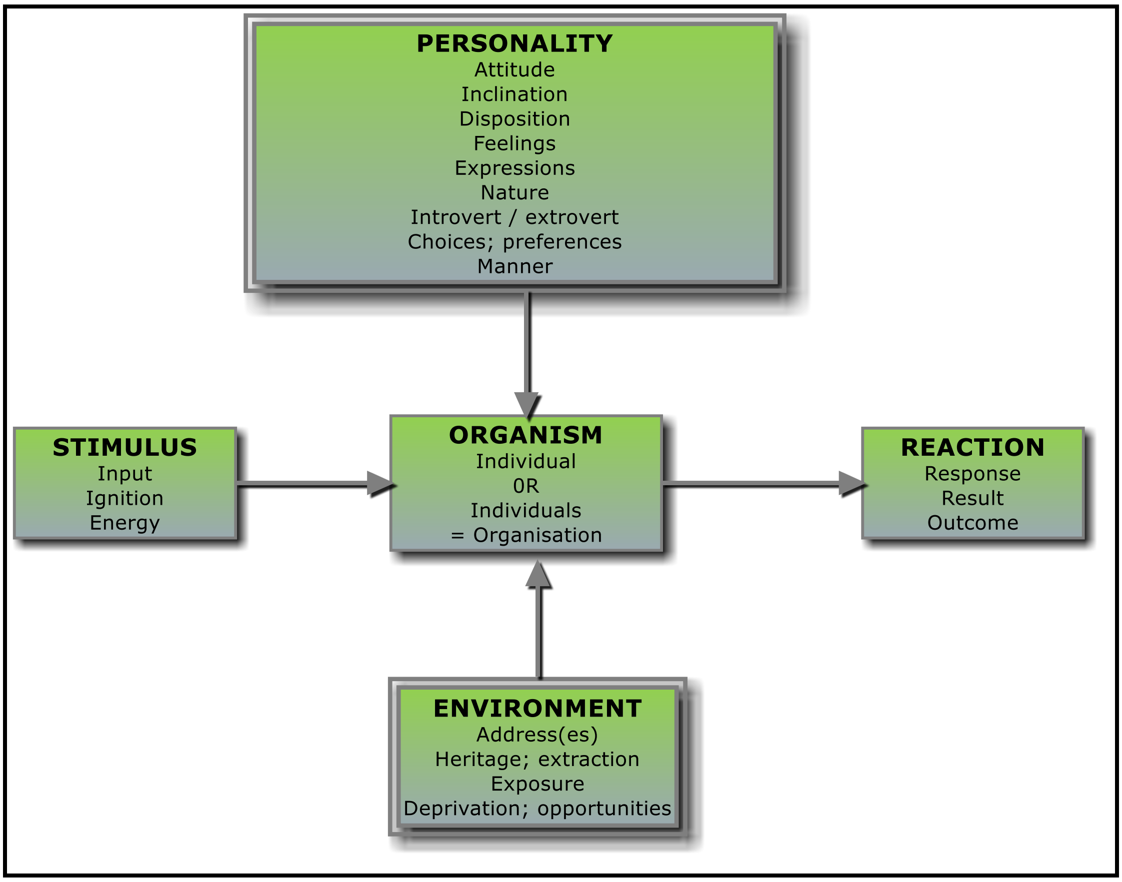

Figure 2.18: Behavioural Triggers: Stimulus ⇨ Organism ⇨ Reaction relation (Source: Coetzee, 2012)

Figure 2.18 describes the behavioural and personality aspects of (specifically) pilots which are defined as functions of their external stimulus and the operating environment. The Organism (read: control volume at the researched company) serves to anneal the various disciplines intrinsically unique to this organisation. Furthermore, the Organism is also the actual helicopter cockpit, the operating environment and the locality of the airport (Coetzee, 2012).

The Organism ameliorates the input from External Stimuli, Environmental factors and the subject pilot's Personality. The expected output or Reaction typically manifests as either a desirable or, perhaps, even undesirable result/outcome.

(e) Attitude

Defining the appropriate or desirable aviation attitude is all but improbable, if not totally impossible. Opinions about aviation attitude amongst flight instructors and experienced pilots will differ when challenged to disclose same. Desirable attitudes observed include (i) submissiveness; (ii) cautionary disposition; (iii) attention to detail; (iv) conservatism; (v) domain respect ("normal" ego); (vi) intuition; (vii) continuous self-evaluation and reflection; (viii) compliance with SOPs and regulatory constraints; and (ix) declarative revelation (Coetzee, 2008).

These attitudinal considerations are explored and tested in the DFE questionnaires discussed in Chapter 3.

(f) Aptitude

The definition of aptitude implies a person's capability, ability and innate or acquired capacity for something. It enforces that such a person possesses a unique talent – more so in relation to a state of readiness or alertness when a situation requires immediate action (Dictionary Reference, 2012).

The author is regularly challenged by parents of young prospective students to make an immediate assessment of their child's aptitude and ability to conquer helicopter flight training. The overarching factor is typically one of financial consideration and mostly aligned with not wanting to make the incorrect decision in both timeframe and monetary terms. Indecisive students pose an immense opportunity for disappointing their parents and peers alike. Their intrinsic concern is founded in a lifetime of indecision and delaying the inevitable pending failure. The stark reality is that failure in aviation leads to huge financial implications, injury or death.

Aptitude cannot be taught, trained or bought (Gawron, 2008), regardless of the required level of aptitude. Various aptitude tests have been developed internationally (Vienna Test System, 2012) and are available commercially for a myriad of specific applications. The Vienna Test System Psychological Assessment Programme includes a Pilot Spatial Test which is "a Rasch-homogenous procedure with the objective of purely measuring high selectivity in the upper range of performance, navigational skills for spatial orientation and diagnostics in aviation psychology" (Vienna Test System, 2012:11). Internal consistency is based on (Cronbach's Alpha) of r = 0.74 and shows fair reliability construct.

In addition to aptitude, the study of proficiency is appropriate at this time. Proficiency refers to a person's present ability to perform representative tasks (Matthews *et al*., 2000), whereas aptitude indicates the individual's potential for learning specific task skills. Predicting a person's performance when compared to his aptitude is typically an inexact science. It is also and highly dependent on the environment in which it is conducted, as well as the person's cognitive and learning abilities and skills acquisition capacity (Matthews *et al*., 2000).

The accuracy of ability tests generally appear to be reliable, but their validity highly questionable (Matthews *et al*., 2000). Criterion validity refers to the ability of a test or measure to predict some intrinsically interesting measure. Construct validity implies whether the ability measure actually assesses a meaningful theoretical construct (Matthews *et al*., 2000).

Figure 2.19 over page indicates the correlation between a person's psychomotor, perceptual and general ability when exposed to a predictive aptitude testing battery. The intersection of the psychomotor and perceptual ability graphs denotes the transition from the Cognitive to the Associative phase. Pure mental abilities tend to decline during this phase and confirms that performance is hence most sensitive to individual differences in general ability, more so, in primary abilities. As the tasks become more complex, mental capabilities become more predictive in relation to perceptual speed and psychomotor abilities (Matthews *et al*., 2000). The final phase relating to predicted Autonomous actions originates at the graph intersection of the increased general ability and decreasing perceptual speed ability point. Perceptual speed is thus replaced by psychomotor ability as the main predictor of performance.

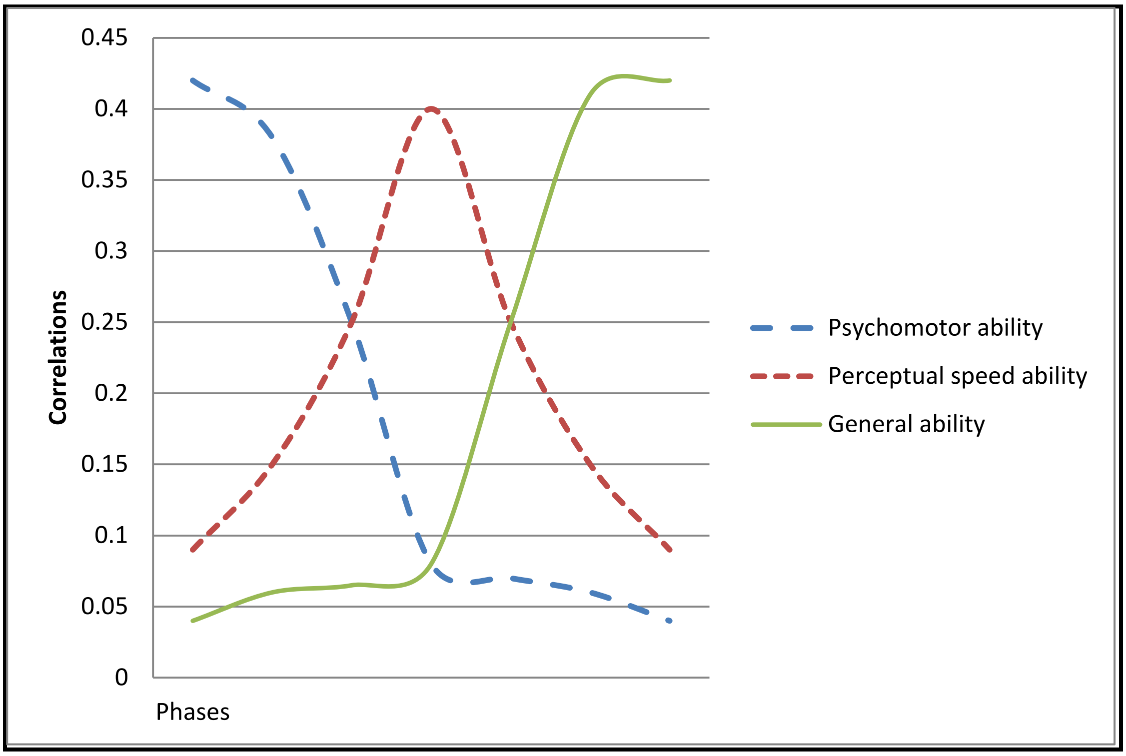

Figure 2.19: Predicted correlations between ability factors and performance (Source: Matthews *et al*., 2000).

The graphic depiction in Figure 2.19 is indicative of the variations encountered when comparing psychomotor, perceptual speed and general ability. The accurate evaluation of aptitude will hence be evaluated in accordance with qualitative research methods whereas pure ability functions will be assessed through quantitative methodology.

2.8 CHAPTER OVERVIEW AND INTEGRATION

Chapter 2 addressed the literature study for the purpose of identifying and embedding the factors conducive to the establishment of a suitable categorisation methodology of pilot safety culture habits, the associated DFE questionnaire and the statistical analysis.

Quoted and cited literature sources provided a comprehensive overview of the subject matter and exposed the study to new concepts. The most profound research discovery made by the researcher was the significant value of *LOC* measurements relating to pilot categorisation.

The challenge for the researcher in this chapter was to remain focused on and congruent with the identified topic of safety culture habits relevant to the compilation of the DFE questionnaires. Hence, it was possible to ascertain the relevance and applicability of the reviewed literature topics and the further adoption of same in the final questionnaires.

In Chapter 3 the reader is introduced to the research design and methodology relating to both the quantitative and qualitative approaches adopted for the purpose of this thesis. A mixed methods approach is utilised and further reduced to the adoption of a convergent parallel design methodology.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTORY PERSPECTIVES

This chapter discusses the methodologies followed in designing the research towards a categorisation process for candidate helicopter pilots. The construct of the research design is based on quantitative and qualitative methodologies, hence the use of a mixed methods approach (Creswell, Plano Clark, Gutmann & Hanson, 2003). A convergent parallel mixed method (Nova, 2013) was utilised, as depicted in Figure 3.1:

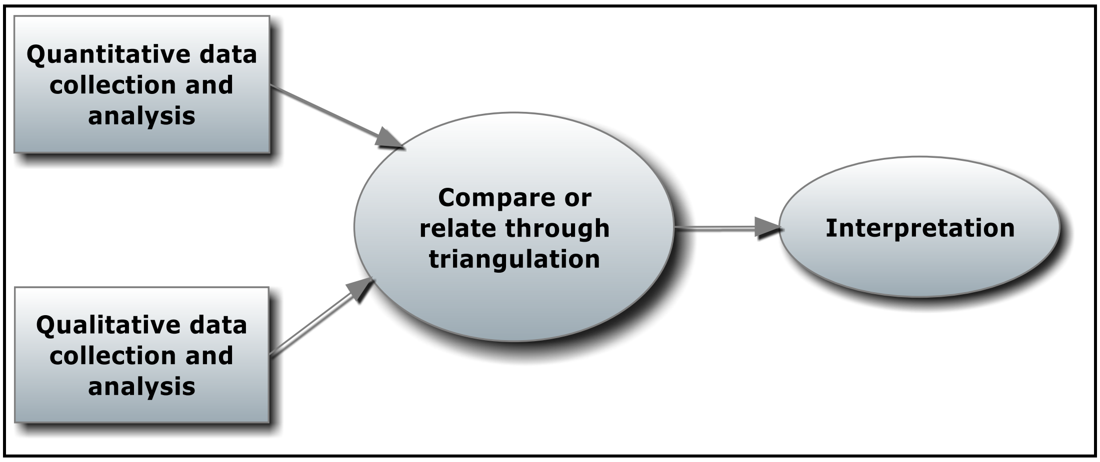

Figure 3.1: Convergent parallel mixed method (Source: Nova, 2013)

Figure 3.1 shows the basic construct of the convergent parallel design which incorporates a comparison or relation (through triangulation) post quantitative and qualitative data collation.

The quantitative section focused on the experiential knowledge of 20 helicopter DFEs, as appointed by the SACAA. By employing the fundamental aspects derived from the literature review a **DFE questionnaire** was prepared and distributed to the 20 DFEs. A 100% response was obtained from the small population.

The statistically significant results from the DFE questionnaires were utilised to construct a further questionnaire for **Instructor Assessments (IAs)**. This served as a measure to objectively evaluate candidate helicopter pilots at the time of their first demonstration flight.

The qualitative portion centered around the successful integration of case studies, in-depth interviews with field experts, auto-ethnographic tales, Shadowmatch™, self-assessment and 360º evaluations (Fleenor & Prince, 1997) with the data obtained from the IAs. The evaluation of the Shadowmatch™ data (individually completed by the candidate pilot) and the IA data sought to verify the stability and reliability of the categorisation process.

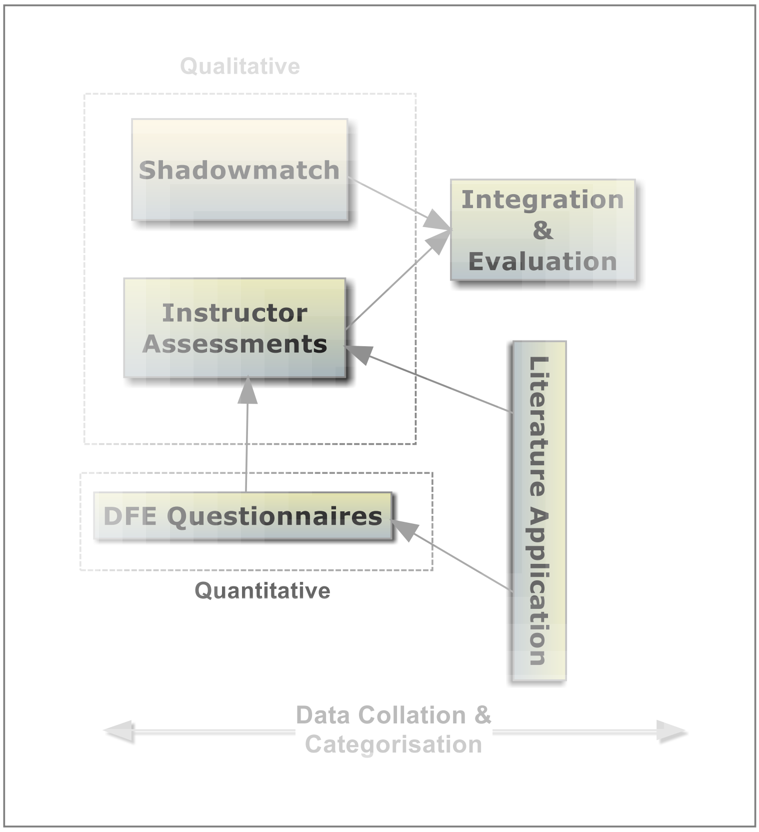

Figure 3.2: Mixed method research process

Figure 3.2 shows research congruence with the formal convergent parallel research method. The two methods are compared and integrated through triangulation and evaluated to produce statistically significant data for the accurate assessment of candidate helicopter pilots. A detailed description of the respective methodologies follows in the remainder of this chapter.

3.1.1 Research design philosophy

The bottom-up thought process (Kozlowski, & Klein, 2000) followed during the conception of the research design process is depicted by Figure 3.3:

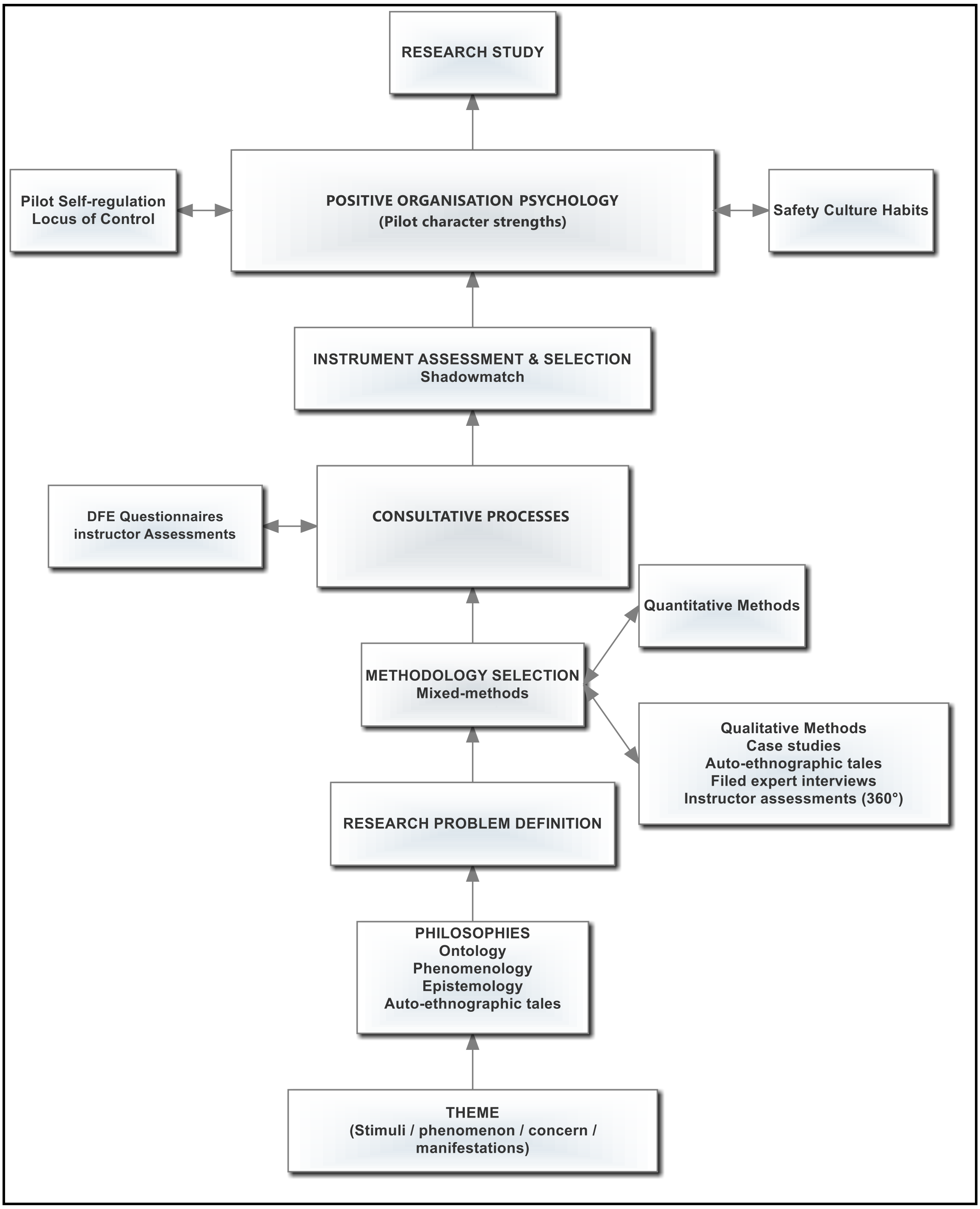

Figure 3.3: Bottom-up thought process

Figure 3.3 provides a broad outline of the research design and thinking process followed prior to the study. The process was initiated by agreeing on a suitable theme to stimulate the phenomenon of *distorted aviation egos* observed at the researched company.

The original **theme** was founded in the observed manifestation and concern for the lack of acceptable **pilot self-regulation** (Cameron & Spreitzer, 20120; Lopez & Snyder, 2003) and **safety culture habits** (Guldenmund, 2000). A stimulus for the theme was therefore to devise a methodology to categorise the self-regulation aspects and safety culture habits of candidate helicopter pilots at the time of first enrolment for helicopter flight training. The theme and stimulus were congruent with a predictive and pro-active approach towards a holistic flight safety culture at the researched company (Peterson & Seligman, 2004).

The author explored various research philosophies which defined the **ontology** of this study as an inference towards the positive, pro-active approach of identifying and categorising pilot safety culture habits (You-yuan, 2011). This philosophy is consilient with the construct of pro-active aviation Safety Management Systems (Stols, 2011). The philosophy of **phenomenology** resides within the researcher's personal experience of and exposure to the South African helicopter industry – more so, the phenomena associated with pilot egos, self-regulation, aptitude and attitude towards safety culture habits (Ferrof *et al*., 2012). The **epistemology** of this study addressed the justified beliefs (Rushby, 2013) concerning flight discipline, diligence towards regulatory compliance and pilot personal conduct beyond reproach through an interprevistic approach (Carr & Kemmis, 1986).

The formal problem definition and statement was addressed in Chapter 1.4. The decision was taken to employ a mixed-methods approach (Nova, 2013), as discussed in the preamble to this chapter. Quantitative and qualitative methodologies are fully analysed in subsequent Chapter 3.2 and 3.3 respectively.

The researcher followed a **consultative process** in constructing the DFE questionnaire. The questionnaires essentially utilised a survey of character strengths through positive organisational psychology (Peterson & Seligman, 2004) and provided a dynamic interface with authoritative resources and experts in the aviation field (Coetzee, 2013). The questions were typical of an open-ended construct (Richardson, 2000) and which tend to develop trust, are perceived as less threatening, allow an unrestrained or free response, and may be more useful with articulate users. The negatives associated with open-ended questions are that they can be time-consuming, may result in unnecessary information, and may require more effort on the part of the user (Richardson, 2000).

The panel of field experts employed for the consultative processes included:

(a)	Prof Johann Coetzee	Industrial- and aviation psychologist
(b)	Dr Johan Engelbrecht	Psychologist
(c)	Dr Joel Hughes	Behaviourist and root cause analyst
(d)	Dr Arvid Huss	Behaviourist
(e)	Dr Nicholas Cooke	Helicopter DFE and risk culture specialist
(f)	Mrs Suzelle du Plessis	Registered industrial psychologist
(g)	Professor Johan Fick	Dean of Engineering Faculty – NWU
(h)	Professor Piet Stoker	NWU

A Delphi technique of interviewing was adopted (Stuter, 2013) and served to involve all the experts, albeit not at a collaborative forum. The construction of the DFE questionnaire follows in paragraph 3.2.1 .

In addition to the classical qualitative methodologies recorded in Chapter 3.3, a suitable data-collation platform was required to assess the safety culture habits of helicopter pilots. The researcher intended to develop such software but timeously realised the extent of such construct and the obvious lack of suitable statistical collaborative data to substantiate research data validation and quality. Various software packages were evaluated and a decision made to use Shadowmatch™. A discussion of Shadowmatch™ follows in paragraph 3.3.4.

The value of **Positive Organisational Psychology** (POP) was identified in the evaluation of pilot character strengths, the study of pilot self-regulation (Peterson &

Seligman, 2004) and the assessment of pilot safety culture habits (Cameron & Spreitzer, 2012). The “positive” approach to psychology, as is the case with Safety Management Systems enforced the pro-active approach towards expanding flight safety cultures and climates at flight schools.

Descriptive statistics of South African aircraft accidents (Barker, 2012b) conclude the chapter and reinforces the notion of the negative effect that a lack of self-regulation and disregard for compliance with pilot safety culture habits has on flight safety.

3.2 QUANTITATIVE METHODS

A formal definition of quantitative research methods is described as an explanation of phenomena by collecting numerical data which is analysed using mathematically based methods, and in particular statistics (Aliaga & Gunderson, 2000). The methodology followed for the purpose of this thesis was (i) sampling; (ii) data gathering; (iii) data analysis; and (iv) ensuring data quality (Viljoen, 2008).

Table 3.1 tabulates the steps followed during the quantitative methodology and the various sub-headings associated with this classic research process:

Table 3.1: Description of quantitative research steps

METHODOLOGY	PURPOSE	DATA GATHERING	DATA ANALYSIS
Quantitative	To establish and obtain field expert benchmark data	**DFE questionnaire**	Questionnaire development NWU Statistical Consultation Service (STATISTICA software)

Table 3.1 provides a concise and comprehensive overview of the quantitative research method employed in the study. The remainder of this sub-chapter is devoted to a detailed discussion of the quantitative methodology and the various statistical methods that were evaluated and examined as most suitable option for this application.

The South African aviation industry harbours some unique idiosyncrasies in terms of pilot flight-testing. In many other countries, flight crew testing and CAA oversight is conducted by authorised officials that are predominantly in the permanent employ of the Aviation Authority (FAA, 2011; CAA UK, 2012). This arrangement ensures that neutrality and objectivity is mostly guaranteed and that negligible interference with the industry is assured. The obvious deficiency of such a system is that a typical bureaucratic environment could develop, and that flight inspectors could eventually become distanced from the requirements of operational reality.

The South African model is distinctly different from that of the USA and most of Europe. DFEs are identified in the aviation industry, appointed by the SA Civil Aviation Authority and revalidated on an annual basis. All DFEs are subjected to an initial process of intense screening and evaluation prior to their appointment, and have to conform to CAA standards, ethics and flight proficiency, which are checked annually. This system has therefore become the norm in South Africa whereby the industry effectively “checks” itself through experts from within the industry. The CAA only provides the industry with Authorised Officials that conduct the annual flight proficiency oversight check flights and assumes the administrative burden associated with licensing and regulating the DFEs (http://www.caa.co.za, 2013).

DFEs are generally appointed based on their standing in the industry, flight experience and a minimum level of suitable flight instruction experience. The number of helicopter DFEs in South Africa totals 20 (CAA, 2011) and is rarely increased due to a generally lethargic response from the aviation industry to provide more candidates.

3.2.1 Development and structure of DFE questionnaire

The population of South African helicopter DFEs is minute due to the relatively small number of private, commercial and airline transport pilots that require flight testing on an annual basis. In order to satisfy sampling requirements, it was decided to make use of a questionnaire in order collate sufficient response data from the small DFE population (n = 20).

Small population research questionnaires are at risk of providing insignificant reliability values (Steyn & Ellis, 2003), and various alternative methods were initially investigated and proposed. However, using 100% of a homogenous population vindicated the methodology and findings.

The data-gathering process in satisfying the quantitative phenomenon entailed applying the DFE questionnaire to Grade I helicopter instructor pilots (n = 20) with at least 10,000 flying hours in order to establish a convincing and authoritative industry benchmark. The questionnaire was developed in consultation and with the assistance of an aviation psychologist (Coetzee, 2008). As part of the quantitative research process, the draft questionnaire was submitted to various field experts (as noted in Chapter 1) for comment regarding layout, academic construct and contemporary relevance. A Delphi technique was adopted in order to achieve a workable consensus within the time constraints of the research process (Stuter, 2013). Further considerations on the technical construct of the questionnaire were to reduce any perceived anomalies or ambiguity when answering the questionnaire, and to ensure that each question would be correctly interpreted.

Empirical interpretation and statistical reliability computations were conducted and employed by an external academic entity (NWU Statistical Consultation Service, 2011; Ellis, 2011) and the results published in Annexure B. Given the relatively unique composition of the small population (n = 20) and the fact that a 100% return on all the submitted questionnaires was expected, a focused statistical approach was designed. The data-gathering process was initiated by evaluating suitable statistical methods and internal consistency checks for the collated datasets. Options considered for the research process included the use of Cohen's Kappa Coefficient ($\hat{\kappa}$), the Analytical Hierarchy Process (AHP) and a Likert-scale.

3.2.1.1 Cohen's Kappa coefficient ($\hat{\kappa}$)

A first iteration of the questionnaire made use of a YES/NO (closed-ended questions) approach to multiple answers (Richardson, 2000). To this end, and in pursuit of statistically significant data, it was proposed that a process of *Multiple*

Rater (respondent) analysis be followed. The effect of Cohen's Kappa ($\hat{\kappa}$) was evaluated, as it is powerful enough to deal with sources of much controversy and interpretation (Cohen, 1960). Uses of Kappa coefficients include a useful way to quantify the level of agreement (effect size measurements) or to test the independency of raters (in this case 20 DFE respondents).

A source of concern whilst using Kappa, remained the fact that it was highly dependent on the proportion of chance (or expected) agreement of the individual raters (Uebersax, 2010; Cohen, 1960). This, by implication, meant that frequency of which the raters would agree on a question would be through chance alone and so render the research suspect (Uebersax, 2010). The inter-rater reliability problem had to be addressed more scientifically in order to substantiate and validate the data content.

3.2.1.2 Analytical Hierarchy Process

A second iteration considered the Analytical Hierarchy Process (AHP), a systematic method for comparing a list of objectives and alternatives (AHP, 2011). This process serves as an accurate mathematical technique for multi-criteria decision making (Saaty, 1980).

AHP is predominantly used for relative critical weighting of indicators and evaluators (Saaty 1990). A three-step approach is applied:

1. Perform pairwise comparisons of the variables
2. Assess the consistency of the pairwise judgements
3. Compute the relative weights of the noted factors.

With this approach a responder can make pairwise comparisons of importance between decision elements with the respect to the following scale in Table 3.2:

Table 3.2: Analytical Hierarchy Process – Pairwise comparison (Saaty, 1994)

COMPARATIVE IMPORTANCE	DEFINITION	EXPLANATION
1	Equally important	Two indicators equally influence the parent decision element
3	Moderately more important	One decision element is moderately more influential than the other.
5	Strongly more important	…
7	Very strongly more important	…
9	Extremely more important	…
2,4,6,8	Intermediate judgement values	Judgement values between equally and extremely
Reciprocals		If v is the judgement value when i is compared to j, then $\frac{1}{v}$ is the judgement value then j is compared to i.

Table 3.2 explains the importance values associated with AHP scoring along with an explanation of the various scoring factors. The consistency of the evaluated pairwise judgements in matrix form can furthermore be simplified by adding a weight for each decision and using mathematical techniques such as Eigenvalues, mean, transformation or the row geometric mean (Saaty, 1994). AHP has the advantage of being able to imitate the way in which humans think about decision making and can be employed as both a quantitative as well as qualitative measuring instrument for specific attributes. Furthermore, it could be suitable for a mixed methods research approach.

In the case of the DFE questionnaires, the simplified AHP structure was selected to ascertain whether the instrument would be suitable for an accurate assessment of the relatively small respondent population (n = 20) and the lack of a large question bank (51). This assessment process included: (AHP, 2011)

1. Identifying the goal and available alternatives to the research process
2. Defining the criteria for selection
3. Structuring of the problem into hierarchical levels
4. Making a pairwise comparison between criteria
5. Checking for the judgement consistency and re-evaluating the set preferences if found inconsistent

6. Estimating the local priority
7. Aggregating the relative weights to get global priority
8. Selecting the best alternative or combination of alternatives.

Figure 3.4 is a graphical depicting of the cascading considerations effect and inter-relational status of the ultimate goal, various criteria and research projects.

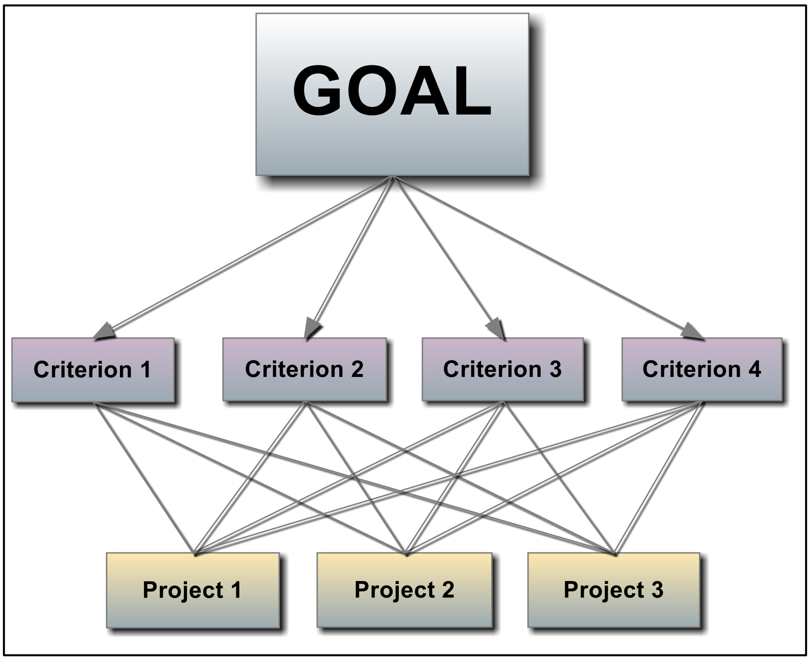

Figure 3.4: Analytical Hierarchy Process (AHP, 2011)

In this case, as denoted by Figure 3.3, the research goal for the project would simply be to prove the null hypothesis that a suitable predictive model did not exist. The criteria to be considered were the defined key construct factors: Safety, Reliability and Profitability. The matrix in Table 3.3 was completed using the rating scale offered in Table 3.2 and applying values for the three criteria of safety (1), reliability (5) and profitability (7):

Table 3.3: Sample AHP matrix for helicopter candidate pilot evaluation

	SAFETY	RELIABILITY	PROFITABILITY
Safety	1	5	7
Reliability	1/5	1	5
Profitability	1/7	1/5	1

The normalised weights within the matrix are found by computing the sum of each column and dividing each value by the corresponding sum, as shown in Table 3.4

Table 3.4: Sample AHP matrix normalised weights

	SAFETY	RELIABILITY	PROFITABILITY	WEIGHTS
Safety	.745	.806	.538	**.696**
Reliability	.149	.161	.384	.231
Profitability	.106	.003	.008	.072

It is clear from Table 3.4 that the numbers in row 1 are larger than in other rows which indicate an inconsistency in the comparisons used in the original matrix. In practice, researchers make use of eigenvalues in the normalised matrix. The weighted calculation for the categorisation model clearly shows that *Safety* manifests as the principal factor in evaluating the proposed criteria.

The AHP was found to be unsuitable for the project due to the complexity of the instrument, but also due to the simplistic nature of the final questionnaire that was decided on. Further research method evaluation led to the use of a Likert-type scale.

3.2.1.3 Likert-type scale

The DFE questionnaire was adapted to include a Likert-type scale. Likert scales are based on uni-dimensional scaling methods and assume the concept being evaluated to be one-dimensional in nature. The questionnaire was divided into three sections and in obtaining data from the DFE population (Datasets 1, 2 and 3). Likert-type scales are commonly used for information gathering in the social sciences, marketing, medicine and business general to attitude, emotion, opinion, personality or manifested behaviour (Gliem & Gliem, 2003).

Respondents are requested to respond to predetermined statements within a question dataset in terms of their own degree of agreement or disagreement (McIver & Carmines, 1981) and a typical five response option is provided ranging from strongly agree (5), agree, undecided, disagree, or strongly disagree (1).

3.2.2 Helicopter DFE data gathering

In establishing a benchmark for the proposed predictive factors common to all DFEs, a three-tiered questionnaire was developed and distributed to all appointed helicopter DFEs in South Africa (Annexure A). Despite a tedious and frustrating return time, a 100% response was obtained.

Significantly, two very distinct groupings emerged from the 20 respondents, namely those pilots that served in the SAAF (15 pilots) and the civilian counterparts (5 pilots). The significance lies in the reality that SAAF-trained pilots have a distinct advantage over civilian-trained pilots when considering age of initiating flight training, state-subsidisation of flight training costs and quality of training syllabi and aircraft.

The six demographic factors collated during the data-gathering process were: (i) pilot age (AGE); (ii) years spent in the aviation industry (YEARS); (iii) helicopter flying hours completed (HELICOPTER); (iv) number of fixed-wing flying hours (FIXED-WING); and (vi) number of flying hours as helicopter instructor (INSTRUCTOR).

Specific attention was given to the gathering of demographic information provided by the respondents. The data was collated, statistically analysed and is recorded in Table 3.5:

Table 3.5: DFE Demographic factors – Descriptive mean and SD values

	MEAN	SD
Age	56.05	8.630
Years	36.80	9.865
Helicopter	8110.05	3645.376
Fixed wing	6541.90	6280.852
Instructor	4002.50	3025.946

As noted in Table 3.5 above, and following the completion of demographic data collation, the remainder of DFE respondents' data was captured and statistically analysed by the Statistics Service at NWU. Relevant statistical values are presented and discussed in the next paragraph.

3.2.3 Statistical data analysis and modeling

The DFE questionnaire used for the first quantitative iteration is found in Annexure A and was completed by all DFE respondents (n = 20). Three unique sets of questions were presented and comprised of 19, 18 and 14 questions respectively. The three datasets focused on criteria established specifically for this research process (Coetzee, 2008). **Dataset 1** addressed fundamental factors pertinent to the pursuance of aviator safety excellence of prospective civilian helicopter pilots. **Dataset 2** posed very specific statements relating to DFE experience and their individual exposure to the aviation industry. **Dataset 3** recorded significant observable factors consistent with the initial encounter between a potential helicopter student pilot and the instructor conducting the demonstration/evaluation flight. The scores for the three sets are recorded in Annexure B.

Through inspection of the three datasets and by only considering effect sizes (d > 0.4), a final abbreviated list of statistically significant questions were isolated and accepted for further incorporation in the IAQ. The relevant effect size scores are ranked in decreasing order in Table 3.6 and furthermore display SAAF vs. non-SAAF returns.

Table 3.6: Effect sizes for ex-SAAF vs. non-SAAF DFE responses (effect size rankings)

Q	DESCRIPTION	SAAF	N	MEAN	SD	M-W U	EFFECT SIZES D
S1_10	Conservatism	No	5	4.60	.548	.066799	1.08
S1_7	Motivation to achieve	Yes	15	4.53	.640	.088738	.83
S1_16	Self-evaluation	No	5	5.00	.000	.088738	.79
S1_2	Higher education	Yes	15	3.47	.990	.294985	.61
S1_15	Self-assessment	No	5	4.80	.447	.458124	.48
S1_9	Attention to detail	No	5	4.40	.548	.484992	.45

Q	DESCRIPTION	SAAF	N	MEAN	SD	M-W U	EFFECT SIZES D
S2_15	GA vs. SAAF training	No	5	4.20	.447	.007762	1.61
S2_9	DFE intuition	No	5	3.80	.447	.137841	.77
S2_2	Aviator Excellence skills	Yes	15	4.40	.507	.162537	.75
S2_17	Recurrent training	Yes	15	3.73	.961	.359397	.46
S2_6	Lucky to be alive	No	5	3.40	1.342	.406976	.44
S2_8	Distorted ego effect	No	5	5.00	.000	.406976	.44
S2_18	Cash pursuit in GA	No	5	3.40	1.517	.382734	.40
S3_10	LOC	No	5	4.40	.548	.097226	.88
S3_1	NASA TLX	No	5	4.00	.000	.205634	.64
S3_6	SA	No	5	4.80	.447	.336976	.53

Table 3.6 indicates that 75% of all the significant questions (n = 16) were confirmed by the non-SAAF DFEs and that only 25% were attributed to the answers of ex-SAAF pilots.

The relevance of the above results is depicted in the final categorisation model assessment structure. The results and ranking order furthermore confirm that a statistically significant paradox exists between the SAAF vs. non-SAAF DFE responses and is confirmed by the interpretation of the correlations values for the three datasets.

The internal consistency of the captured data had to be proven in order to ensure the quality of the three datasets prior to proceeding with the preparation of the IAQs. Three statistical methods were employed, namely Cronbach’s alpha coefficient, t-test and correlations. These are discussed in detail below.

3.2.3.1 Cronbach’s alpha coefficient (α)

Ideally, after completion of the Likert-scale questionnaire individuals with the most favourable attitudes will have the highest scores and the opposite applies for the lowest scores. It is important to note that no “correct” answer exists for each question. Gliem and Gliem (2003) conclude that when using Likert-type scales, it is imperative to calculate and report Cronbach's **α** for internal consistency reliability for any scales or subscales.

Cronbach's **α** is not robust against missing data entries and the internal reliability of test scores generally increases as the inter-correlations among test items increase. It therefore indirectly indicates the degree to which a set of items measure a single uni-dimensional construct.

Cronbach's **α** is defined as:

$$\alpha = \frac{K \cdot \bar{c}}{(\bar{v} + (K-1) \cdot \bar{c})}$$

where: K is the number of items, $\bar{v}$ equals the average variance for the current sample of persons and $\bar{c}$ is the average of all covariances between the items across the sample of persons (IDRE, 2013).

Cronbach's **α** normally ranges between 0 and 1, but no actual lower limit exists. The best indication of internal consistency is achieved through alpha values closer to 1. A useful aid to predicting a reliable alpha value is noted as:

> 0.9 – excellent
> 0.8 – good
> 0.7 – acceptable
> 0.6 – questionable
> 0.5 poor
< 0.5 – unacceptable (George & Mallery, 2003)

In total, 51 questions were incorporated (K) and 20 respondents (DFEs) represented a 100% sample population return. The complete questionnaire is found in Annexure A and the calculations in Table 3.6. Cronbach's **α** was calculated as follows:

Table 3.7: Cronbach's α calculations for Datasets 1, 2 and 3

N	TEST MEAN	TEST VAR.	TEST STD. DEV.	CRONBACH'S A
51	187.8	375.75	19.38	0.87

From Table 3.7, the Test Mean **(187.8)** is simply the average value of summations for the individual respondents' scores. The Test Variance **(375.75)** represents the squared deviation of the Standard Deviation for the entire dataset **(19.38)** from its test mean value.

The calculated value for **α = 0.87** represents a good to excellent internal consistency or reliability for the dataset. The confidence interval (CI) at the desired probability of 0.9500 is calculated as **0.7733 ≤ α ≤ 0.9393**.

3.2.3.2 t-Tests

The t-Test values for the three question sets are presented in tabular form and indicate the values for DFEs that served in SAAF (1) or not (0). The significance of this comparison is contained in the historical versus more contemporary expectation of DFE approval and the considerations mentioned in the opening paragraph of this chapter.

The three youngest DFEs are incidentally from a non-SAAF background and were appointed by the CAA well after the demise of the compulsory National Military Service conscription of the 1980s and early 90s. Of further interest and statistical value is the fact that the three youngest DFEs also all hold a minimum of a post-graduate qualification at Master's level.

The non-parametric p-values of the Mann-Whitney (M-W) U-test are shown in column 6 of the respective tables (Annexure B). As is the case with the t-Test, the M-W p-values are used to good effect to determine if a difference exists between two groups (MacFarland, 1998). In this case study the two groups are ex-SAAF vs. non-SAAF DFEs.

Major differences between the M-W U-test and the t-Test are related to normal distribution of the dataset. As the M-W U-test is a non-parametric test, normal distribution of data is not required. The t-Test p-values in column 7 (Annexure B) are deemed not applicable due to the small size of the population groups and the fact that values have not been obtained in a random fashion (Steyn, 2011). The effect size index for this particular sample is relatively small (n = 51) but can still be used to determine the interrelationship in order to make suitable claims regarding practical significance (Steyn, 2011). The statistical significance for this particular complete (100%) population is not applicable (Steyn, 2011) and sample drawing is obviously not required.

Research by Ellis and Steyn (2003) confirms that statistical significant tests (t-Test) have a tendency to yield small p-values as the size of the dataset increases and that it is important to note that the effect size is independent of the sample size. Small p-values ($p < 0.05$) are considered adequate in assuming statistical significance (Ellis & Steyn, 2003), but that this result does not automatically imply practical significance. A more accurate and representative method of ensuring practical significance is to consider the effect size of the difference between means which makes the difference independent of units and sample size, but also relates the effect to the spread of the limited data in this set (Miller, Freund & Johnson, 1990).

The **effect size value** for means of the t-Tests relating to the three sets of questions is depicted by Cohen's d-value and defined by the equation (Ellis & Steyn, 2003):

$$d = \frac{|\bar{x}_1 - \bar{x}_2|}{s}$$

where: d is the effect value

$\bar{x}$ is the mean value for each set

s is the pooled standard deviation and assuming $\sigma_1 = \sigma_2$

Cohen (1988) provides guidelines for the interpretation of effect sizes as:

Small effect: $d = 0.2$

Medium effect: $d = 0.5$

Large effect: $d = 0.8$

Data with $d \geq 0.8$ is regarded practically significant.

3.2.3.3 Correlations

The statistical correlations between the various questions (n = 51) and the deeper effect of the SAAF vs. non-SAAF DFEs revealed fundamental and intricate correlations. Conforming to the following acceptable statistical standard (Ellis, 2011):

$r \approx 0.1$	for insignificant correlation values
$r \approx 0.3$	for values of medium significance
$r \approx 0.5$	values of large significance

where **r** is defined as Spearman's rho and various questions and sub-indices were evaluated and inspected for correlatory values. Only statistically significant values with an effect value of **r = 0.4** or higher were regarded for this analysis and further discussion in Tables 3.8, 3.9 and 3.10:

Table 3.8: Dataset 1 – Descriptive mean and SD values

SET 1	MEAN	SD
S1_14	4.45	.826
S1_7	4.40	.598
S1_15	4.40	.995
S1_16	4.40	.940
S1_18	4.25	.716
S1_12	4.10	.788
S1_9	4.05	.945
S1_19	4.05	.759
S1_11	4.00	.858
S1_17	3.90	1.021
S1_4	3.80	1.196
S1_8	3.75	1.020
S1_13	3.70	.979
S1_10	3.50	1.357
S1_2	3.30	1.031
S1_6	2.95	1.276
S1_3	2.80	1.056
S1_1	2.60	1.314
S1_5	2.35	1.226

Questions are numbered sequentially e.g. **S1_1** indicating Dataset 1 and Question 1 and the keywords printed in *italics*:

Dataset 1 challenged respondents to select their most suitable answer in determining factors that would affect the ultimate **aviator safety excellence** of prospective civilian helicopter pilots.

S1_1: *Wealth* addresses the effect that an individual's affluence has on helicopter flight safety. As expected, a high correlation exists with **S1_3: *Social status*** (r = .490, $p < 0.05$, medium significance). This is in line with the author's perception that wealth and social status are significant drivers in any individual's choice of becoming a helicopter pilot. Furthermore, a positive correlation manifests with **S1_11: *Self-image*** (r = .470, $p < 0.05$, medium effect) and **S1_12: *Pilot ego*** (r = .515, $p < 0.05$, medium significance). The latter two factors are expected and conform to wealth vs. self-image vs. inflated ego perceptions. An interesting inverse correlation presents with the demographic factor relating to the number of fixed-wing flying ***(F/W)*** hours that DFEs possess (r = -.503, $p < 0.05$, medium significance). Notably, this could be attributed to the bulk of respondents (95% or n = 19) who are also accomplished fixed-wing pilots, while fixed-wing aircraft are inherently cheaper than helicopters to operate and are perhaps not regarded as a notable measure of safety excellence. The respondents ranked **S1_1** as the eighteenth most important factor for this question set (q = 19, mean = 3.6, SD = 1.314).

Since the inception of the study, the author has maintained that evidence of secondary or higher education, or lack thereof, is a major factor in assessing the aptitude, attitude and general cognitive construct of a potential helicopter pilot. **S1_2: *Secondary education*** shows evidence of positive correlation (r = .567, $p < 0.01$, large significance) with **S1_4: *Age/maturity***. Experiential evidence clearly indicates that 'younger' pilots definitely show greater inclination to irresponsible behaviour and a lack of self-discipline. The converse further indicates that a small proportion of *older* pilots have merely aged in years and not necessarily in maturity. Against the author's expectation and interpretation of the importance of higher education, the respondents ranked **S1_2** as fifteenth most important factor (q=19, mean = 3.3, SD =

1.031). S1_4 featured around the median of all means in eleventh position (q = 19, mean = 3.80, SD = 1.196).

The interaction between a candidate pilot's **S1_3: *Social status*** (whether actual or perceived) and the elevation in **S1_11: *Perceived self-image*** strongly correlates (r = .563, p < 0.01, large significance) with the generally acceptable principles of *achievement* and *success* once embarking on helicopter flight training. The danger lies in the fact that students might feel compelled to artificially inflate their recently acquired social status by flaunting their newly acquired worth and demeanour. The potential adverse manifestations raised by the Dunning-Kruger Effect (2011) and the Peter Principle (2008) undoubtedly contribute to an escalation in flight safety risks and indeed general risky behaviour (Zuckerman, 2006). Based on the DFE responses, **S1_3** ranked very low in seventeenth position (q = 19, mean = 2.8, SD = 1.056) and **S1_11** returned ninth in rank (q = 19, mean = 4.00, SD = .858).

The very nature of a high-risk vocation, pastime or investment in a venture such as aviation demands utmost professionalism, dedication, attention to detail and discipline (Barker, 2009). The (unfortunate) over-regulation of for instance, the aviation industry, calls for a diligent approach to these noted attributes, but more so, constant compliance with, and implementation of, such established virtues. **S1_5: *Submissiveness*** *s*trongly correlates with the notion presented in **S1_11: *Self-image*** (r = .771, p < 0.01, large significance) and **S1_12: *Domain respect*** (r = .469, p < 0.05, medium significance). Notably, an increase in the extent of student and other pilots' submissiveness (to regulations, SOPs, flight school systems) should be brought about by a reduction in self-image as a negative correlation rather than the current direct relationship. A possible explanation to this statistical anomaly is a misinterpretation of the question by most respondents (lowest achieved mean of 2.35 and SD = 1.226 for question set 1). The direct correlation with sixth position **S1_12** (q = 19, mean = 4.10, SD = .788) insofar the positive increase in domain respect when considering the extent to which a 'normal' vs. distorted pilot ego will affect flight safety, is plausible and congruent with accepted aviation norms. The normative and moral factors raised and correlated between the three questions have a significant impact on the structure of the categorisation model.

Question S1_6: *Extroverted communication style* showed no significant correlation with any of the other questions in this question set and is not considered a major factor when evaluating prospective candidate pilots. **S1_6** ranked low in the question set (q = 19, mean = 2.95, SD = 1.276).

The interrelation between **S1_7: *Motivation to achieve*** and **S1_14: *No compromise on fundamentals*** (r = .601, p < 0.01, large significance) is a significant observation. It serves to confirm the expected virtue of adhering to established regulations and procedures in the quest for successful achievement motives. The obvious potentially negating consideration would be an over-zealous approach to achieving specific goals *at any cost*, albeit still within the ambit of not compromising fundamental aviation disciplines. A typical observation is the increase in motivation to complete certain exercises and to remain ahead of other students in the same peer group. Specific deliverables during the PPL programme are the build-up and completion of the first solo flight, transitioning to the helicopter general flying area and cross-country navigation flights (solo), and successful completion of the final PPL flight test. Without fail, students tend to enter a mind-set of a subconscious, but patently obvious, motive to achieve and complete the PPL course within the prescribed timeframe, despite instructors (and even peers) advising against same. Individual progress monitoring and a challenge against oneself, rather than the rest of the student pilot fraternity, should be the drivers towards success and flight safety. Significantly enough, **S1_7** ranked as second most important factor (q = 19, mean = 4.40, SD = .598) to **S1_14** in first position (q = 19, mean = 4.45, SD = .826).

An interesting observation with regards to **S1_8: *Cautionary disposition*** is that no significant correlations appeared from the statistical analysis. The returns from DFE questionnaires ranked the question twelfth highest (q = 19, mean = 3.75 and SD = 1.020).

Attentive conduct and execution are key drivers within the aviation industry. **S1_9: *Attention to detail*** addresses this consideration and shows medium positive correlation with **S1_14: *No-compromise on fundamentals*** (r = .526, p < 0.05, medium significance). A raised awareness amongst student pilots about the absolutely religious and rigid following of, *inter alia*, pre-flight inspection patterns and cockpit checklists is imperative in ensuring continued discipline and adherence to regulations and SOPs once they graduate to full PPL (and higher) status. **S1_9** ranked in seventh position (q = 19, mean = 4.05, SD = .945).

Much has been written about pilot exhibitionism and impulsive behaviour when often challenged with situations that would ideally necessitate a more conservative demeanour (Barker, 2010). This holds especially true for seasoned air show and display pilots that fall foul of personal and legislative dictates and inevitably result in a fatal outcome. Conscription to a conservative approach towards helicopter flight and flight safety is tantamount to ensuring a safe operating environment for all aviation stakeholders. **S1_10:** ***Conservatism/'no risk'*** *approach* shows medium correlation (r = .558, $p < 0.05$, medium significance) with **S1_16:** ***Self-evaluation***. The fact that **S1_16** ranked forth (q = 19, mean = 4.40, SD = .940) is both significant and encouraging when considering that DFEs are highly qualified and generally pragmatic individuals. Soft skills such as *introspection* do not typically sit well with 'Type-A personalities' (Coetzee, 2000), hence the surprising outcome of the questionnaire ranking. **S1_10** ranked fairly low in fourteenth position (q = 19, mean = 3.5, SD = 1.357) and returned the highest standard deviation of the question set.

S_11: ***Perceived self-image*** is intrinsically linked to the human ego, be it Parent, Adult or Child (Berne, 1964). Aviation, by its very nature, is an ideal platform for exhibitionism, parading a pompous display given the high cost of ownership and maintenance of proficiency. The romantic side of aviation evokes scenes of serene beauty, success and affluence – virtues that can be as debilitating as they are potentially lethal to a pilot with a distorted ego. The bulk of South African pilots fly for leisure only, the so-called "weekend warriors". The escalating cost of aircraft ownership, or simply utilising a flight school's equipment for hire and fly, has had a serious negative influence on private pilot proficiency and ultimately flight safety. Similarly, many successful businessmen and other champions of industry that pursue aviation as a newly found hobby or pastime, tend to employ the same business strategies and tactics in their flying – often with fatal consequences (Merrick, 2012). Successful business nature implies steely determination, success at all costs, extreme levels of confidence and motivation to achieve – failure is not an option. The exact same factors have inherent fatal consequences if directly employed in helicopter flying. The perceived “step-down” in social status, being a student pilot and instantly at the mercy of a young(er) instructor pilot, combined with the new disciplines of studying, preparation and diligent execution typically evokes discomfort with a wealthy 50-year old person. **S1_12: *Domain respect*** (normal vs. distorted ego) is in perfect correlation (r = .593, p < 0.01, large significance) with **S1_11** and confirms the probable elevation in the student’s perceived self-image with an increase of ego distortion.

Despite its similarity to at least three other questions in Set 1, the underlying meaning in **S1_13: *Declarative openness*** does not correlate with any level of significance with any other question. The confronting nature of the question in addressing the notion of actually revealing personal deficiencies, mistakes and failure does not bode well for any pilot’s ego and stature, hence the low score of thirteenth overall (q = 19, mean = 3.70, SD = .979).

The interrelation between **S1_15: *Self-assessment/reflection*, S1_16: *Self-regulation*** (r = .761, p < 0.01, large significance) and **S1_18: *Deficiency revelation and self-grounding*** (r = .600, p < 0.01, large significance) is of great significance and confirms the mature nature of the DFE approach to candidate assessment. The onus principally remains with every pilot to conduct individual self-evaluation and assessment through all facets of flight. More so, it should permeate through to all spheres of the pilot’s lifestyle and not only be regarded exclusively for aviation. Self-assessment and reflection, self-management (Coetzee, 2008), self-grounding and introspection are factors that have to be instilled with prospective candidates from the first day of flight. A common phenomenon observed with recently qualified commercial helicopters pilots is the expectation of instantly becoming professional pilots. Professional conduct and construct should be evident from the first day that a pilot commences his training and continue to expand and develop during the course of PPL and further training. **S1_15** ranked third in the questionnaire (q = 19, mean = 4.40, SD = .995) and is encouraging to be regarded as one of the top priorities in the estimation of DFEs. **S1_18** was placed in forth position overall (q = 19, mean = 4.25, SD = .716).

The author posits that the aviation industry is over-regulated and expected to be over-compliant with the Civil Aviation Regulations (CARs), Civil Aviation Technical Standards (CATS) and individual operators' SOPs. The ranking of **S1_17: *Compliance*** with *CARs, CATS and SOPs* does not fully support this sentiment and in fact ranks as the median score in tenth position (q = 19, mean = 3.90, SD = 1.021). Correlation (r = .496, $p < 0.05$, medium significance) is found between this question and **S1_14: *No compromise on fundamentals*** in addressing the absolute necessity of following and adhering to established and proven operating guidelines and flight rules. **S1_14** also correlates positive with **S1_18: *Deficiency revelation and self-grounding*** (r = .485, $p < 0.05$, medium significance)

In line with the (almost) metaphysical consideration of intuition and gut-feel, no correlation shows between **S1_19: *Intuition*** and any of the other questions. A possible reason for this is the fact that it is difficult, if not impossible, to scientifically quantify both intuition and gut-feel in an objective manner (Gladwell, 2008). This effect is furthermore compounded by personality clashes, inherent character dislikes and discrepancies in individuals' action and behaviour. **S1_19** ranked in eight position overall (q = 19, mean = 4.05, SD = .759).

The contents of Dataset 1 showed medium to good correlation between most of the similarly presented questions. Specific areas of large significance were addressed by questions **S1_1: *Wealth,* S1_11: *Perceived self-image* and S1_14: *No compromise*** *on fundamentals* which all showed correlations with four other questions in the dataset.

Dataset 2 used the same Likert-scale to challenge DFE respondents with the theme of *Aviator Excellence* (AE) and the interpretation thereof for various industry scenarios. Table 3.9 contains the data relevant to the second sets of questions in the DFE questionnaire:

Table 3.9: Dataset 2 – Descriptive mean and SD values

SET 2	MEAN	SD
S2_14	4.95	.224
S2_8	4.65	.933
S2_13	4.60	.681
S2_2	4.15	.875
S2_12	4.10	.641
S2_1	3.95	1.191
S2_5	3.65	1.226
S2_17	3.55	1.146
S2_10	3.50	1.051
S2_3	3.45	.999
S2_11	3.35	1.137
S2_9	3.00	1.298
S2_6	2.95	1.356
S2_18	2.95	1.234
S2_15	2.85	1.268
S2_4	2.30	1.174
S2_16	2.25	1.020
S2_7	2.05	1.050

Questions 1-4 addressed various nuances relating to aviator excellence and the interpretation of the proposed pilot classification method towards this research.

Questions 5-10 touched on personal experiences of DFEs in helicopter aviation, whereas questions 11-14 comprised uniquely South African aviation industry issues.

Questions 15-18 explored actual helicopter training methods and recurrent flight training programmes. Table 3.9 tabulates the ranking of the questions in Dataset 2 in order of mean values and shows the respective standard deviations accordingly.

S2_1: ***AE existence*** is regarded as an exploratory question for all the DFEs that are challenged with the concept AE for the first time. The question furthermore seeks to confirm the acknowledgement and acceptance of DFEs, or lack thereof regarding the existence of AE in the South African helicopter context. **S2_1** ranked in sixth position for Dataset 2 (q = 18, mean = 3.95, SD = 1.191) and revealed correlation with

S2_17: *Recurrent training in practice* (r = .543, p < 0.05, medium significance), DFE *Age* (r = .504, p < 0.05, medium significance) and DFE *Years in aviation* (r = .465, p < 0.05, medium significance). The inter-relation is in line with the generally accepted sentiment that AE will manifest in older (*Age*), more experienced (*Years*) and continually-trained (*Recurrent training*) pilots.

Question **S2_2: *AE skill*** challenged respondents to disclose whether AE is in fact an acquirable skill. As could be expected from the question structure in Dataset 2, a negative correlation exists between **S2_2** and **S2_4: *Pilots are born*** (r = -.589, p < 0.01, large significance), as well as **S2_9: *DFE intuition*** (r = -.519, p < 0.05, medium significance) which both confirm the experiential foundation that DFEs have the luxury of accessing when judging AE. Positive correlation (r = .499, p < 0.05, medium significance) between **S2_2** and **S2_17**: ***Recurrent training programmes*** is congruent with the statistical expectation that *Aviator Excellence Skills* will improve with an increase in structured recurrent training programmes. This understanding serves to enhance the postulated Continued Private Pilot Development (CPPD) programmes being implemented at the company.

Interestingly, negative correlation (r = -.532, p < 0.05, medium significance) displays between **S2_3: *AE intrinsically part of all candidates*** and **S2_11: *Governing bodies.*** The author assumes that new candidate pilots will have possibly not had exposure to government entities such as Airports Company of South Africa (ACSA), Civil Aviation Authority (CAA) and Air Traffic Navigation Services (ATNS). AE is therefore statistically inversely significant when compared to the very institutions that act as regulators and priority aviation service providers. Positive correlation exists (r = .498, p < 0.05, medium significance) between **S2_3** and **S2_12: *Governing bodies frustrating industry*** which confirms the DFE expectation that aviation statutory entities, regulatory bodies and service providers will in all likelihood tend to frustrate new candidate pilots once exposed to it.

Question **S2_4: *Pilots are born*** correlates negatively (r = -.569, p < 0.01, large significance) with the number of helicopter flying hours (*Heli*) completed by DFEs.

The experience level of all the DFE implies that pilots are rather *developed* than born.

S2_5: *Pilot development* interestingly only correlates ($r = .478$, $p < 0.05$, medium significance) with **S2_8: *Distorted ego***. The effect of this interrelation denotes that pilot development within a formal environment should preclude the onset of a distorted ego, albeit a gross generalisation and perhaps unrealistic. **S2_8** ranked as second highest question in Dataset 2 ($q = 18$, mean = 4.65 and SD = .933).

Question **S2_6: *Lucky to be alive*** shows correlations with no less than 5 other questions and is second only to the DFE demographic question relating to years' experience (*Years*). A first correlation exists ($r = .589$, $p < 0.01$, large significance) with **S2_10: *Fraternal issues*** in addressing the typical SAAF vs. non-SAAF perspective on flying and indeed flight training. Military pilots are generally far more exposed during operational and other flight missions, which is probably construed as a higher risk or more hostile operating environment. Secondly, negative correlation manifests ($r = -.623$, $p < 0.01$, large significance) when compared with **S2_17: *Recurrent training in practice***. Continuous training and honing of proficiency skills will undoubtedly serve to enhance a pilot's survivability, rather than only luck. *Age* proves to be a further negative correlatory factor ($r = -.666$, $p < 0.01$, large significance) and substantiates the notion even further that luck is not a function of age either. The final inverted correlations are with *Years* in aviation ($r = -.531$, $p < 0.05$, medium significance) and fixed-wing experience ($r = -.543$, $p < 0.05$, medium significance).

S2_7: *Allowing any person to fly* and S**2_16: *Recurrent training programmes efficacy*** have no significant correlation with any other questions. Both ranked low in Dataset 2 and occupy the last positions.

The correlation between **S2_10: *Fraternal issues*** and **S2_11: *Governing bodies*** ($r = .494$, $p < 0.05$, medium significance) is a confirmation that the existence of aviation fraternal issues, whether perceived or actual, is consistent with the *domineering* effect that aviation governing bodies seem to project to the industry.

S2_12: *Governing bodies frustrating industry* shows negative correlation (r = .459, p < 0.05, medium significance) with *Years* – again, a clear indication that DFE experience tends to override the seemingly overwhelming watchdog approach that that governing bodies assume.

Affirmative Action (AA) and Broad Based Black Economic Empowerment (BBBEE) are major factors when considering the advancement of persons within an industry that inherently relies on a substantial experience base. The South African reality is that AA and BBBEE is forced onto any government body with the single intention of ascribing to government transformation policies rather than the pursuit of competence. South Africa's long legacy of advancing only white candidates for specific key positions undoubtedly left an indelible scar on career expectations of candidates of colour. Regrettably this now tends to evoke exactly the opposite appointment and implementation standards for white candidates. The intention of raising questions **S2_13: *Affirmative acceleration*** and **S2_14: *Industry immunity*** *to AA* was to ascertain, at a low level, whether highly experienced pilots such as DFEs also, and/or still, regard these policies as a burden to the aviation industry. **S2_13: *Affirmative acceleration*** negatively correlates with *Age* (r = -.633, p < 0.01, large significance), *Years* (r = -.499, p < 0.05, medium significance) and *Fixed-Wing* experience (r = -.625, p < 0.01, large significance). Interestingly, **S2_14** indicates no further correlations with any other questions, but ranked as the question with the highest mean and lowest SD values for Dataset 2 (q = 18, mean = 4.95, SD = .224). This question therefore has a direct and considerable effect on the evaluation of new candidate pilots – more so on persons of colour.

The preamble to this chapter addressed the intrinsic divide between SAAF vs. non-SAAF pilots and the profound effect it has had on the composition and psyche of the South African pilot population. The demise of the SAAF since the end of the Angolan Bush War has undoubtedly left the civilian aviation industry reeling due to the sudden lack of experienced pilots that would enter the system upon their departure from the SAAF. It is generally accepted worldwide (Coetzee, 2009) that South African pilots (read: SAAF or SAA trained) are well sought after and tend to command senior positions within aviation organisations. The perceptions surrounding the *invisible feud* between the two distinct aviation camps has thankfully subsided to a large extent, and both positive and negative factors can be deduced from the training approaches offered by the SAAF and civilian training organisations.

S2_15: *SAAF vs. civilian flight training* shows negative correlation with *Age* (r = -.501, p < 0.05, medium significance) and *Years* (r = -.538, p < 0.05, medium significance), reiterating that the responses from experienced SAAF DFEs confirm that civilian training is inferior to military training standards. Referring to Table 14 it is clear from the tabulated data that **S2_15** is regarded, by a substantial margin, to be the most significant question (Cohen's effect size value: d = 1.61). Interestingly though, the statistical significance of this question was determined by the five non-SAAF DFEs that is linearly opposed to the author's posit.

S2_17: *Recurrent training programmes in practice* touches on one of the fundamental proactive postulates that the author proposes, Continued Private Pilot Development (CPPD) as an extension of recurrent training. The positive correlation with *Age* (r = .715, p < 0.01, large significance) and *Years* (r = .649, p < 0.01, large significance) authenticates the requirement for recurrent training programmes and CPPD (Coetzee, 2009).

The final correlations for Dataset 2 are found between *Age* and *Years* (r = .918, p < 0.01, large significance), *Age* and *Fixed-Wing* hours (r = .513, p < 0.05, medium) and the number of *Heli* hours and *Instructor* hours on helicopters (r = .537, p < 0.05, medium significance).

Dataset 2 presented a consistent amount of significant correlation values, both positive and negative, and reiterated the profound effect that the respondents' age, years in aviation and flying experience have on the accurate prediction of the major factors that drive the safety culture in South African aviation.

Dataset 3 continued with the same process of utilising a Likert scale to extract specific technical insight from the DFE respondents when conducting an accurate evaluation of prospective helicopter student pilots. Table 3.10 tabulates the ranking of the questions in Dataset 3 in order of mean values and shows the respective standard deviations accordingly.

Table 3.10: Dataset 3 – Descriptive mean and SD values

SET 3	MEAN	SD
S3_14	4.45	.999
S3_9	4.30	1.261
S3_6	4.25	1.251
S3_8	4.15	.933
S3_12	4.15	1.089
S3_7	4.10	1.071
S3_2	3.85	1.089
S3_10	3.80	.894
S3_13	3.80	.951
S3_5	3.70	1.342
S3_11	3.65	1.040
S3_1	3.60	.754
S3_3	3.60	.995
S3_4	3.40	1.188

Table 3.10 lists a total of 14 questions according to decreasing mean values, as posed to the DFE respondents. The factors addressed in this final dataset ranged from highly technical and specialised helicopter handling and ergonomics questions, to the 'softer skills' associated with moral health and SA. The extent of the latter questions is typically not regarded as easy to convey to new pilots and would generally be intrinsic qualities that accompany such pilots from the introduction of the careers until retirement age. Inter-correlatory values were obtained for the entire dataset and significant statistical effect isolated for discussion.

S3_1: ***NASA TLX*** describes the extent to which a pilot should perform when subjected to normal and strenuous task loads. The NASA TLX is a contemporary evaluation tool devised by the National Aeronautics and Space Administration (NASA) and is regarded as a multi-dimensional subjective work-load rating assessment instrument (Gawron, 2008). A further dimension to the NASA TLX is the phenomenon of cockpit saturation and the real effect it has on pilot performance, regardless of experience level. **S3_1** correlates well with **S3_2: *Cooper-Harper scale*** (r = .559, p < 0.05, medium significance) and describes the apparent coexistence of the task load effect when compared to handling of workload and cognitive overload factors by the C-H scale. Further strong correlations combine with **S3_6: *Situational awareness*** (r = .614, p < 0.01, large significance), **S3_7: *Spatial disorientation*** (r = .483, p < 0.05, medium significance) and **S3_10: *Locus of control*** (r = .528, p < 0.05, medium significance).

S3_2: *Cooper-Harper handling scale* is the question with the most significant correlations within Dataset 3. Interrelations exist with ***S3_3: Yerkes-Dodson arousal law*** (r = .565, p < 0.01, large significance), **S3_5: *Procedures and checklists*** (r = .646, p < 0.01, large significance), **S3_7: *Spatial disorientation*** (r = .511, p < 0.05, medium significance), **S3_8: *Attention span*** (r = .477, p < 0.05, medium significance), **S3_10: *Locus of control*** (r = .485, p < 0.05, medium significance) and *Age* (r = .447, p < 0.05, medium significance). It is most encouraging to note the various correlations and the direct influence of the Cooper-Harper workload handling scale on the relevant questions. The DFE response is on par with the expected outcome of the similarity of the questions and enforces the cockpit experience that the respondents possess.

The Yerkes-Dodson Law accurately describes the relation between arousal and performance. The theoretical model associated with the Y-D Law encompasses virtually all facets of a helicopter flight training syllabus and is an accurate reflection of the real effect that *unknown* flight scenarios have on new students. Examples such as practice auto-rotations (briefed or unannounced) or abrupt control inputs by either the instructor or the student serve enhance the arousal effect and may serve to impair or increase the student's performance. **S3_3: *Reaction during arousal*** correlates with **S3_5: *Adherence to checklists*** (r = .481, p < 0.05, medium significance) and shows a strange correlation with **S3_11: *Language*** (r = .514, p < 0.05, medium significance) and **S3_12: *Moral health*** (r = .754, p < 0.01, large significance). **

Performance graphs and load factors for any aircraft are based on the ambient conditions associated with the location. The combination of prevailing temperature and airfield elevation collude to present a hazardous operating environment. Add to this a heavily laden piston-engine helicopter and the equation slants quite profoundly towards an unsafe flight. The ergonomic layout of, for instance, a Robinson R22 helicopter can be most uncomfortable for a South African male of average build. The successful and accurate manipulation of flight controls, radios and safety equipment may be severely impeded by a cluttered cockpit layout and contribute to an unsafe flight deck. Correlation between **S3_4:** ***Cockpit ergonomics*** and **S3_5:** ***Adherence to checklists*** (r = .532, p < 0.05, medium significance), *Age* (r = .563, p < 0.01, large significance) and *Years* (r = .548, p < 0.05, medium significance) all reiterate the positive effect that actual "cockpit time" has on assessing new candidates. **S3_4** ranked with the lowest mean value in fourteenth position (q = 14, mean = 3.40, SD = 1.188).

The importance of using standardised checklists in a cockpit environment is imperative in ensuring a safe operating ambit. Observed correlations between **S3_5:** ***Adherence to checklists*** and **S3_6:** ***SA*** (r = .479, p < 0.05, medium significance), **S3_8:** ***Attention span*** (r = .516, p < 0.05, medium significance) and S3_9: ***Effects of intoxication*** (r = .449, p < 0.05, medium significance) vindicate the notion through DFE responses of vigilant preparation and usage of aircraft manufacturers' checklists. There is a further correlation with *Age* (r = .541, p < 0.05, medium significance).

The respondents ranked **S3_6:** ***SA***as the third most important question, based on the mean value (q = 14, mean = 4.25, SD = 1.251) and consequently confirmed the high regard for SA in practice. As expected, **S3_6** correlates well with **S3_7:** ***Spatial disorientation*** (r = .660, p < 0.01, large significance) and **S3_10:** ***Locus of control*** (r = .582, p < 0.01, large significance). Significantly, a further interrelation exists with **S3_14:** ***Mental health*** (r = .448, p < 0.05, medium significance) which confirms the subtle cognitive appreciation that SA demands and is upheld by the DFE responses.

Similarly, **S3_7: *Spatial disorientation*** is regarded by the author as an extension of SA and reveals a further cognitive feature for the initial introductory flight assessment. It correlates well with **S3_8: *Attention span*** (r = .489, $p < 0.05$, medium significance), **S3_9: *Effects of intoxication*** (r = .491, $p < 0.05$, medium significance) and **S3_10: *Locus of control*** (r = .731, $p < 0.01$, large significance). It is obvious from the DFE responses that a high cognitive priority is placed on Spatial Disorientation and its consequential effects on the correlatory factors.

S3_8: *Attention span* is of significance in aviation and any high-demand vocation or passtime. This question correlates with **S3_9: *Effects of intoxication***, **S3_10: *Locus of control*** (r = .594, $p < 0.01$, large significance) and **S3_12: *Moral health*** (r = .619, $p < 0.01$, large significance). Research conducted by Transport Canada (1989) verifies that successful *attention span* and *remembering* depends on continuous repetition and practice – two major factors for consideration in basic and recurrent flight training.

In the author's opinion and experience the abuse of primarily alcohol is the single most important consideration when evaluating flight safety programmes, or indeed lack thereof. Social *establishment* values dictate that alcohol is the focus point for any entertainment function and aviation is not excluded. Very strict "bottle to throttle" legislation has been published, but sadly it is seldom enforced. Ironically, even enforcement agencies would plan a Safety Seminar around the beverage focal point, albeit only frequented after completion of the day's events. The author has attended numerous air shows and fly-in events where the Saturday night's party is superceded by a quasi-sober group of pilots departing to their respective home airfields. The author maintains that an individual and collective risk culture simply cannot be proposed, developed and implemented in any organisation whilst alcohol use and abuse is accepted by management. **S3_9: *Effects of intoxication*** clearly manifests in reduced human cognitive conduct, and inevitably leads to degraded performance, judgement error and reduction in Aeronautical Decision Making (ADM). Quite refreshingly, DFE responses showed good correlation between **S3_9** and **S3_12: *Moral health*** (r = .752, $p < 0.01$, large significance), as well as **S3_13: *Physical health*** (r = .467, $p < 0.05$, medium significance). The notable deduction by

DFEs in this instance is the undisputed degrading effect of constant alcohol use on flight crews.

Surprisingly, only two significant correlations were exposed for question **S3_11: *Language***. Both **S3_13: *Physical health*** ($r = .507$, $p < 0.05$, medium significance) and **S3_14: *Mental health*** ($r = .494$, $p < 0.05$, medium significance) correlate with medium significance to language and the use of a pilot's mother tongue when considering proficiency. The International Civil Aviation Organisation (ICAO) has in recent times launched a major initiative worldwide to enhance the level of aviation radio telephony (RT). Pilots are now forced to complete an approved Language Proficiency Rating (LPR) and comply with a minimum standard prior to being issued with a Student Pilot Licence (SPL). **S3_12: *Moral health*** correlates with the same questions as $r = .549$, $p < 0.05$, medium significance and $r = .527$, $p < 0.05$, medium significance respectively. **S3_13** furthermore correlates with **S3_14: *Mental health*** ($r = .537$, $p < 0.05$, medium significance) with medium significance and confirms that both physical and mental health attributes are highly prioritised when evaluating flight safety.

Final DFE demographic correlations are presented between *Age* and *Years* ($r = .918$, $p < 0.01$, large significance), *Age* and *Fixed-wing* hours ($r = .513$, $p < 0.05$, medium significance), as well as *Heli* hours and helicopter *Instructor* hours ($r = .537$, $p < 0.05$, medium significance).

Dataset 3 consisted of 14 questions and was particularly focused on the highly technical aspects of the candidate pilot's introductory flight. The high number of significant correlations enforced the author's belief about the relevance of these questions to the research model and was prominent in compiling the final categorisation methodology.

3.3 QUALITATIVE APPROACH

In compliance with the requirements of satisfying the selected convergent parallel mixed method research (Nova, 2013; Creswell *et al.*, 2003), the second approach utilised in this thesis is of a qualitative nature. Qualitative research is defined as "any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification” (Golafshani, 2003). The qualitative research paradigm calls for a process where the author engages with his environment (control volume), relying on experiential knowledge to lead him towards his initial research domain and hypothesis (Cooke, 2012). The convergent parallel mixed method is used by employing both quantitative and qualitative methods and integrating and evaluating same after an extensive literature review through a process of (i) sampling; (ii) data gathering; (iii) data analysis; and (iv) ensuring data quality (Viljoen, 2008) – refer Figure 3.2 – which also notes the use of Shadowmatch™ software as a collative part of the qualitative research methodology.

The multivariate and indeterminate nature of the research domain also calls upon a broader enquiry into seemingly unrelated topics rather than simply offering a linear solution (Camic *et al*., 2003). Qualitative research design is not merely a singular methodology; it remains an on-going process that entails continuous reassessment and movement between the various components of the design, assessment of implications of goals, theories, research questions, methods and validity threats (Maxwell, 2005). The design of such research should not only fit with its use, but also with its environment (Maxwell, 2005).

The author’s experience in flight training and helicopter flight operations provided a foundation and definitive starting point. By virtue of analysing existing procedural systems, accident and incident investigative techniques (reactive) and discreet interviews, both formal and informal, suitable research material was revealed. It can be argued that the initial analysis of accident data reflect a research philosophy more oriented towards that of Grounded Theory (Bryant & Charmaz, 2007). This is on the basis that no solid or empirical evidence is initially present to elicit a problem statement. This is further supported by the fact that the classic Grounded Theory methodology provides a systematic process for the abstract conceptualisation of latent patterns within a social reality (Glaser & Strauss, 1967).

In stark contrast to the strength of quantitative research, whereby definitive though arbitrary questions are posed and data collated about *reliability* (repeatability), *validity* (i.e. truth value) and *generalisability* (scope and boundaries of applicability) (Camic *et al.,* 2003), qualitative research methodology exploits four basic functions to satisfy the quality of evidence:

(a) Internal validity – ensuring strong casual inferences can be made from findings
(b) External validity – applicability of findings to other studies, systems and concepts
(c) Construct validity – the degree to which the measures of the study accurately map the underlying concepts
(d) Conclusion validity – the extent to which findings are quantitatively strong. Qualitative research methodology tends to elicit a further interest and experience into the study *phenomenon* and is an angle often missed by the student (Trochim, 2006a).

An innovative approach is thus required towards existing literature to gain new insight and perspectives of the research domain. Therefore qualitative research is used as a distinct basis for direct experience, provided that a conscious mindset is adopted to formulate tentative theories and hypotheses that can be explicitly tested. Qualitative research excels at telling the story from a participant's perspective, but also from an author's (read: authoritative source) perspective (Trochim, 2006a). It thereby provides rich descriptive detail that places quantitative results into their human context.

The convergent parallel mixed method research aimed to produce a more complete understanding of the two databases, corroborate the results from the quantitative and qualitative databases and allow a justified comparison of multiple levels within the research system (Nova, 2013), as depicted by Figure 3.5. The author posits that a large majority of incidents and accidents appear to be (pilot) behaviour based. The complexity of the phenomenological nature of human behaviour in a relatively complex technically-oriented domain, such as helicopter flight training, favoured a mixed method approach to the research methodology. Table 3.11 shows the various qualitative methods used for **data gathering** during the research study:

Table 3.11: Description of qualitative research steps

METHODOLOGY	PURPOSE	DATA GATHERING	DATA ANALYSIS
Qualitative	To provide context for research	Case studies	Phenomenology
	To provide context for research	Auto-ethnographic tales	Content analysis
	To identify pertinent Safety Culture Habits (SCH)	Shadowmatch™	Literature application Content analysis
	To explore identified SCH	Self-assessment/360° evaluation	Content analysis Internal audits
	To interpret further assessment statistics	IA/Peer review	Descriptive statistics
	To understand expert observations, experience and analysis	In-depth interviews with field experts	Delphi method
	To assimilate aviation industry values and expectations	Interviews with flight instructors	Focus groups

The qualitative research methodologies noted in Table 3.11 are discussed in the ensuing paragraphs.

3.3.1 Case studies

In providing context toward the research study (Yin, 1998; Yin 2002), the use of actual case studies experienced by the researcher over a period of 2 years at the researched company served to confirm and validate the data. Three serious helicopters accidents were recorded and investigated by the Civil Aviation Authority and in-house flight safety office.

Significantly, the three accident pilots were all qualified flight instructors and fully acquainted with company policies and SOPs. The financial implication of the three case study losses amounted to ± R6m and proved to have a dire effect on flight operations at the researched company. One helicopter was completely destroyed and the other two exposed to substantial insurance claims.

A complete evaluation of the three accident pilots regarding the lack of pilot self-regulation and disregard for pilot safety culture habits follows in Chapter 5.

3.3.2 Auto-ethnographic tales

The methodology of auto-ethnography can be defined as a self-narrative that critiques the *situatedness* of self with others in social contexts (Spry, 2001). Auto-ethnography opens new ways of writing about social life, through a synthesis of post-modern ethnography and autobiography (Spry, 2001).

Auto-ethnography furthermore exposes a specific form of autobiography–a personal narrative of the researcher's life experience (Huss, 2008–and has become a widely used observation and interview method for study of performance, sociology of new media, journalism and applied fields such as management studies. Auto-ethnography gives us the "truths of our experiences" (Devault, 1997) and focuses on the author's subjective experience rather than the beliefs and practices of others. By citing auto-ethnographic tales in this thesis, the author's experience and exposure to the South Africa helicopter industry is exploited to good effect. Instructional exposure, managerial conduct and inherent safety/disciplined construct are the foundations of the auto-ethnographic study approach. Two notable auto-ethnographic tales recorded at the company are detailed below:

Tale One:

Instructor: "You should really ensure that you have permission to land at your house next to the Vaal River."
Owner pilot: "It is my helicopter and my house – I will do as I please."

Tale One relates to the typical interaction between a concerned flight instructor and a helicopter owner pilot. The owner had a history of illegal landings and conduct unbecoming a pilot of his experience level. His demeanour was typical of a pilot manifesting a distorted aviation ego state (Berne, 1961) and displayed clear macho signs and tendencies of invincibility.

Further analysis of the above short auto-ethnographic tale explains the level of discomfort that the said pilot evoked whilst interacting with other pilots and staff members at the flight school. As a successful businessman and champion of industry, he regarded the acquisition of a new hobby (and helicopter) as a logistical extension of his normal course of business. His behaviour expressed negative alignment with the more desirable safety culture habits discussed in later paragraphs.

Tale Two:

Operator: "May we please use your helicopter this weekend for a charter?"
Owner pilot: "How many times have I told you that I fly my own machine over weekends?!"

Tale Two is indicative of the authoritarian approach and disposition that certain helicopter owners display. The level of intimidation provoked by the above exclamation served no purpose in arriving at suitable and polite answer to a reasonable request by the operator.

The recording of auto-ethnographic tales assisted the researcher in developing and expanding on real-life scenarios. Self-critique experienced through the annotation of the tales led the author to believe that the level of subjectivity during these "tale processes" could be counter-productive and even invasive.

3.3.3 Shadowmatch™

In order to establish a conclusive, scientifically founded and validated qualitative methodology of conducting the interview process associated with qualitative research relevant to this thesis, the author explored an existing software package, namely Shadowmatch™.

Shadowmatch™ is a South African designed and patented software platform created by Pieter de Villiers and Lizette Bester. It determines habits in the behaviour of an individual by simulating tasks for the individual to ascertain how he will act by selecting from a list of multiple answers. By identifying trends associated with specific conditions and circumstances (habits) that the candidate is exposed to; a scientific calculation made consistent with the selected answers.

The result is a graph that indicates the level to which these habits are embedded in the behaviour of the individual according to a set of behavioural definitions. A high score indicates that the individual has consistently selected answers that indicate a strong preference towards behaving in a specific manner. A low score indicates that the individual did not consistently select answers that would represent congruent behavioural patterns of the specific nature calculated as a habit. On the list of 18 habits, the score can even be less than zero. This indicates an anti-habit, also referred to as a counter-habit. The person then indicated a habit against the habit being calculated.

The validation of the Shadowmatch™ product is published in full by kind permission of Pieter de Villiers (2012) in Annexure M .

3.3.4 Interviews and instructor 360° feedback

A further qualitative iteration involved the use of interviews with aviation field experts and an aviation psychologist (Coetzee, 2008 & 2013). Notable aviation self-management and self-regulation related checklists were consulted (Institute for Aviation Psychology, 2013) and redrafted for gathering and analysing qualitative data. Questions relating to the classification of pilot character strengths (Park, Peterson & Seligman, 2003) were extracted and re-formulated for congruence with the pilot safety culture habits relevant to this thesis. The six specific character strengths, ultimately representing the pilot safety culture habits, were recorded as:

(a) Wisdom and knowledge
(b) Courage
(c) Humanity
(d) Justice
(e) Temperance
(f) Transcendence (Park *et al.*, 2003).

Temperance refers to the level of moderation or self-restraint (Oxford Dictionary, 2013) and has direct relevance to the notion of pilot self-regulation within defined pilot character strengths. It is the strength that forges simplicity and protects us against excess. In this thesis, it serves as a meaningful basis to found pilot safety culture habits on. The conscious and constant compliance of all pilots with the with the researched company's set of internal regulations and SOPs are paramount in ensuring a flight safety culture conducive to a reduction of incidents and sustainment of good flight safety habits.

The evaluation of instructors followed the aviation field experts' interview process. In-depth discussions and internal auditing processes provided a method for both gathering and analysing factual data. Specific interviews were recorded between the researcher and the Chief Flying Instructors at the researched company (Merrick, 2012; Bezuidenhout, 2013). A thorough investigation and de-brief session were conducted with all three accident instructors and referred to an aviation psychologist for further trauma intervention (Engelbrecht, 2011).

Fleenor & Prince (1997) regard the 360° feedback method as a "multisource assessment, through multi-rater feedback and full-circle evaluation", which entails gathering data form multiple sources within the person's circle of influence. For the purpose of this thesis, the circle of influence is the flight school environment at the researched company. The author furthermore conducted an informal 360º feedback session on specific pilot safety habits during a bi-annual flight instructor meeting. The comparison and integration through triangulation is discussed in Chapter 4 and introduces the reader to the fusion of the research methodologies employed for this thesis.

Examples of auto-ethnographic tales involving flight school management and instructor pilots who have completed Shadowmatch™ and 360° feedback include:

> **Invigilator**: "What was your experience with the completion of Shadowmatch™ and the assessments?"

Instructor:	"It was a waste of time as far as I'm concerned. The habit summary does not reflect my character at all."

Of all the instructors rated at the researched company, this candidate statistically scored as the third lowest and experienced a major helicopter accident in September 2012. This instructor scored high on "Individual Inclination" with the Shadowmatch™ assessment and started flying at the age of 35.

Chief Pilot:	"Are you still enjoying your flying?"
Instructor:	"It has its moments, but I get bored with doing the basics only."

The above instructor's Shadowmatch™ and interview assessments displayed a high locus of external control. He statistically ranked the second lowest of all assessed instructors and exhibited a distinct sense of entitlement. This was possibly due to his age (33 years) and experienced a hard helicopter landing in November 2011 with major damage.

3.4 SOUTH AFRICAN DESCRIPTIVE AVIATION ACCIDENT STATISTICS

This section serves to expose the reader to the **descriptive accident statistics** relevant to this thesis. By performing a **content analysis** of the available accident data (SACAA, 2010), a picture emerges of the factors affecting flight safety and indeed pilot flight safety habits (Barker, 2012b). The accurate prediction of aviation and flight safety has historically been a challenging aspect. South Africa is not excluded in this regard and is an integral part of the rest of Africa when annual continental safety statistics are released by ICAO and IATA. Africa has by far the highest incidence of aviation accidents and incidents (IATA, 2010) as confirmed by statistics in Table 3.12:

Table 3.12: IATA – Hull Losses per million sectors

REGION	2006	2007	2008	2009	2010
Africa	4.31	4.09	2.12	9.94	7.41
Asia-Pacific	0.67	2.76	0.58	0.86	0.80
Commonwealth of Independent States	8.60	0.00	6.43	0.00	0.00
Europe	0.32	0.29	0.42	0.45	0.45
Latin America and Caribbean	1.80	1.61	2.55	0.00	1.87
Middle East and North Africa	0.00	1.08	1.89	3.32	0.72
North America	0.49	0.09	0.58	0.41	0.10
North Asia	0.00	0.88	0.00	0.00	0.34
Industry	0.65	0.75	0.81	0.71	0.61
IATA Members	0.48	0.68	0.52	0.62	0.25

The statistics contained in Table 3.12 for the calendar year 2010 confirm that Africa's flight safety statistics are in excess of twelve times the industry norm and 29 times the norm for IATA members. This statistic is indicative of the extreme safety challenges that continental Africa faces, and sadly, helicopter operations form part of this precarious picture.

Unlike typical airline and air forces' approaches to evaluate and select pilot candidates, the general aviation industry tends to accept virtually any potential student that happens to appear at any flight school's front desk with the desire to become a helicopter pilot. Private Pilot Licencees thus have the luxury of choice, anent flight school, training hours, flexibility and finances.

A major consideration in developing an accurate and scientifically representative and suitable categorisation methodology is the fact that it will effectively be rendered useless until such time that an incident or accident occurs involving a student who completed the formal assessment process. The obvious observation dictates that no such occurrence is wished on any inexperienced pilot and that the typical outcome is generally associated with a high morbidity, or worse, mortality factor.

The work of Frankel and Clark (2007) shows the intrinsic relationship between total reported accidents and accidents apportioned to pilot error (Figure 3.5) It is specifically noted that not all pilot error accidents can be authentically regarded as *Ego Related Accidents* (ERA) (author's parenthesis), and that the sample only takes into account accidents between 1999 and 2005, as no further comprehensive data is available from the CAA, specifically correlating the number of accidents to pilot error:

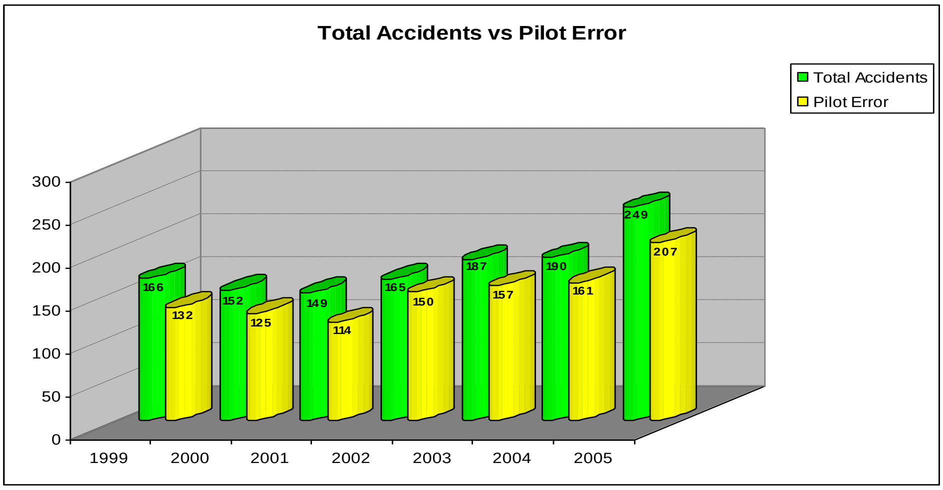

Figure 3.5 Total number of SA accidents vs. pilot error accidents

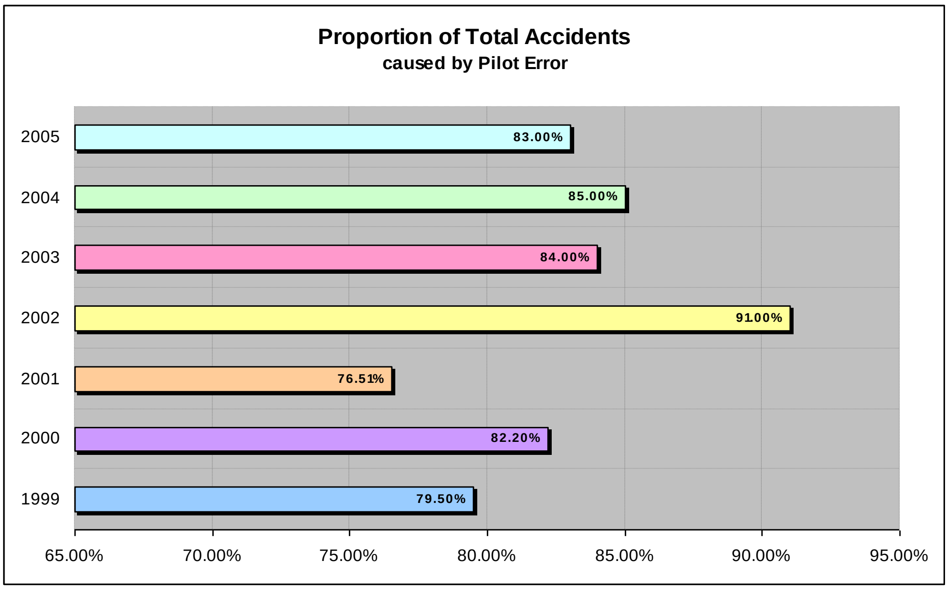

Figure 3.6: Proportion of SA accidents caused by pilot error

The bar graphs in Figure 3.6 intimate that 2002 returned the worst proportion of accidents caused by pilot error (91%). The average value for the period 1999-2005 was 83%. Barker (2011) continues that flying related accidents occur regardless of the type of flight crew licence held, or even the type of flight operation undertaken. Figure 3.7 depicts the pie chart distribution of the type of flying licence held.

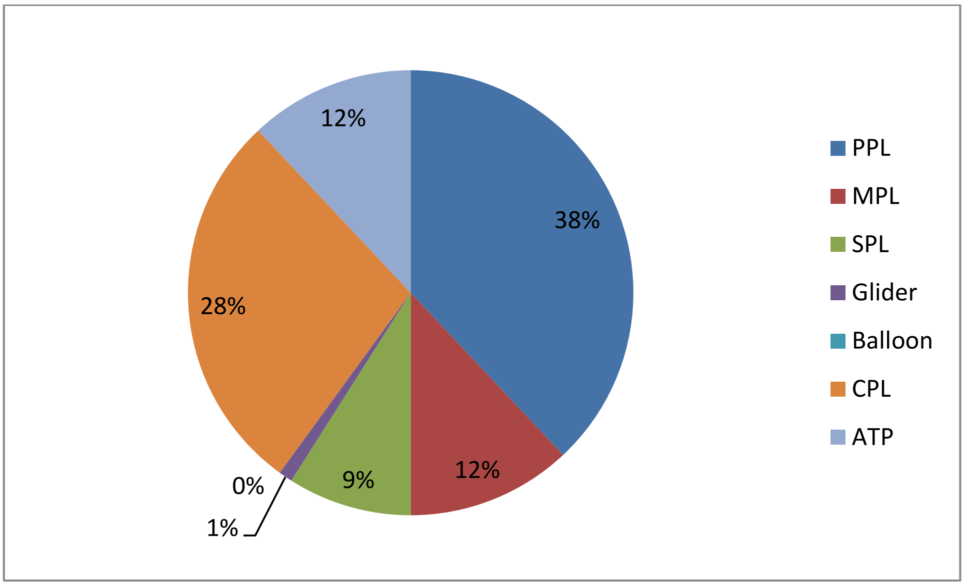

Figure 3.7: Accident analysis: 1999-2010 (by licence category)

Significantly, as noted in Figure 3.7 and correlating with the author's expectation, the majority of all aviation accidents in South Africa (38%) were experienced by Private Pilot Licence holders. Commercial Pilot Licence holders apportioned 28% of the total number of accidents recorded for the period 1999-2010 and a worryingly high statistic of 12% of all accidents were attributed to Airline Transport Pilot licence holders for the same period. The balance of noted accidents comprised of Microlight Pilot Licence holders (12%), Student Pilot Licences (9%) and an insignificant proportion to Glider pilots.

A further iteration by Barker (2011) surmises that very specific phases of flight reveal significant accident statistics. Figure 3.8 reports that the bulk of all recorded accidents for the period 1999-2010 were attributed to complications during the landing phase (36%). Readers should bear in mind that the landing speed of fixed-wing aircraft is drastically higher than that of helicopters. Helicopters have the distinct advantage of being able to enter hover flight (zero forward, vertical or lateral speed) which assists in reducing loss of control related accidents due to high horizontal and vertical closing speeds. Helicopters generally achieve to elicit the dubious accolade of being a perfectly unstable operating platform, which is inherently due to the substantial number of dynamic components and associated accelerations, gyroscopic and torque effects and moment couples.

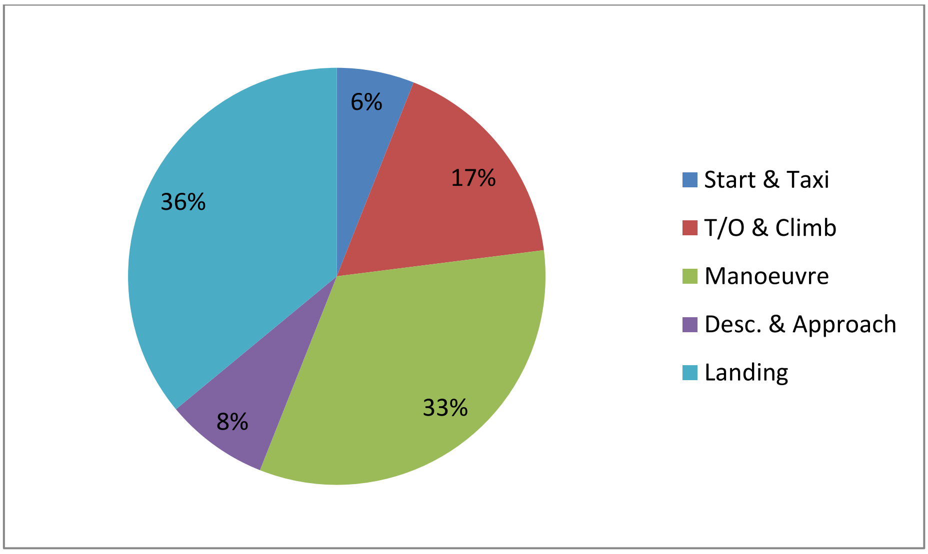

Figure 3.8: Accident analysis: 1999-2010 (by flight phase)

The negative effect of inappropriate flight manoeuvring (33%) clearly displays as a significant accident causal factor, as per Figure 3.8. Accidents occurring during the take-off and climb phases of flight represent 17% of the total apportionment.

Various casual contributors invoke the onset (read: RCA) of all accidents. Based on Barker's (2011) data collation Figure 3.9 indicates that the main causal contributor for all South African aviation accidents (1999-2010) can be attributed to human factors (Man: 56%). This value is at least 14-19 percentage points lower than the international statistic. Despite Original Equipment Manufacturers' (OEM) and Aircraft Maintenance Organisations' (AMO) safety claims and publications relating to equipment reliability, an alarming proportion (32%) of all recording period accidents relate to machine failures. Medium (operating conditions) contributed to a mere 10% of all accidents. As a final analysis, Figure 3.9 shows the causal factor breakdown for each main causal contributor.

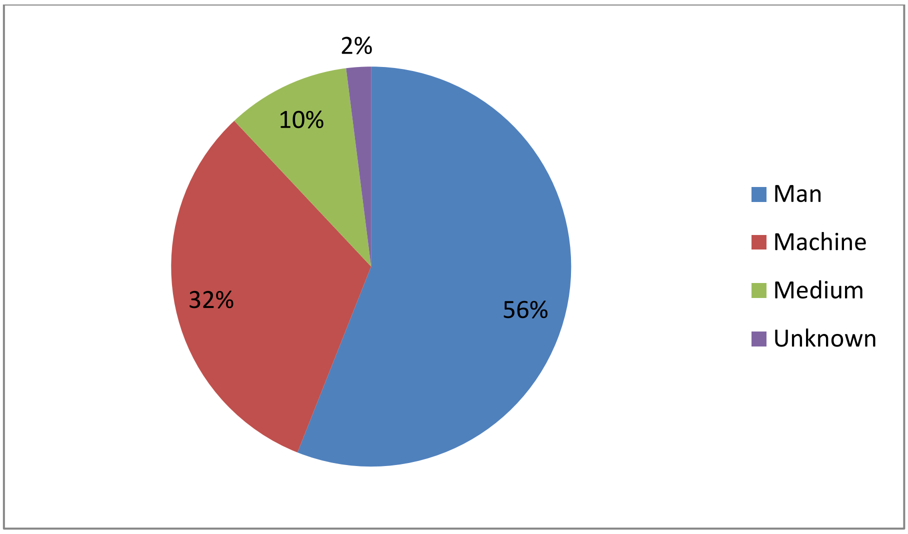

Figure 3.9: Accident analysis: 1999-2010 (by causal contributor)

Figure 3.10 presents all accident causal factors in bar-graph. Control Loss clearly represents the highest proportion (307 accidents) for the 12-year period within the Human (*Man*) factors causal contributor realm. Similarly, Engine Failure is shown to be the single most prominent casual factor (359) for all causal contributors and *Machine* and significantly higher than any *Medium* (90, due to wind shear on landing).

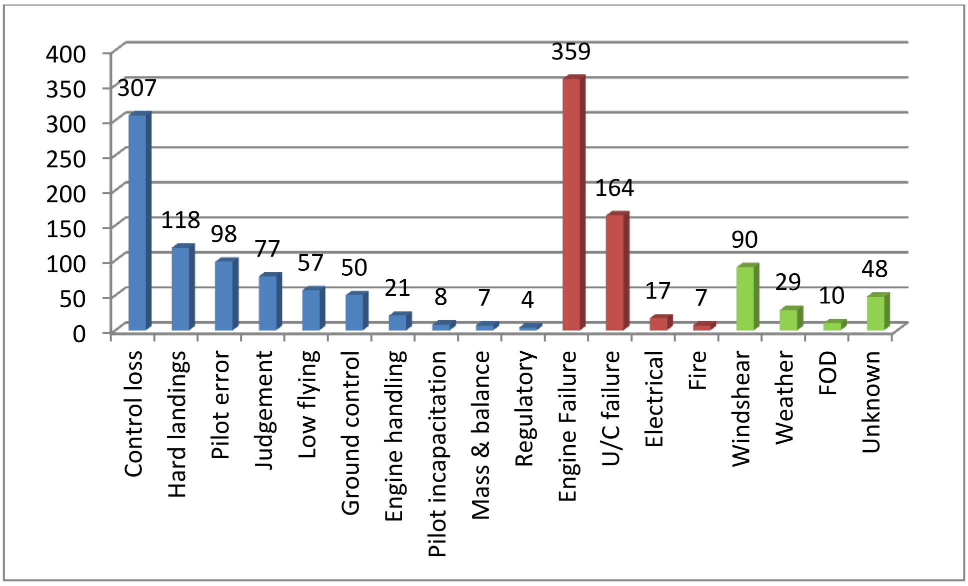

Figure 3.10: Accident analysis: 1999-2010 (by accident causal factor breakdown)

The mystery of the *Unknown* portion in of all accidents will continue to haunt and mystify the aviation fraternity forever (Figure 3.10).

South African aviation accident statistics are regrettably seldom recorded accurately and collated by the regulatory body, the CAA. The initiative of doyens such as General Des Barker ensure that the validity and significance of these statistics are continuously recorded, classified and ratified in accordance with internationally accepted best practices.

3.5 INTEGRATION OF RESEARCH

By employing both qualitative and quantitative methods through a convergent parallel design mix method and in preparation for the final categorisation model, the author was able to isolate specific areas of relevance and significance. The statistical analysis of the completed DFE questionnaires exposed multivariate collations and well-defined determinants anent focus areas for further inspection. These questions were prioritised and incorporated into the categorisation assessment form (IA) for new prospective pilots.

The qualitative methodology explored various post-modernist methodologies such as aetiology, ontology, phenomenology, appreciative enquiry and epistemology. It must be noted that the quantitative section of the research domain was completed *circa* 6 months prior to exposure to the qualitative Shadowmatch™ assessment software. The eighteen personality traits and "habits" were compared with the author's postulations and DFE questions, and a high correlation was found between the two databases. The final format of the categorisation model is thus undoubtedly a function of mixed quantitative and qualitative research methodologies and should be treated as such.

A brief analysis and inspection of the accident data reflective of the South African aviation scene serves to confirm the undeniable effect that *human factors* has on accident statistics. Of great significance is the fact that South African "*human error*" statistics were at least 15 percentage points lower than that of the international benchmark.

In this chapter the methodologies followed in designing the research towards a categorisation process for candidate helicopter pilots was explicated.

Chapter 4 focuses on the formal definition of the categorisation methodology and incorporates the further integration of the mixed methods (quantitative and qualitative) and the literature application.

CHAPTER 4: DEFINING THE CATEGORISATION METHODOLOGY FOR CANDIDATE HELICOPTER PILOTS

4.1 INTRODUCTION

This chapter is the culmination of the literature review and application in substantiating the mixed methods approach. Chapter 3 followed an approach of incorporating qualitative data collated from: (i) in-depth interviews with aviation field experts and flight instructors; (ii) auto-ethnographic tales relating to scenarios at the helicopter flight school; (iii) introduction of Shadowmatch™; and (v) the use of descriptive statistics through the utilisation of the final IAs.

The quantitative methodology drew upon DFE questionnaires that were designed by incorporating the relevant literature aspects and statistically analysing the results (NWU, 2011). The DFE benchmarking process utilised in Chapter 3 served as primary verification methodology for the collation of statistically significant questions towards the preparation of the final IAs.

Chapter 4 integrates quantitative and qualitative research methodologies in order to synthesise and triangulate themes relevant to the mixed methods approach. In doing so, the iterative process ensures authenticity of a scientifically founded categorisation methodology for candidate helicopter pilots by identifying and measuring pilot safety culture habits.

Figure 4.1 serves as a further reminder of the previously presented mixed methods research process (Chapter 1), as employed in this thesis:

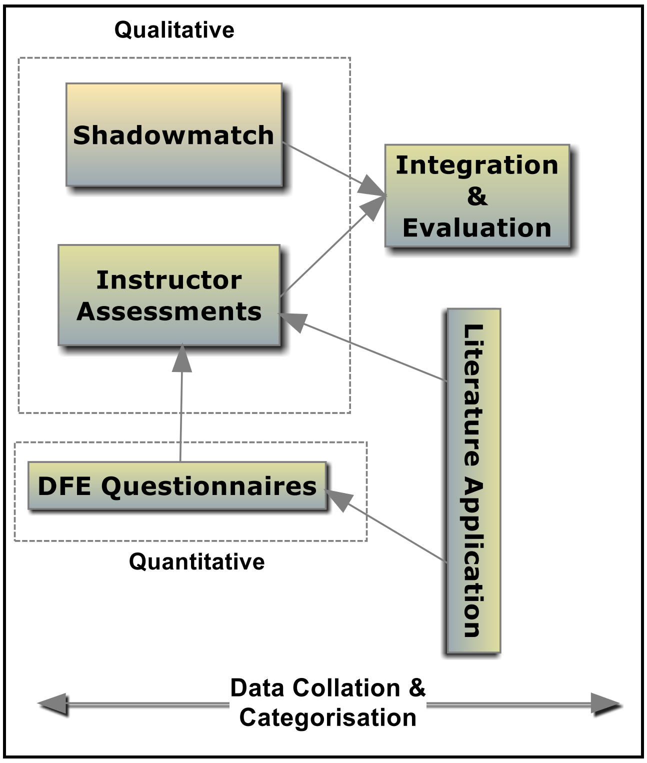

Figure 4.1: Mixed methods research process

As a brief summary and recollection of the processes discussed in Chapter 1 and Chapter 3, the first quantitative methodology employed a sampling process of DFEs (n = 20). After the data had been gathered statistically significant questions contained in three different datasets were extrapolated. The data analysis provided quality results for usage in the preparation of the further qualitative iteration: IAs.

Table 4.1 recaptures the most statistically significant DFE questions based on calculated effect sizes and ranked in descending order for the three separate DFE datasets (S1, S2 and S3). The noted questions correlated significantly with the layout and behavioural and safety culture habits assessment function of the Shadowmatch™ software platform and are integrated into the final IA questionnaire. STATISTICA software was used for the data analysis and ensured data quality. The data analysis was conducted externally and independently by the Statistical Consultation Service at NWU (Ellis, 2011).

Table 4.1: Final IA questionnaire data

Q	DESCRIPTION	SAAF	N	MEAN	SD	M-W U	EFFECT SIZES
S1_10	Conservatism	No	5	4.60	.548	.066799	1.08
S1_7	Motivation to achieve	Yes	15	4.53	.640	.088738	.83
S1_16	Self-evaluation	No	5	5.00	.000	.088738	.79
S1_2	Higher education	Yes	15	3.47	.990	.294985	.61
S1_15	Self-assessment	No	5	4.80	.447	.458124	.48
S1_9	Attention to detail	No	5	4.40	.548	.484992	.45
S2_15	GA vs. SAAF training	No	5	4.20	.447	.007762	1.61
S2_9	DFE intuition	No	5	3.80	.447	.137841	.77
S2_2	Aviator Excellence skills	Yes	15	4.40	.507	.162537	.75
S2_17	Recurrent training	Yes	15	3.73	.961	.359397	.46
S2_6	Lucky to be alive	No	5	3.40	1.342	.406976	.44
S2_8	Distorted ego effect	No	5	5.00	.000	.406976	.44
S2_18	Cash pursuit in GA	No	5	3.40	1.517	.382734	.40
S3_10	Locus of control	No	5	4.40	.548	.097226	.88
S3_1	NASA TLX	No	5	4.00	.000	.205634	.64
S3_6	Situational awareness	No	5	4.80	.447	.336976	.53

Table 4.1 provides a summarised overview of the significant statistics in preparing the IA. The following sections assimilate the construct of both Shadowmatch™ and the final IA by comparing and integrating the identified safety culture habits and addressing the research problem.

Figure 4.2 over page presents the sequence of events associated with a new student reporting for his/her demonstration flight. It also provides a conscise overview of the complete process of enrolling a new candidate helicpoter pilot and gathering quantitative and qualitative data.

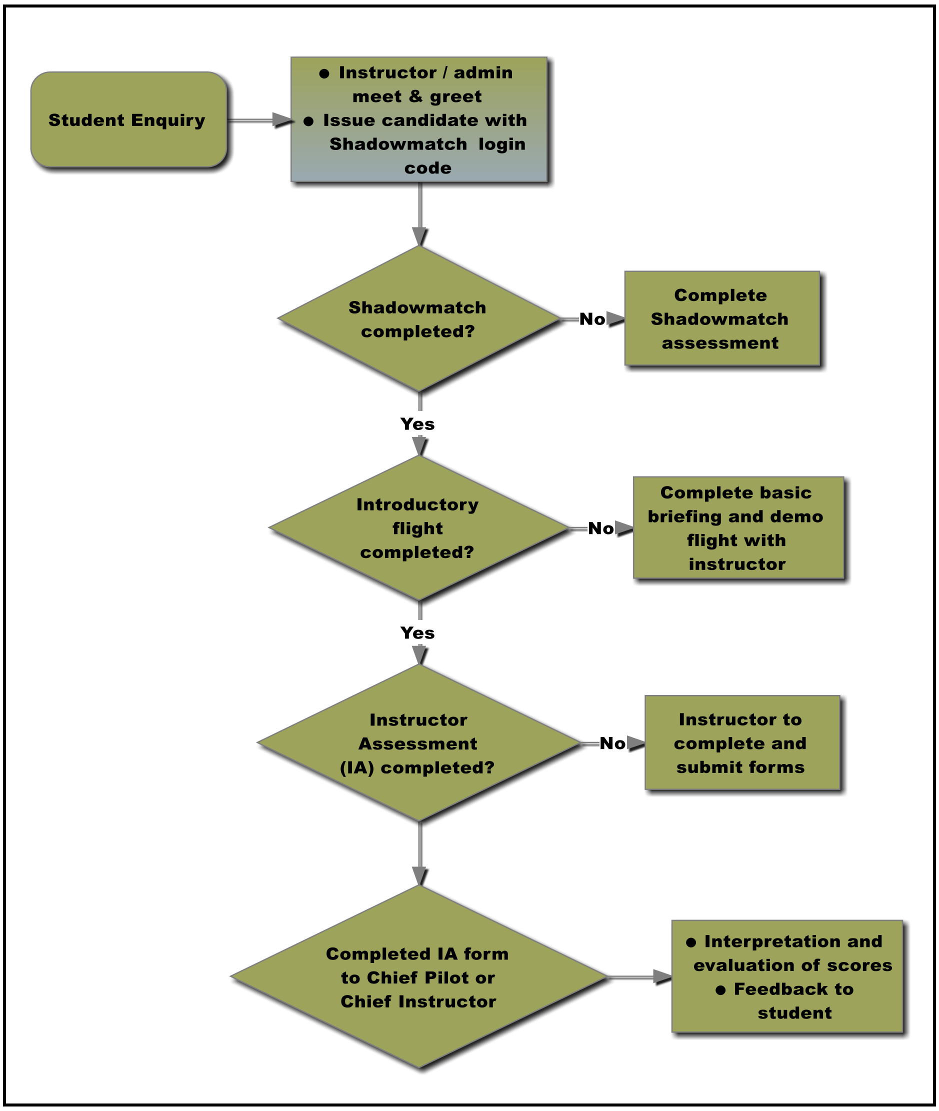

Figure 4.2: Candidate pilot assessment flowchart

4.2 IMPLEMENTING QUALITATIVE METHODS AND DATA

We are what we repeatedly do. Excellence then is not an act but a habit.

Aristotle

In the context of the researched company, the basis for the success of employing qualitative methods resides in the accurate compilation of a suitable benchmark group from the population of available in-house flight instructors. The ultimate objective is the accurate and reliable categorisation of candidate helicopter pilots by identifying potentially hazardous flight safety culture habits of prospective pilots who enrol at the flight school.

Chapter 3 provided a comprehensive discussion of the qualitative research steps followed. The research steps are noted for clarity:

(a) Case studies were used to provide context for research
(b) Auto-ethnographic tales were employed to provide background and research context.
(c) In-depth interviews with field experts and flight instructors were utilised to understand expert observations, experience and analysis anent pilot safety culture habits.
(d) IAs and 360° Feedback provided an opportunity to explore safety culture habits and compare accident descriptive statistics.
(e) Shadowmatch™ software was used to identify and collate qualitative data pertaining to the relevant safety culture habits in the literature application (Chapter 2).

4.2.1 Criteria for selecting top performers (benchmark population)

The criteria for selecting suitable candidates for establishing the benchmark population is based on the following considerations (De Villiers, 2009):

(a) Candidates must be working in the operation and current position for a period of more than 8 months.
(b) Candidates must consistently be amongst the top performers in the operation on all levels of the work they do (quality of work, quantity delivered, task efficiency in performing the task).
(c) Candidates must have a positive influence on the team they work with and play a motivating role in the group. (All people they work with must experience them as positive and enthusiastic towards their environment and the work they do).
(d) Candidates must be the most skilled and knowledgeable workers in the operation.

Subsequently, the five most senior helicopter flight instrcutors at the researched company were subjected to the Shadowmatch™ assessment and recorded as the benchmark score (or "shadow").

Appropriate benchmark instructor pilots were evaluated and selected according to the above guidelines and in compliance with flight instructor seniority. The demographic data of the five instrcutors is captured in Table 4.2 and has been collated and statistically ranked in accordance with the overall habit match (18-habit profile):

Table 4.2: Researched company Shadowmatch™ benchmark population

NAME	LICENCE	HOURS	AGE	OVERALL MATCH (18 factors)	CRITICAL MATCH (5 factors)
BH	CPL/Gr II	4,800	38	94%	94%
AC	ATPL/Gr I	11,800	40	90%	89%
BB	ATP L/ Gr I	18,500	62	89%	95%
PE	ATPL/Gr II	2,850	28	83%	90%
PM	ATPL/Gr II	13,100	38	82%	85%

Table 4.2 displays the Shadowmatch™ benchmark population data ranking for the 18 habits under consideration (Overall Match). Furthermore, it highlights the five Critical Match benchmark factors for company pilots as: (i) Responsiveness; (ii) Simplification; (iii) Problem solving; (iv) People positive behaviour; and (v) Resilience.

Figure 4.3 is an actual screenshot and graphical depiction of the company's benchmark population (or shadow). The graphic displays the Overall Match habits (n = 18) along with the Critical Match habits (n = 5) in the format of a bar graph for easy interpretation.

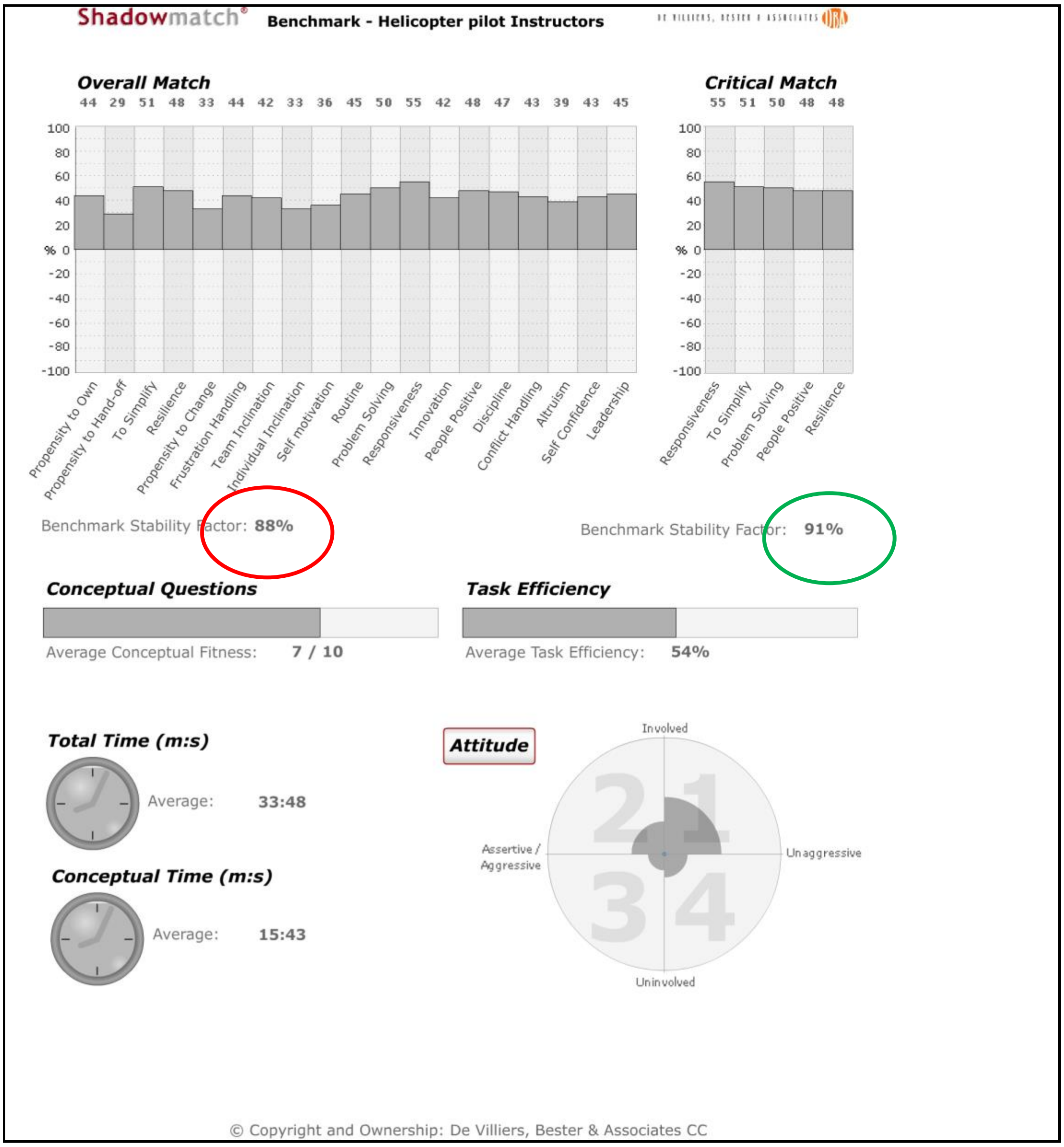

Figure 4.3: Instructor pilot benchmark ("shadow") (n = 5)

From Figure 4.3 Shadowmatch™ clearly confirms the Benchmark Stability factor for the Overall Match as 88% (red oval) which in itself is considerd particularly high (De Villiers, 2011). The Benchmark Stability factor for the Critical Match factors is 91% (green oval) which is regarded as exceptional by the creators of Shadowmatch™ (De Villiers, 2011).

4.2.2 Pilot safety culture habits (overview)

The identified pilot safety culture habits relevant to this thesis were discussed in Chapter 2. The literature application in Chaper 2.3 was contexttualised through the use of relevant theories and reviews, the effective implementation of case studies, relating auto-ethnographic tales recorded at the researched company, conducting in-depth interviews with aviation field experts and assessing flight instructors, and finally using Shadowmatch™ as a suitable data gathering and analysis platform.

The theme of pilot safety culture habits was found to be insufficiently contextualised in available literature, with most aviation references focusing predominantly on millitary and airline pilots (Hunter, 2010). The literature application and analysis of pilot safety culture habits were found to be suitably measurable in accordance with the theoretical constructs through the use of Shadowmatch™.

Shadowmatch™ incidentally provided an appropriate data collation platform which had direct research value pertinent to the requirements of this thesis. It proved to be helpful in assessing the relevant pilot safety culture habits and categorising same in accordance with the stipulations and expectations of the DFE questionnaire and IAs. Shadowmatch™ was found to be to be a suitable off-the-shelf product for this thesis and negated the researcher's efforts to develop a similar product unnecessarily.

Figure 4.4 provides an example of an individual's Shadowmatch™ score sheet. The grey areas represent the actual benchmark ("shadow") and the blue overlay sections depict the individual's match to the benchmark. The right-hand portion of the graph is an extraction of the five Critical Match (CM) habits and the subsequent isolation form the remainder of the Overall Match (OM) habits.

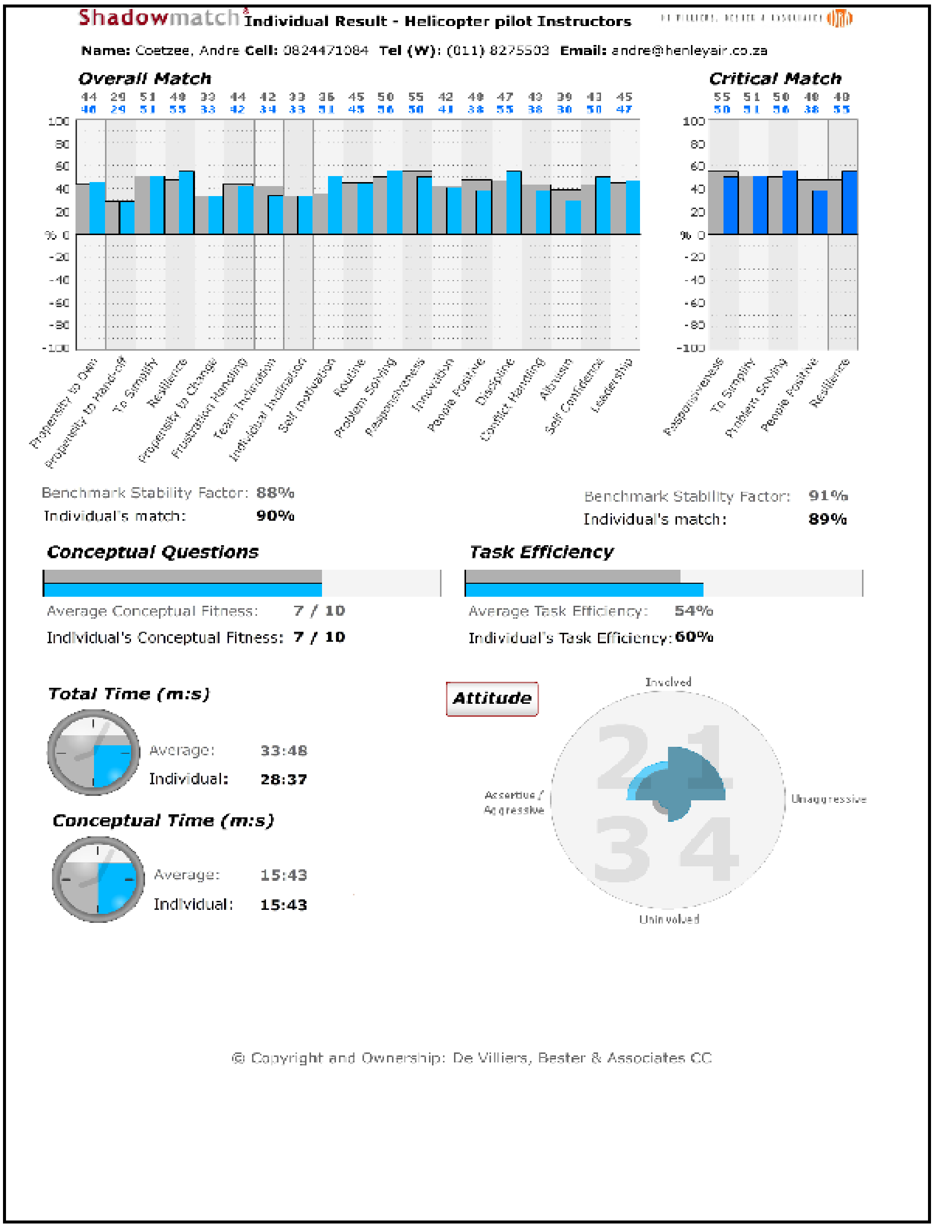

Figure 4.4: Shadowmatch™ scoring results for instructor pilot "AC"

Further indicators on the score sheet, as depicted in Figure 4.4 display the candidate's comparative scores to the benchmark scores for conceptual and task efficiency measurement, time allocation and attitudinal aspects.

Shadowmatch™ draws a map of behavioural habits. By means of a worksheet which the individual completes by answering a series of questions. The questions place the individual in normal day-to-day situations. The individual then selects an answer that best describes the way he behaves in such a situation.

The answers selected by the individual are then processed by a fuzzy logic calculator that identifies behaviour patterns. The identified behaviour patterns (habits) are then weighted against recurrence patterns as well as the relative strength of the behavioural indicator.

All these calculations are done to identify habits in the behaviour of the individual and to determine how well these habits are formed and matured in the way the specific individual lives his life. The results are displayed as a graph indicating which habits are well established This forms the basis of the definition of thesafety culture habits of pilots employed in this thesis.

4.3 IA PROCESS

The assessment methodology used to ensure the reliable categorisation of candidate helicopter pilots included considerations such as **simplicity**, **singularity** and the prevention of **cognitive overload** on the instructor (Coetzee, 2008). The accurate and immediate collation of data was crucial in compiling the final assessment and instructors completed the forms immediately after the initial introductory flight.

Instructors were briefed on the appropriate process to be followed with the emphasis on simplicity (ease of completion in both comprehension and time domains), singularity (avoiding confusing or ambiguous questioning) and respecting the potential for cognitive overload on both instructor and student. The formal briefing document would be read prior to every flight and is contained in introductory pages of the assessment form.

The aim of the IA process is to avoid any stressful interpretations of a patently harmless questionnaire. Similarly, candidate pilots should not be coerced or forced into completing the assessments, but should rather be motivated to embrace the initiation and execution of the assessment process in a diplomatic manner befitting the social and financial status that new students possess. The process is regarded as totally voluntary however, a student’s reluctance or refusal to complete same should be duly noted on the IA form.

Granularity refers to the level of detail in a set of data (Oxford Dictionary, 2013) and was discussed with individual instructor pilots during post-flight de-brief sessions. The complexity level of the IAs ranged from “simple” to “somewhat complex”, for the lowest common assessment denominator – Grade III instructors. It is significant that instructors that did note the higher level of complexity had not fully read the pre-flight briefing material.

Bias describes an inclination or prejudice for or against one person or group, especially in a way considered to be unfair (Oxford Dictionary, 2013). The risk of both negative and positive instructor bias was raised during the de-brief sessions and primarily focused on the initial student impression gleaned from the first visual encounter.

(a) Demographic data capturing

Demographic information was recorded in the standard format and collated along with Shadowmatch™ and IA form, as attached in Annexure F.

(b) Instructor guidelines and detailed briefing

The legend below provides specific briefing instructor guidelines when assessing every aspect of the categorisation process. Instructors had to familiarise themselves with the precise definition of the various assessment aspects and conform to the relevant scoring legend

(c) IA form layout

The IA form comprised three distinct phases: pre-flight, in-flight and post-flight. The scoring for each phase is captured on a standard 5-point Likert scale and instructors used the scoring legend for the various assessment phases:

Legend:	1: Poor	2: Below average	3: Average	4: Above average	5: Exceptional

Only the Chief Pilot or Chief Flying Instructor was allowed to collate and interpret the Shadowmatch™ and IA data.

4.4 CHAPTER OVERVIEW

Chapter 4 addressed the final layout and categorisation methodology for implementing both Shadowmatch™ and the IAs at the researched company. A total of 106 pilots were subjected to the Shadowmatch™ software and 33 candidate pilots were assessed by flight instructors on their demonstration flight.

The combined scores were collated and integrated as a further measurement to establish authenticity and data verification. This process, including validation of the research data, is discussed in Chapter 5.

CHAPTER 5: RESEARCH VERIFICATION, VALIDATION AND FINDINGS

5.1 INTRODUCTION

The previous chapter reported on defining and implementing the categorisation methodology at a helicopter flight school. In this chapter the author integrates the research findings and builds a case that the research data has adequately addressed the research problem through verification, and that the results produced a valid and reliable result in categorising the flight safety habits required to mitigate potential flight incidents and accidents.

The qualitative **data-gathering** process centered around the use of case studies (Yin, 1998), reciting auto-ethnographic tales and in-depth interviews with aviation field experts and flight instructors (Chapter 3.3). The **data-analysis** process employed during the development and evolvement of the categorisation methodology is defined in Figure 5.1 as follows:

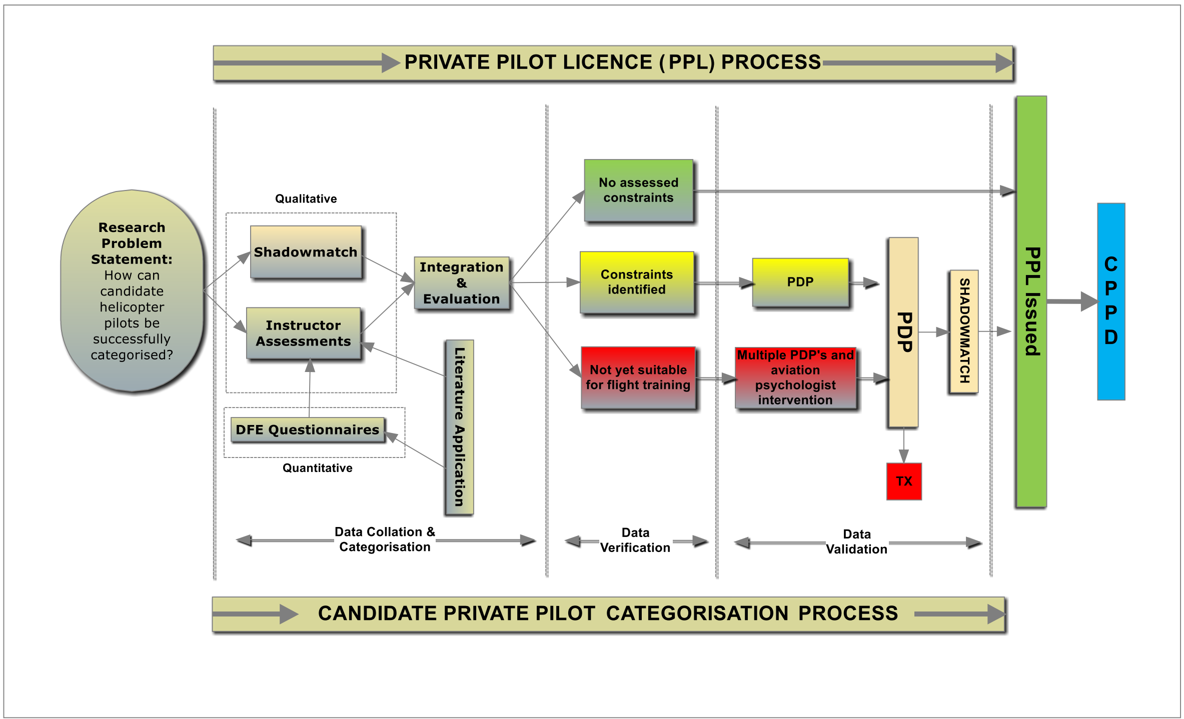

Figure 5.1: Candidate pilot categorisation process

Figure 5.1 above details the various phases associated with the convergent parallel design method (Chapter 1).

The accurate representation and collation of research data is significant in the evaluation, verification and validation of the researched material. By implementing statistical techniques and through further inspection, the significance of the data is presented in a discernible manner in order to explore the developed value-adding assessment instrument and in order to report on the research findings.

The first phase of collating the data required for the development of the Instructor IA entailed using input from SACAA DFEs to ascertain the reliance and functionality of the postulated question sets. The use of a commercial career assessment software package, Shadowmatch™, was combined in parallel to the IAs, and 33 students were assessed by utilising both systems.

Eleven helicopter flight instructors were used to provide objective assessments of the various *ab initio* students. All instructors were provided with comprehensive briefing material on the subject matter prior to completing the IAs.

5.1.1 Results of instructor interviews

Instructor pilot and DFE interviews and 360° feedback sessions were conducted and recorded as part of the qualitative data-gathering process. A summary of the questions posed is noted in Annexure A_2.

Commonality and congruency in the returned DFE interview answers were noted for the following questions and served as confirmation regarding the posed notion of "Aviator Excellence" and the definition of good pilot safety culture habits (Bezuidenhout, Broberg & Marais, 2011): (i) all rounded pilot; (ii) good handling skills; (iii) superior preparation; (iv) low macho characteristics; (v) attention to detail and cognisant of rules and regulations; (vi) ability to fly "seat of the pants"; (vii) not overly reliant on cockpit technology and automation; (viii) desirous for continued and advanced training; and (ix) humility.

Specific attention was given to the gathering of demographic information provided by the DFE respondents, collated, statistically analysed and recorded in Table 5.1:

Table 5.1: DFE Demographic factors – Descriptive mean and SD values

	MEAN	**SD**
Age	56.05	8.630
Years in aviation	36.80	9.865
Helicopter hours	8110.05	3645.376
Fixed wing hours	6541.90	6280.852
Instructor hours	4002.50	3025.946

The age spread amongst the respondents was recorded in Figure 5.2 as:

AGE	**COUNT**	**%**
≤ 40	2	10
41-45	1	5
46-50	1	5
51-55	5	25
56-60	2	10
61-65	7	35
65 +	2	10
TOTAL	20	100

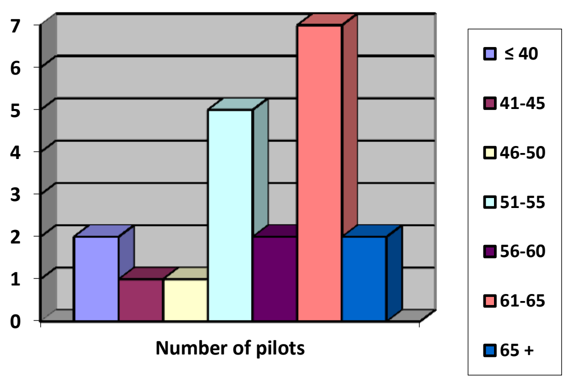

Figure 5.2: DFE age frequency

Figure 5.2 confirms that the largest concentration of DFEs cluster in the 61-65 years age bracket (7) with an average population age of **56.1** years (SD = 8.6). The youngest DFE was 39 years old and the oldest person 68. Notably, the two youngest DFEs (≤ 40 years) and the oldest DFE (68 years) were not in the South Africa Air Force (SAAF). Figure 5.3 over page captures the number of years spent in aviation:

YEARS	COUNT	%
0-20	2	10
21-25	1	5
26-30	2	10
31-35	3	15
36-40	3	15
41-45	5	25
46 +	4	20
TOTAL	20	100

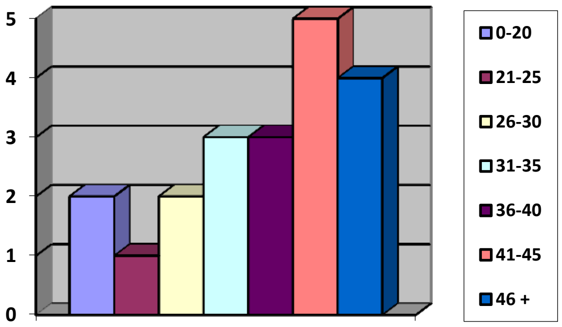

Figure 5.3: DFE years' experience in aviation

The graph in Figure 5.3 clearly shows that five DFEs had between 41-45 years aviation experience and represents the largest concentration. The average number of years' experience is **36.8** (SD = 9.9), the lowest number is 17 years (1 DFE) and the highest number 50 years (2 DFEs).

Actual flying hours is normally an accurate method of determining any pilot's level of experience and competence and for insurance purposes. The helicopter (H) flying experience of the respective DFEs is tabulated in Figure 5.4:

FLYING HOURS (H)	COUNT	%
0-2000	1	5
2001-4000	1	5
4001-6000	5	25
6001-8000	4	20
8001-10,000	4	20
10,001-12,000	3	15
12,001 +	2	10
TOTAL	20	100

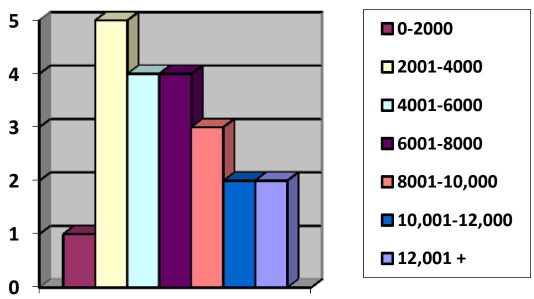

Figure 5.4: DFE helicopter flying hours accumulated

The population average is **8,110.1** hours (SD = 3645.4) flown on helicopters, with a lowest value of 1,221 and a highest value of 18,200. Five DFEs accumulated between 4,001-6,000 flying hours on helicopters which represents the highest frequency for the data set.

As noted in the preamble, the minimum qualification to acquire DFE status is 3,000 helicopter flying hours, of which at least 1,500 hours must be as an instructor. Figure 5.5 collates the number of instructional flying hours on helicopters:

INSTRUCTION HOURS (H)	COUNT	%
0-1000	2	10
1001-2000	3	15
2001-3000	4	20
3001-4000	3	15
4001-5,000	3	15
5001-6,000	1	5
6,001 +	4	20
TOTAL	20	100

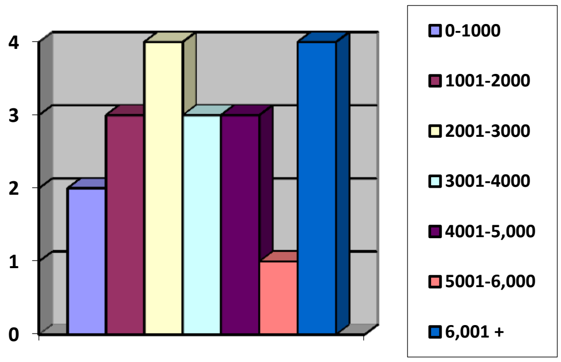

Figure 5.5: DFE helicopter flight instruction hours accumulated

From the data contained in Figure 5.5 it was interesting to note that two DFEs did not comply with the minimum requirements of the Civil Aviation Regulations and were awarded the DFE status due to a regional and provincial oversight requirement. The average number of helicopter flight instruction hours were **4,040.7** hours (SD = 3,025), with a lowest value of 450 and a highest value of 13,600 hours. It is noted here that the DFE with the highest overall flying hours on helicopters also has the most instructional hours.

The relevance of fixed-wing hours to this specific study is negligible, but does provide an indication of the overall level of experience contained in the sample population. All but one DFE held dual-ratings (both helicopter and fixed-wing) and the most senior respondents were employed by airlines.

The number of fixed-wing hours is captured in Figure 5.6 as:

FIXED-WING HOURS	COUNT	%
0-2000	8	40
2001-4000	2	10
4001-6000	2	10
6001-8000	0	0
8001-10,000	0	0
10,001-12,000	5	25
12,0001 +	3	15
TOTAL	20	100

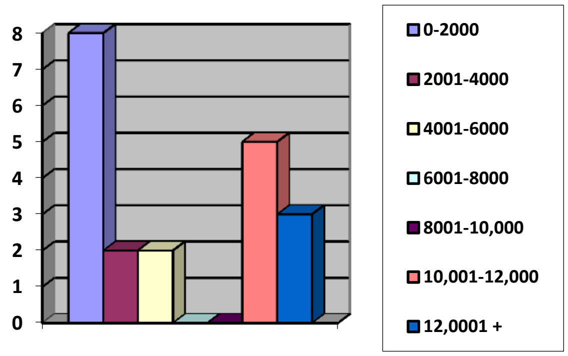

Figure 5.6: DFE fixed-wing flying hours

The graphic depiction in Figure 5.6 indicates that the greatest percentage of helicopter DFEs had very little (7 DFEs) or no (1 DFE) fixed-wing experience. The average fixed-wing hours per DFE is **6,541.9** hours (SD = 6,280.9).

5.2 DATA VERIFICATION

As depicted in Figure 5.1, the data-collation phase entailed the acquisition of two distinct sources for data gathering:

5.2.1 Shadowmatch™

As discussed in Chapter 4, the designers of Shadowmatch™ used a benchmarking ("shadow") comprising at least five strong candidates. This benchmark was then compared to evaluate any new potential candidate(s) applying for a similar position with the organisation. Both the benchmark candidates and prospective employees were subjected to the same online assessment questionnaire and graded in accordance with 18 habits (Chapter 2) with respect to time management skills, conceptual prowess, task efficient considerations and overall attitude. The five Critical Match habits for the company's benchmark group were identified by Shadowmatch™ as: (i) Responsiveness; (ii) Task simplification; (iii) Problem solving; (iv) People positive behaviour; and (v) Resilience.

5.2.2. Instructor Assessments

It was found that historical pilot assessment methods focused only on psychometric testing and extensive test batteries that evaluate potential rogue personality traits in pilots. This is specifically true for airline and military candidates where substantial numbers of aspirant pilots apply for prestigious appointments and are initially filtered through basic screening processes.

The IAs developed in this research domain (discussed in Chapter 4) focused on the instructor's assessment of actual hands-on flying qualities, in parallel to the objective observation and evaluation of soft skills not normally associated with pilot evaluation at typical flight schools. The assessment was preceded by a comprehensive briefing guideline and aimed to eliminate subjective and biased responses.

The Three-Phase approach to the assessment completion process encompassed a Pre-Flight Reception phase (meet and greet), in-flight phase and post-flight phase. The latter assessment subtly addresses the eighteen Shadowmatch™ habits and aimed to provide the instructor with a concise overview of the student's flight experience, demeanour and reaction to predetermined stimuli.

The **data-verification process** centered around statistical correlation of data obtained from the Shadowmatch™ assessment, as completed in private by the new student, and the IA, as assessed by any flight instructor familiar with the IA briefing guidelines.

5.2.3 Internal consistency of datasets

Through **triangulation** (Bulsara, n.d.; Creswell, 2009; Bergman, 2008) and integration of the datasets, the **internal consistency** of the datasets is calculated for Cronbach's alpha (α), the standardised alpha and the inter-item correlations, as depicted by Table 5.2.

Table 5.2: Internal consistency for three IA phases only

DATASET	MEAN	STD. DEV.	N	CRONBACH α	STANDARDISED α	AVG. INTER-ITEM CORR.
Phase 1	59.2121	8.92944	33	0.564589	0.864230	0.290782
Phase 2	62.5000	7.29424	33	0.688890	0.66699	0.102412
Phase 3	104.033	14.3491	33	0.928303	0.935389	0.339204

Table 5.2 denotes that Cronbach's alpha coefficient as not robust against missing data entries and the internal reliability of test scores. Cronbach's alpha generally increases as the inter-correlations among test items increase. As can be seen in Table 16, Cronbach's alpha coefficient is defined as

$$\alpha = \frac{K \cdot \bar{c}}{(\bar{v} + (K - 1) \cdot \bar{c})}$$

where K is the number of items, $\bar{v}$ equals the average variance for the current sample of persons and $\bar{c}$ is the average of all covariances between the items across the sample of persons (Gliem & Gliem, 2003).

Cronbach's alpha reliability coefficient normally ranges between 0 and 1, but no actual lower limit exists. The best indication of internal consistency is achieved through alpha values closer to 1. A useful aid to predicting a reliable alpha value is noted as:

> 0.9 – excellent; > 0.8 – good; > 0.7 – acceptable; > 0.6 – questionable; > 0.5 – poor; and < 0.5 – unacceptable (George & Mallery, 2003).

Through inspection it is able to determine that alpha (α) values for Phase 1 (0.564589) and Phase 2 (0.688890) range between “questionable” and “poor” in terms of statistical consistency. Phase 3, which incorporates 18 Shadowmatch™ habits, shows excellent internal consistency (0.928303) and is suitable for further evaluation and discussion.

5.2.4 Effect sizes

The t-Test values for the two datasets (SM and IA) revealed exceptionally low p-values, and hence the effect sizes were calculated, as recorded in Annexure D.

In descriptive statistics, an effect size is a measure of the strength of a phenomenon (for example, the relationship between two variables in a statistical population) or a sample-based estimate of that quantity. An effect size calculated from data is a descriptive statistic that conveys the estimated magnitude of a relationship without making any statement about whether the apparent relationship in the data reflects a true relationship in the population. In that way, effect sizes complement inferential statistics such as p-values (Steyn, 2009). Reporting of effect sizes is considered good practice when presenting empirical research findings in research fields such as, sociology, education and psychology. The reporting of effect sizes facilitates the interpretation of the *substantive* as opposed to the statistical significance of a research result.

For ease of use and reference, the effect size value for means of the T-test relating to the two datasets is again depicted by Cohen’s d-value and defined by the equation (Ellis & Steyn, 2003)

$$d = \frac{|\bar{x}_1 - \bar{x}_2|}{s}$$

where d is the effect value

$\bar{x}$ is the mean value for each set

s is the pooled standard deviation and assuming $\sigma_1 = \sigma_2$.

Cohen (1998) provides guidelines for the interpretation of effect sizes as:

small effect: d = 0.2

medium effect: d = 0.5

large effect: d = 0.8.

Data with d ≥ 0.8 is regarded practically significant and is listed in Table 5.3:

Table 5.3: Effect sizes for IA vs. SM responses (effect size rankings)

Q	DESCRIPTION	N	MEAN	SD	P-VALUE	EFFECT SIZE
17	Responsiveness	33	4.606061	0.747470	0.000000	1.9051
8	Responsiveness	33	4.500000	0.866025	0.000003	1.2072
24	Self-confidence	33	4.272727	0.839372	0.000025	1.1553
15	Routine	33	2.69697	0.809508	0.00003	1.0481
9	Task simplification	33	3.848485	0.833712	0.000138	1.0372
20	Discipline	33	4.242424	0.751262	0.000451	0.8356
4 A-F	Task-load index	33	2.231818	0.825172	0.000280	0.7804
10	Resilience	33	3.909091	1.011300	0.010102	0.7487
16	Problem solving	33	4.060606	0.826869	0.003049	0.6963
11	Change management	33	2.727273	1.125631	0.047931	0.4577
8	Locus of control	33	2.787879	0.280354	0.563416	0.4324
19	People positive	33	3.181818	1.157976	0.058056	0.4187
4 F	Frustration	33	3.30303	1.103541	0.160469	0.3295
13	Team inclination	33	2.818182	0.46466	0.105631	0.2961
22	Conflict	33	3.454545	1.063335	0.493956	0.171
12	Frustration	33	3.303030	1.103541	0.561009	0.1373
18	Innovation	33	3.242424	0.867118	0.629251	0.1048
23	Altruism	33	3.121212	1.243925	0.714040	0.0974
14	Self-motivation	33	3.545455	1.063335	0.797391	0.057
16	Cognition	33	3.530303	0.769937	0.810141	0.0522

Table 5.3 ranks the effect sizes for the IA vs. SM responses. The effect size cut-off line is indicated below change management in the table. Highlighted areas (in yellow) conform to the five critical match habits identified by Shadowmatch™ as: (i) Responsiveness; (ii) Task simplification; (iii) Problem solving; (iv) People positive behaviour; and (v) Resilience.

The data rankings confirm that the effect of Responsiveness is paramount for both IA and SM respondents, followed by Task Simplification, Resilience and Problem Solving. Notably, People Positive behaviour falls outside the criteria (< 0.45) and is hence not considered an effect size of suitable significance.

5.2.5 Correlations

The practical significance of the IA vs. SM datasets assists in verifying the data collation methods of the Shadowmatch™ benchmark (as completed by the student) and the external IA (as assessed by any flight instructor, regardless of grading). Flight instructors are graded in accordance with their instructional experience levels: Grade III depicts the lowest ranking (0 – 200 hours), Grade II (200 – 1,500 hours) and Grade I (1,500 hours + and subject to extensive theoretical training).

The comparative datasets for IA and SM values show that 11 different instructor pilots were used to evaluate the 33 candidates. The breakdown of the number of candidates evaluated per pilot is noted in Table 5.4:

Table 5.4: Instructor Assessments candidates

NO.	INSTRUCTOR RATING GRADE	NO. OF CANDIDATES
1	Grade III	4
2	Grade II	4
3	Grade III	1
4	Grade II	5
5	Grade I	1
6	Grade II	2
7	Grade I	1
8	Grade II	11
9	Grade II	1
10	Grade II	2
11	Grade II	1

From Table 5.4, and highlighted in shaded yellow, Instructor #8 clearly conducted the most evaluations (n = 11) and is hence used to further evaluate the IA vs. SM correlation data.

A scatterplot of the various instructors' IA scores (Annexure E) shows limited consistency for the respective candidates and more so for the five Critical Match habits, as identified by Shadowmatch™. Correlation data for all instructors (n = 11) is recorded in Annexure G and shows no significant correlations between the five *Critical Match* habits.

Data for Instructor #8 (Annexure H) follows a similar non-correlatory trend and reveals a positive correlation for habit Task Simplification only (r = 0.685772). The scatterplot for this habit confirms the correlation (Annexure E). A summarised version of the correlations is presented in Table 5.5:

Table 5.5: Summarised IA vs. SM correlations (all instructors and Instructor #8)

DESCRIPTOR	ALL INSTRUCTORS	INSTRUCTOR #8
Responsiveness	0.096268	-0.080077
Task simplification	0.092693	0.685772
Problem solving	-0.063103	0.005324
People positive	0.054606	0.045014
Resilience	0.034497	-0.097752

Table 5.5 confirms that the only habit Task Simplification shows significant correlation value for both the completed IA and SM questionnaires.

5.3 DATA VALIDATION

Data validation is defined as the inspection of all the collected data for completeness and reasonableness, and the elimination of erroneous values. This step transforms raw data into validated data (Resource assessment handbook, 2012). The validated data is then processed to produce the summary reports required for further analysis. This step is also crucial to maintaining high standards of data completeness during the course of the research process. The quality of the acquired data refers to the "fitness for the intended purpose through a multi-faceted evaluation of states, such as completeness, validity, consistency, precision and accuracy" (Wiggins, Newman *et al.*, 2009).

Kvale (1989) argues that qualitative studies have been rejected as subjective, unreliable and invalid. Validation is regarded by Kvale (1989:74) as “investigation, continually checking, questioning and theoretically interpreting the findings.”

Through the development of a data validation routine in compliance with the categorisation model (Figure 5.1), continuous, reliable data validation for future student assessment is assured.

5.3.1 Shadowmatch™ validation criteria

Inspection of the benchmark presentation for all company helicopter instructor pilots reveals the five Critical Match habits as (i) Responsiveness; (ii) Task simplification; (iii) Problem solving; (iv) People positive behaviour; and (v) Resilience.

Figure 5.7 displays seven additional visual representations of the integrated question scores. Consultation with De Villiers of Shadowmatch™ (2012) assisted in defining specific validation criteria for each classification:

(a) Benchmark stability factor for 18 Overall Match habits (red oval)

The benchmark stability factor is a crucial indication of the overall internal stability of the scores obtained from the benchmark candidates (n = 5). Shadowmatch™ regard a stability factor > 70% as an acceptable and a benchmark percentage of 88% is exceptionally strong for all 18 habits. This individual match indicates the representative score for the respondent as 90%.

(b) Benchmark stability for five Critical Match habits (blue oval)

Shadowmatch™ automatically collates the five highest scoring habits for the benchmark group and extracts the habits under Critical Match habits. Similarly, the benchmark stability factor for the five Critical Match habits presents as 91%, again exceptional. The example individual has scored 89% and is denoted by a question mark.

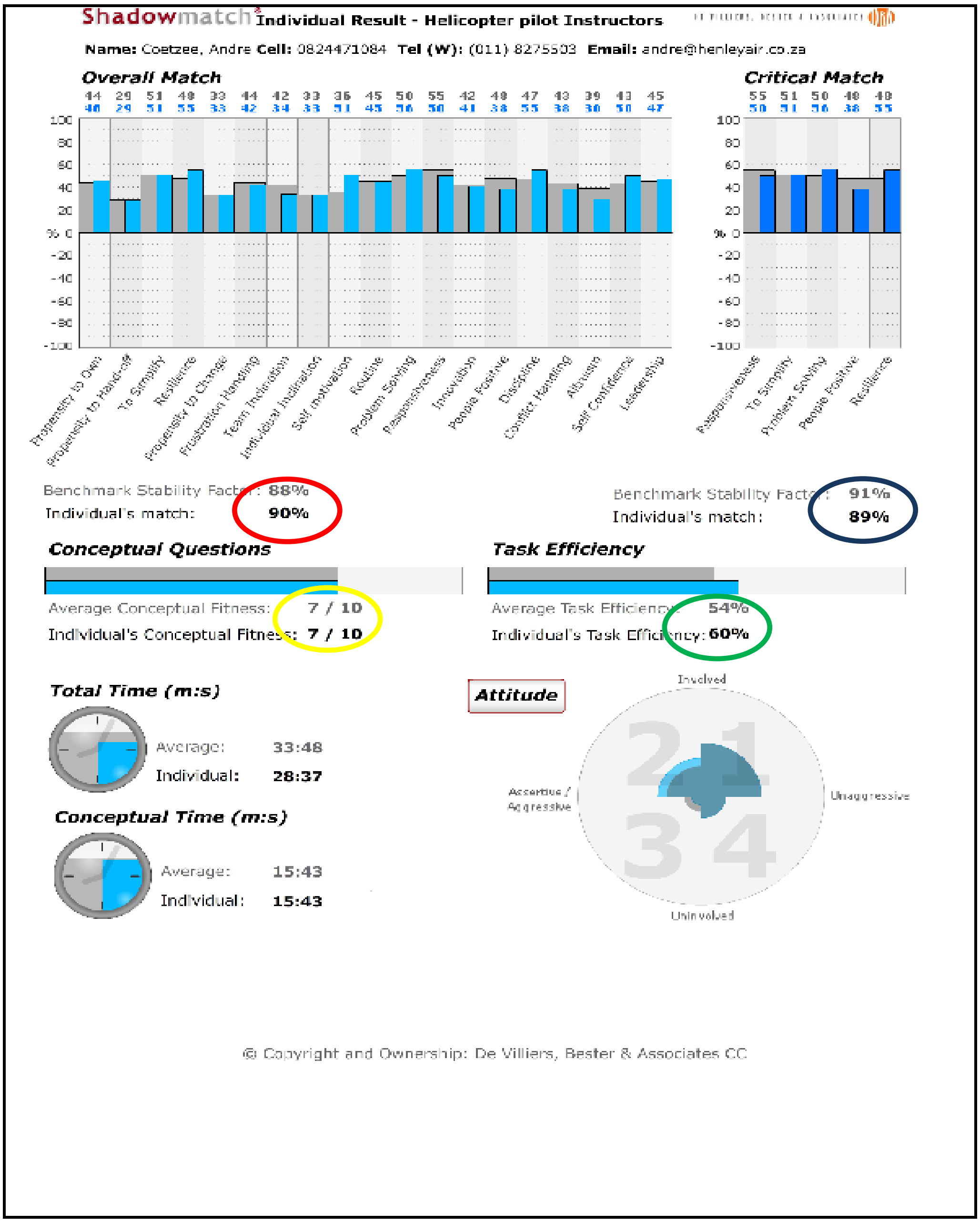

Figure 5.7: Shadowmatch™ benchmark for instructor pilots

(c) Conceptual question score (yellow oval)

Shadowmatch™ utilises 80 questions for the full assessment. Ten questions within the full complement challenge the respondent to perform mental, cognitive and deductive reasoning in order to ascertain intellectual analysis functions. The average benchmark group was 70% and this candidate returned the same value. The recommended and accepted helicopter pilot validation standard for this categorisation purposes is a variance < ± 10%.

(d) Task efficiency score (green oval)

The name clearly defines the scoring range. The average for the benchmark group shows a mere 54% and relates to all the completed answers. Candidates returned a higher than average score of 60%. The same validation standard for a variance of < ± 10% applies when categorising candidate pilots.

Figure 5.8 continues to assist in extracting valuable information from the screenshot presentation.

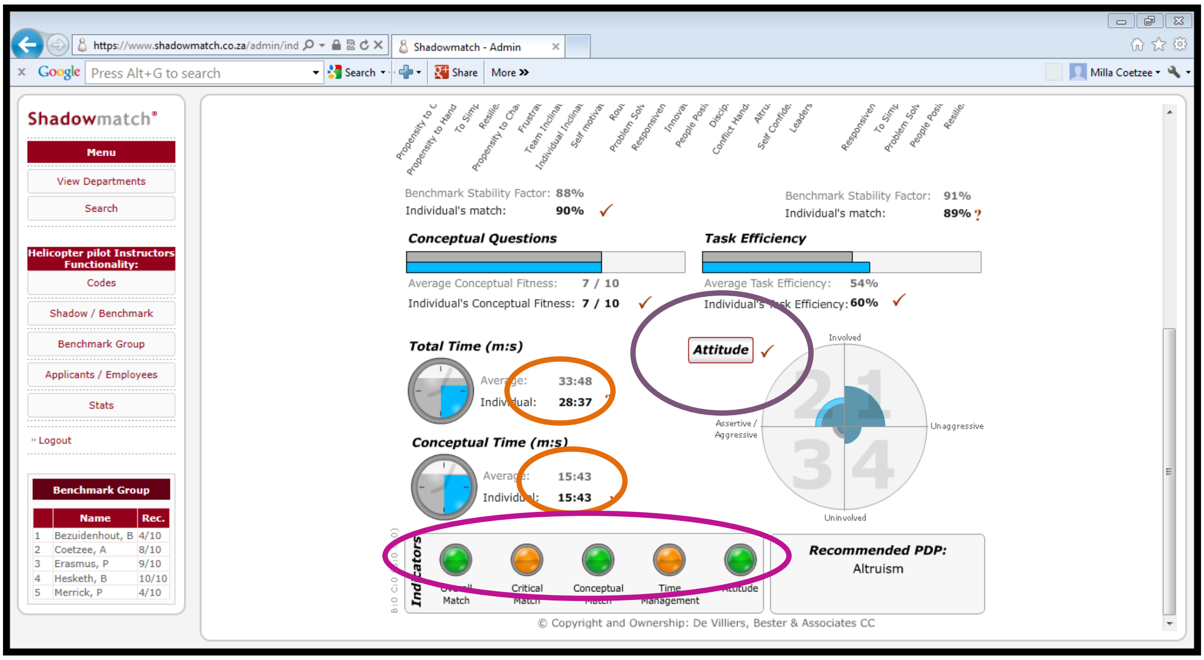

Figure 5.8: Shadowmatch™ benchmark for instructor pilots

The following additional information is made available in Figure 5.8:

(a) Total Time for completion and Conceptual Time (orange ovals)

The two clocks show the average benchmark times to complete the total assessment conceptual component of the programme. The suggested variance limit for both completion periods should not exceed ± 90 seconds.

(b) Attitude (purple oval)

The quadrantal display of the Attitude barometer visually expresses the respondent's inclination to present aggressive vs. non-aggressive involvement in situations. Quadrant 1 confirms that the benchmark group's highest inclination is one of an unaggressive, involved nature. Respondents displaying high scoring in quadrant 1 are typically highly motivated and willing to contribute substantially towards a priority (De Villiers, 2009). Quadrant 2 indicates "aggressive/assertive, involved" behaviour and the benchmark group. A visible albeit smaller portion of the benchmark group displays quadrant 2 behavioural characteristics.

The least desirable personality depiction is an aggressive, uninvolved, quadrant 3 behavioural pattern. This quadrant should be avoided whilst evaluating candidate helicopter student pilots.

(c) Comprehensive Match Indicator panel (pink oval)

The final and perhaps most important evaluation tool are the coloured robot lights.

	Green indicates a perfect match to the benchmark group
	Amber indicates further analysis of the candidate
	Red indicates obvious deficiencies and requires intervention

A red indicator at any of the five assessment areas represents an immediate area of concern and a formal recommendation to complete a Personal Development Programme (PDP), as generated by Shadowmatch™. Figure 5.9 displays the Comprehensive Match indicators:

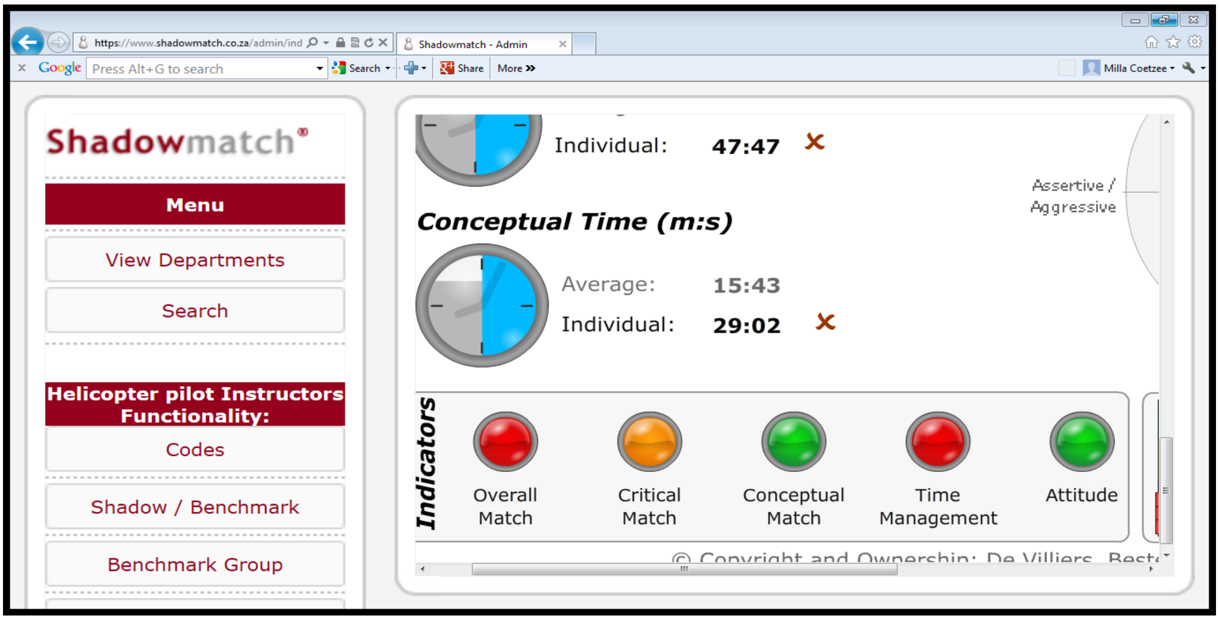

Figure 5.9: Shadowmatch™ Comprehensive Match (CHM) indicator panel for assessed pilots

The Indicator lights in Figure 5.9 represent an instant visual report for factors:

(a) Overall match for 18 Habits (OM)

(b) Critical match for 5 Habits (CM)

(c) Conceptual match for 10 questions (CONC)

(d) Time management (TIME)

(e) Attitude analysis (ATT)

Table 5.6 presents a concise overview of the assessment criteria for prospective pilots and provides various permutations in establishing the correct classification order for candidate pilots. As an example, a pilot qualifying for a green progression through his PPL would be required to return a maximum of one amber indicator, perfect attitude overlay, overall and conceptual time management within 90 seconds of benchmark times, task efficiency within 10% of benchmark, conceptual fitness within $\frac{1}{10}$ (10%) of benchmark and both overall and critical match scores ≤ 2% of stability factor:

Table 5.6: Pilot categorisation criteria

	OM	CM	CONC	TE	TIME	ATT	CHM	PDP	PSY
Green	$\Delta \leq \pm$ 2%	$\Delta \leq \pm$ 2%	$\Delta < \pm 1$	$\Delta <$ ± 10%	$\Delta \leq \pm$ 90 sec	Perfect overlay	≤ 1 amber	No	No
Amber	± 2% < $\Delta \leq \pm$ 3%	$\Delta \leq \pm$ 3%	$\Delta \leq \pm 1$	$\Delta <$ ± 10%	90s ≤ $\Delta \leq$ 120s	Over/underlay ≤ 10%	1 < amber ≤ 2	Yes	No
Red	$\Delta > \pm$ 3%	$\Delta \leq \pm$ 4%	$\Delta < \pm 1$	$\Delta <$ ± 10%	$\Delta > \pm$ 120 sec	Over/under lay > 10%	≥ 1 red or 2 amber	Yes	Yes

Where: OM = Overall Match
CM = Critical Match
CONC = Conceptual Match
TE = Task Efficiency
TIME = Overall Time Management
CHM = Comprehensive Match
PDP = Personal Development Programme completion
PSY = Aviation Psychologist intervention

A brief summary of the sample pilot population at the company and the respective Comprehensive Match (CHM) scoring matrix presents as (n = 106):

Table 5.7: Comprehensive Match scoring matrix – all pilots

	OM	CM	CONC	TIME	ATT
Green	3	22	69	38	102
Amber	54	62	28	14	4
Red	49	22	9	54	0

Column 5 (ATT) of Table 5.7 clearly indicates that almost all pilots ($\frac{102}{106} = 96\%$) displayed Attitudes congruent (green indications) with the benchmark complement. No pilots presented red indicators.

Column 4 (TIME) reveals that 51% of all assessed pilots had unacceptable time management skills (red indications) if compared to the benchmark group which 36% compare favourably (green).

The number of pilots in column three (CONC) indicates that Conceptual prowess (green) is well developed in 65% of all pilots. 26% of the sample population required PDP intervention.

Of all sampled pilots noted in column one (amber), $(\frac{54}{106} = \mathbf{51}\%)$ would require PDP intervention to address specific behavioural habit fallouts.

Figure 5.10 presents a final screenshot of significant statistical data representation – specifically the Comprehensive Match results.

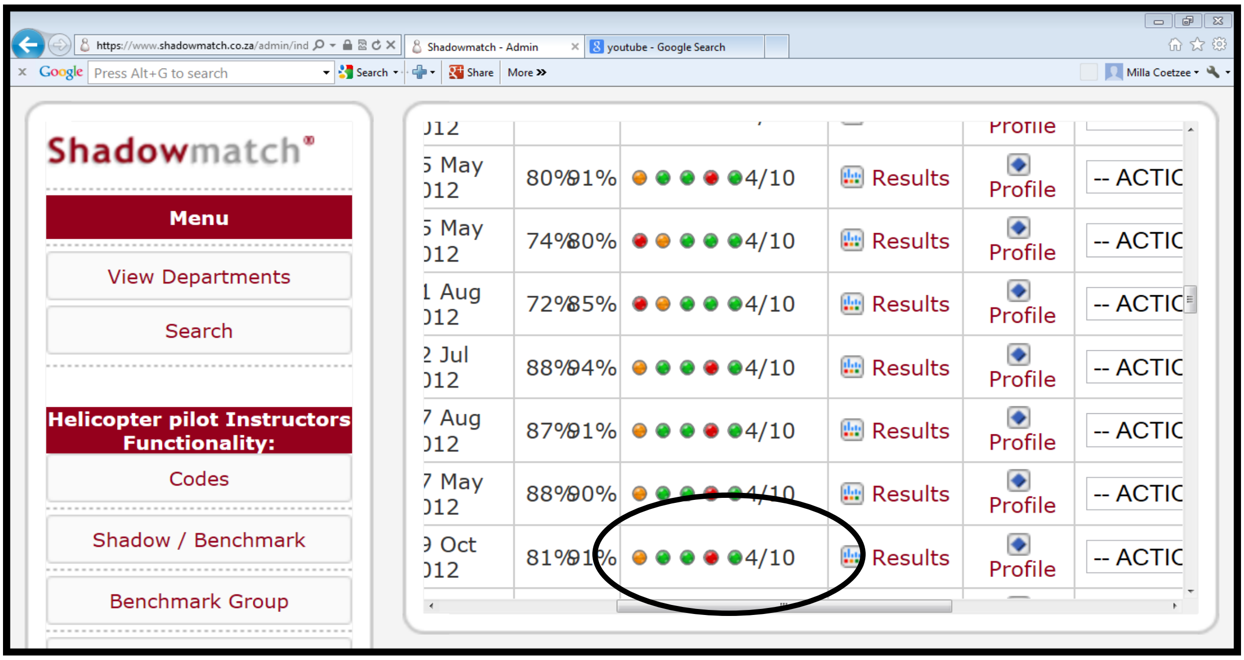

Figure 5.10: Shadowmatch™ Comprehensive Match results for pilots

Figure 5.10 provides a powerful visual overview of the complete pilot population. Adjacent to the Indicator Lights (black oval above), a statistical ranking ($\frac{x}{10}$) is presented and provides a sorted ranking value for the entire population (n = 106).

The Comprehensive Match (CHM) ranking revealed for all pilots (n = 106; $\bar{x}$ = 11; σ = 12.2; median = 5) and for instructors (n = 10; $\bar{x}$ = 1; σ = 1.4; median = 0), as per Table 5.8:

Table 5.8: Pilot sample population: Comprehensive Match

RANKING	N (ALL PILOTS)	N (INSTRUCTORS)
1/10	3	0
2/10	12	1
3/10	22	3
4/10	42	4
5/10	0	0
6/10	5	0
7/10	5	0
8/10	12	2
9/10	5	0
10/10	0	0
Total	106	10

Table 5.8 confirms that $\frac{42}{106}$ = 40% of all assessed pilots returned a Comprehensive Match score of $\frac{4}{10}$.

A graphic depiction is found in Figure 5.11 over page where the pilot sample population at the company (n = 106) comprised various licence-type holders as captured in Table 5.9:

Table 5.9: Company pilot sample population (by licence type)

LICENCE TYPE	NUMBER
SPL	15
PPL	38
CPL	36
ATPL	12
No licence	5

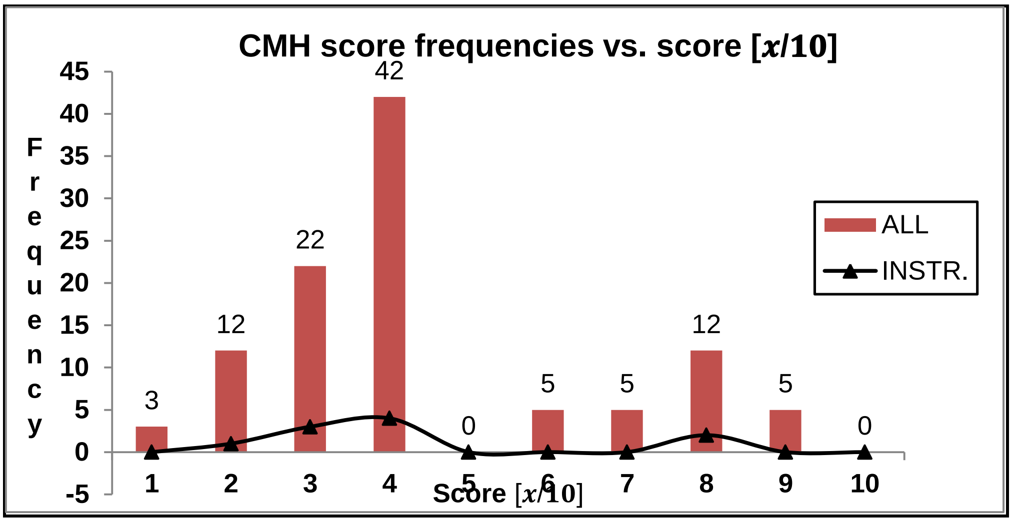

Figure 5.11: Comprehensive Match frequencies versus scores

5.3.2 Company Shadowmatch™ accident statistical analysis

The introduction of Shadowmatch™ at the researched company was initiated in August 2011 and the initial test population comprised of 10 freelance helicopter flight instructors. Significantly, three of the 10 instructors experienced serious helicopter accidents since completion of the Shadowmatch™ assessment. Table 5.10 records the SM scores of the three accidental instructor pilots, along with two other accident pilots that had completed SM:

Table 5.10: Company accident pilots score analysis for *Comprehensive Match*

bb	CHM Rank	Completed	Acc. Date	OM	CM	CONC	TIME	ATT	Injury	Value
$\frac{2}{10}$	94	30 Aug 11	18 Apr 12	🔴	🔴	🟢	🔴	🟢	Nil	R2,8m
$\frac{3}{10}$	70	23 Aug 11	19 Sep 12	🔴	🔴	🟢	🟢	🟢	Minor	R3,2m
$\frac{3}{10}$	91	25 Aug 11	16 Nov 11	🔴	🔴	🟡	🟡	🟢	Nil	R125k
$\frac{3}{10}$	79*	22 May 12	13 Mar 12	🔴	🟡	🟢	🔴	🟢	Nil	R20k*
$\frac{4}{10}$	32**	15 May 12	30 Jun 12	🟡	🟢	🟢	🔴	🟢	Death	R1,5m**

* Charter pilot, engaged in vehicle tracking operation and struck telephone wires. Assessment completed post-accident.

** Jet display pilot. Died during air show routine and totally unrelated to company operations.

The significance of Table 5.10 resides in the fact that the three subject instructors also occupied the three lowest rankings on the Comprehensive Match scale.

Their respective habits that were identified as potential constraints include, *inter alia*, and are presented in Table 5.11:

Table 5.11: Company accident pilots habit analysis for *Comprehensive Match*

Rank	Altruism	Change	Self-Conf.	Moti-vation	Resil-lience	Response	Simpli-fication	Int. LOC	Frustration	Conflict
94	X	X	X	X	X	X	-	-	-	-
91	-	X	X	-	X	X	X	X	-	-
70	X	X	X	-	X	-	-	-	X	X

Table 5.11 shows that the correlation habits are identified as excessive Self-Confidence, Resilience (relentless pursuit of task execution) and reluctance to accept Change. Lesser correlation existed for habits Altruism and Responsiveness.

The validation is hence confirmed by comparing the Critical Match habits and red indicator lights from Table 5.10 with the noted factors above. Shadowmatch™ recommended Personal Development Programmes (PDP) for:

(a) Rank 94: Leadership PDP
(b) Rank 91: External locus of control PDP
(c) Rank 70: Individual inclination PDP.

The three accident-instructors all showed inherent habits of excessive self-confidence, relentless task/goal directed pursuits and an intrinsic reluctance to accept change. The resultant helicopter accidents that followed manifested through their common, unacceptable behaviour, based on their unaligned individual habits.

5.3.3 Personal Development Programmes (PDP)

The power of Shadowmatch™ provided the functionality and capability of generating individual Personal Development Programmes (PDP) for candidates that required (recommended) intervention. Figure 5.12 explains the consolidated systems engineering approach by postulating PDPs for individuals that did not score within the Green robot lights of the initial Shadowmatch™ and IAs.

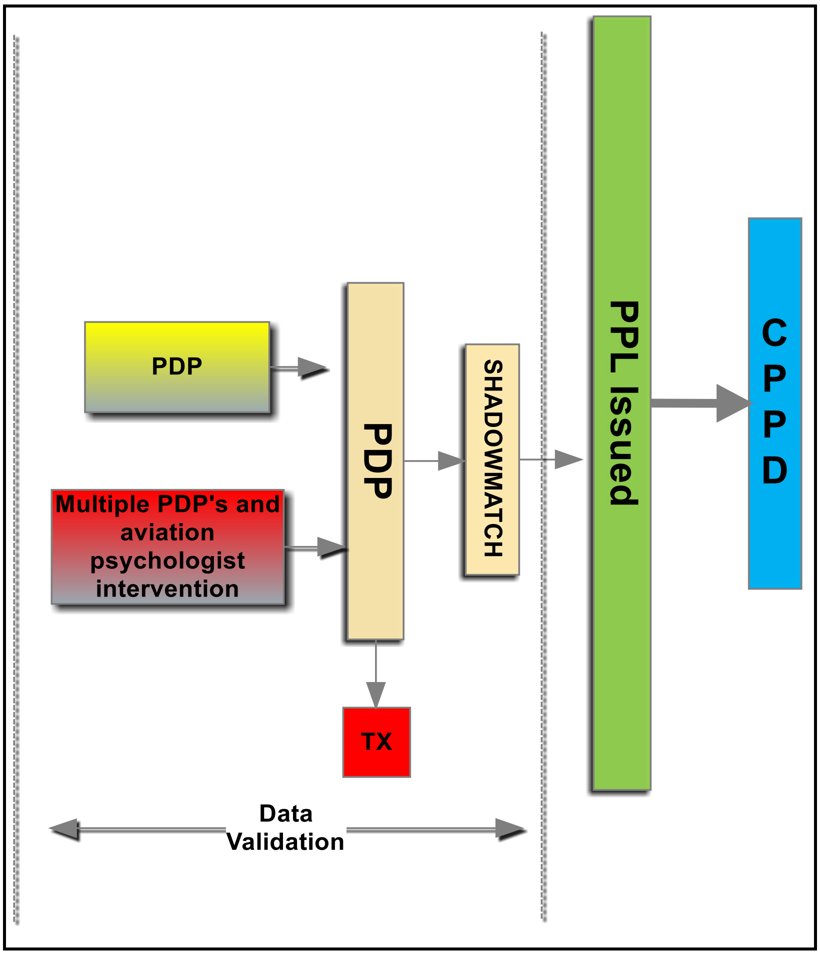

Figure 5.12: Data validation process (abbreviated)

From Figure 5.12 it is evident that pilots who scored more than two amber indicator lights should complete the recommended PDP within the stipulated timeframe. More importantly, the pilot will have to report to his/her assigned mentor on a scheduled basis and complete the entire PDP prior to completing a further and final Shadowmatch™ validation assessment. The PDPs are completed in parallel with the flight training syllabus in pursuit of a Private Pilot Licence.

Generic PDPs have been developed for all 18 habits associated within the Shadowmatch™ software. Every respondent is furnished with a most-suitable assessment report which addresses the various habits, albeit on a very low level.

In the event that more than one amber light is noticed on the Comprehensive Match indicator, the subject pilot must be provided by a PDP relating to that specific habit of concern. More than two amber lights, or a single red light, raise reason for concern and it is recommended that multiple PDPs and even aviation-specific psychological intervention be considered. A complete PDP programme requires six months for full completion and only one PDP at a time may be attempted.

An example of a generic PDP, as allocated to the researcher and addressing habit #14 “People Positive Behaviour”, is recorded in Annexure L and is based on a six-phase process. Recommendations and PDP revisions to ensure an aviation related approach are recorded in Chapter 6.

5.3.4 Aviation psychologist intervention

Figure 5.12 indicates that a yellow result requires the completion of the PDP highlighted by Shadowmatch™. It is in the best interest of the pilot and the flight school that successful completion of the PDP occurs within the stipulated timeframe and concurrent with the formal PPL process.

A red result calls for multiple PDP completions and a recommended visit to an aviation psychologist. The intervention will focus on the recommendation(s) delivered by Shadowmatch™ and serves as guidance to the pilot through the PDP and PPL processes. The intention of utilising an aviation psychologist must not be construed as forced encounter towards a clinical evaluation, but rather a conduit for a value-added service to all candidate students that may require additional professional intervention.

Upon successful completion of the PDP(s), the aviation psychologist must advise the flight school and provide a written report of the student’s progress and achieved PDP outcomes. An example of the interventions completed with three accident pilots by a registered psychologist attached in Annexure I. The categorisation methodology makes provision for the aviation psychologist to propose termination of further flight training in the event that a candidate performs below par in the requisite PDP(s).

5.3.5 Post PDP and intervention validation

A final validation iteration entailed the completion of a further Shadowmatch™ assessment by the pilots that received psychologist intervention in order to compare pre and post results. The ideal measureable result would present a marked reduction in outlying habits and a positive increase of the five Critical Match habits towards the nominal benchmark ("shadow") values.

Table 5.12 compares the results of Shadowmatch™ assessments #1 (completed pre-PDP) and assessment #2 (completed post-PDP). Three of the accident pilots completed two Shadowmatch™ assessments, PDPs and psychological intervention. Pilot #94 failed to respond to a request for PDP and intervention. The shaded areas in Table 5.12 denote the five Critical Match relevant habits.

The analysis for the five Critical Match habits indicates that pilot #79 returned the best improvement to align with the nominal benchmark scores. His scores improved for aspects Task Simplification, Problem Solving and Responsiveness, post PDP intervention. A slight reduction in score was noted for aspects Resilience ($\Delta = +2$) and People Positive behaviour ($\Delta = +5$).

Table 5.13 indicates the remainder of the Shadowmatch™ habits. Pilot #79 showed a positive increase in Critical Match score ($\Delta = +10\%$). Time Management decreased from a green to red indicator. Task Efficiency drastically increased ($\Delta = +30\%$) and found to be on par with the benchmark score. The final Comprehensive Match score increased positively to $\frac{4}{10}$ ($\Delta = +1$) to correlate positively with 40% of all company.

The psychologist's report (Annexure I) revealed that pilot #79 showed the greatest interest in the PDP process, attempted further research into the subject matter and returned the best result. Pilots 70 and 91 displayed reluctance to comply and contribute to the PDP process, as noted by the psychological report.

Despite the small population of accident pilots that could be considered for research purposes, a factual assumption can be made that the PDP and psychological intervention had a positive effect on the candidate that showed the highest level of involvement with the process.

5.4 RESEARCH FINDINGS

The purpose of the study was to ratify the stated hypotheses noted in Chapter 1. An engineering design process was followed by integrating an existing commercially available software package, Shadowmatch™, with original research assessment material obtained through a two-pronged quantitative methodology.

Hypothesis H_1 states that if the safety culture habits of helicopter pilot can be measured reliably, training for candidate pilots could be optimised.

Data gathering and collation entailed incorporating two datasets successfully and ratifying the content. The IAs questionnaires were conceived, created and developed through expert data input obtained from helicopter DFEs (n = 20) in South Africa.

Table 5.12 shows the comparative scores for pre-(SM#1) and post (SM#2) PDP intervention, while Table 5.13 shows the accident pilot combined Shadowmatch™ analysis (SM #1 and SM #2)

Table 5.12: SM #1 vs. SM #2 comparative scores for pre- (SM #1) and post (SM #2) PDP intervention

Pilot #		INTERNAL LOC	EXTERNAL LOC	TASK SIMPLIFICATION	RESILIENCE	CHANGE MANAGEMENT	FRUSTRATION HANDLING	TEAM INCLINATION	INDIVIDUAL INCLINATION	SELF-MOTIVATION	ROUTINE	PROBLEM SOLVING	RESPONSIVENESS	INNOVATION	PEOPLE POSITIVE	DISCIPLINE	CONFLICT HANDLING	ALTRUISM	SELF CONFIDENCE	LEADERSHIP
	Benchmark =>	44	29	51	48	33	42	44	33	36	45	50	55	42	48	47	43	39	43	45
70	SM #1	50	28	56	72	55	64	54	25	52	37	60	59	52	57	61	62	56	64	55
	SM #2	60	25	58	67	58	67	52	33	56	31	55	67	58	61	55	57	51	65	54
79	SM #1	46	32	58	58	33	52	62	19	47	37	62	64	45	56	65	57	48	64	57
	SM #2	39	40	47	60	39	56	66	18	43	37	54	58	45	61	55	67	59	55	52
91	SM #1	59	19	67	68	58	53	41	37	48	55	63	70	52	51	57	52	52	63	54
	SM #2	51	29	70	58	48	41	48	30	47	51	65	72	50	45	52	41	39	59	52
94	SM #1	54	25	56	67	55	56	59	18	56	35	66	72	58	62	64	57	67	64	58
	SM #2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Shaded areas denote Critical Match Habits

Table5.13: Accident pilot combined Shadowmatch™ analysis (SM #1 and SM #2)

Where: OM = Overall Match; CM = Critical Match; CONC = Conceptual Match; TE = Task Efficiency; TIME = Overall Time

		OM		CM		CONC		TIME		ATT		TE	PDP	CHM SCORE
PILOT	Benchmark =>	88%		91%		7/10						54%		
70	SM #1	71%		79%		8/10						66%	Individual inclination	3/10
	SM #2	70%		78%		8/10						59%	Routine	3/10
79	SM #1	77%		82%		8/10						25%	Leadership	3/10
	SM #2	75%		85%		6/10						55%	Individual inclination	4/10
91	SM #1	72%		73%		9/10						57%	Prop. to hand off	3/10
	SM #2	80%		75%		10/10						54%	Individual inclination	2/10
94	SM #1	65%		65%		8/10						16%	Leadership	2/10
	SM #2	-	-	-	-	-	-		-		-	-	-	-

Various correlations were obtained between questions, and notably, the difference in opinion existing between SAAF vs. non-SAAF DFE instructors.

The research into a sample population of 33 student pilots showed that very little or no correlation existed between the pool of helicopter instructors, their ownIAs and the completed Shadowmatch™ assessments. Case studies involving certain instructor pilots that had completed Shadowmatch™ prior to experiencing a helicopter accident served as validation standard once the **data analysis and verification** process was completed.

The effect sizes of the statistics obtained from the Instructor versus Shadowmatch™ assessments was of significant, albeit low in correlation values. The five noted Critical Match benchmark habits for the operation were identified as:

1. Responsiveness (Effect size = 1.9051)
2. Task simplification (1.0372)
3. Problem solving (0.6963)
4. People positive behaviour (0.4187)
5. Resilience (0.7487)

where effect size (d) > 0.45 is an acceptable value for small populations.

The research failed to verify that positive correlation exists between the data captured by the student prior to enrolling at the flight school by comparing Shadowmatch™ and the expected response by the instructor conducting the initial demonstration flight and completing the IA. However, the effect sizes obtained from the data analysis by the Statistical Consultation Services at NWU confirmed that the five Critical Match habits identified by Shadowmatch™ were similar in significance when compared to the IAs.

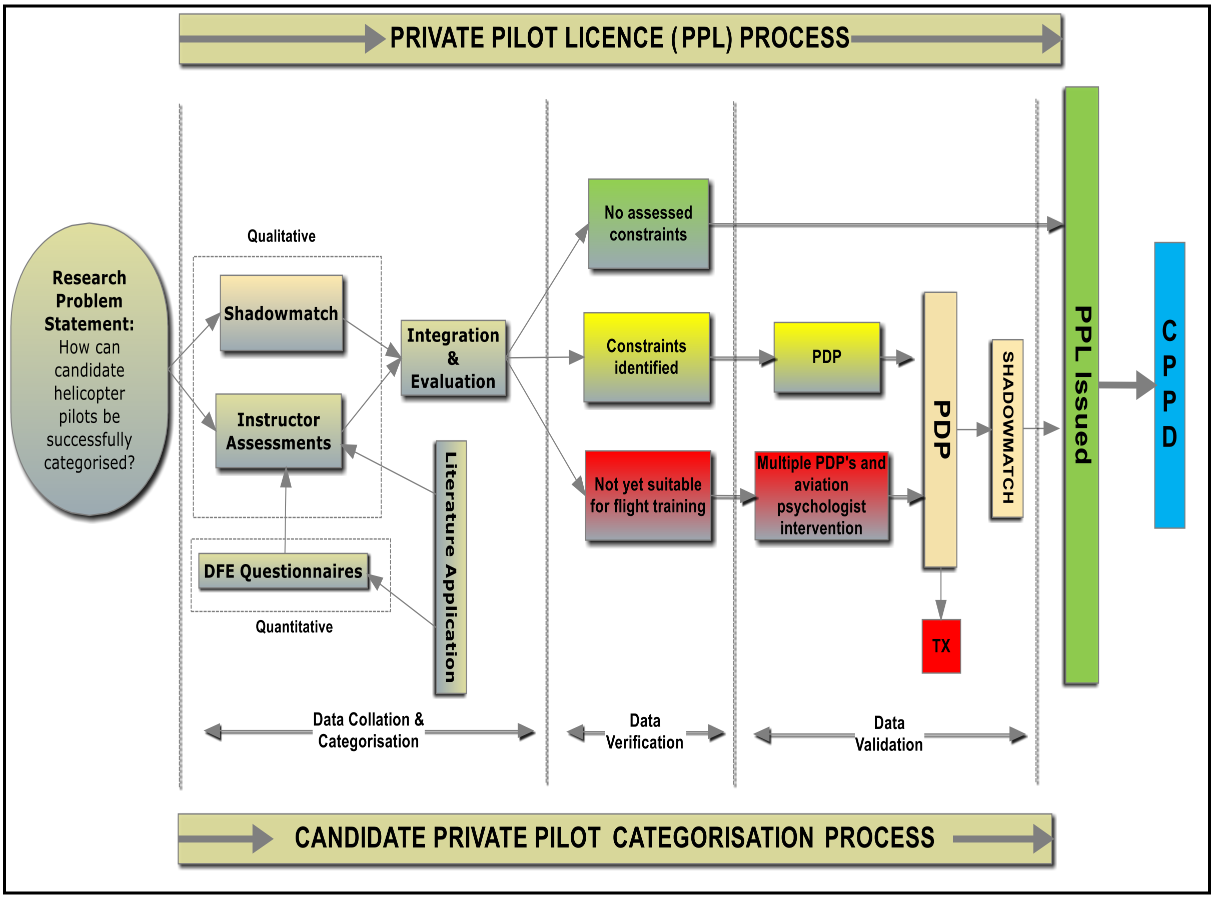

Figure 5.13: Candidate pilot categorisation process

Data validation for a research project of this nature ultimately depended on a successful reduction of helicopter incidents and accidents. The potential delay in collating suitable statistical values, combined with external factors that could possibly contaminate the integrity of the incident/accident statistics will undoubtedly have a material effect on the long-term data validation. An interim methodology was adopted to investigate three recent helicopter accidents (2011) which had occurred and the incidents were validated through Shadowmatch™ and IA data.

A final validation iteration revealed that a pro-active and motivated participant to the PDP and psychological intervention process showed higher positive correlation for the post-intervention Shadowmatch™ assessment. The measurement of the safety habits of helicopter pilots could be determined reliably and provided reliable results.

The researcher was able to statistically prove that data validation existed between the Shadowmatch™ assessments (as completed by new candidate pilots) and the post-introductory flight review conducted by flight instructors per the IAQ. The positive statistical effect sizes obtained through the comparative datasets sourced from Shadowmatch™, IAQs, post-PDP and aviation psychologist intervention and final interpretation served to ratify the research problem.

Chapter 6 addresses the discussion, recommendations and conclusion of the research problem.

CHAPTER 6: DISCUSSION, RECOMMENDATIONS AND CONCLUSION

6.1 INTRODUCTION

The research problem presented the challenge of proving that the proposed methodology to categorise the safety culture habits of helicopter pilots would provide reliable results. This categorisation methodology would improve flight safety at a helicopter flight school and also present a unique business case whilst enabling the reliable assessment of candidate helicopter pilots.

The first dimension of the study incorporated a DFE questionnaire that addressed specific nuances relating to helicopter flight instruction. The acumen and experience of 20 helicopter DFEs were employed and their responses disseminated to reduce the statistically significant questions into a more concise version.

A further iteration of the original question bank presented an original IA document for the evaluation of candidate helicopter students. The IAs for 33 candidates were compared with Shadowmatch™ assessments completed by the individual students before attempting their first introductory flight with an instructor. Statistical significance was derived from the effect sizes obtained through comparison between IA and SM responses. These findings were supported from themes that emerged from interviews and personal notes in the researcher’s journal. The fundamental objectives were to assess mechanical inclination and adaptability as well as behavioural suitability.

The research and development in conceiving a suitable methodology to categorise candidate helicopter pilots presented unique challenges. The typical sequence of logistical events included conception, design, implementation and operating phases. A suitable implementation platform was used at the researched company and the complete spectrum of pilots (student, private, commercial and airline pilots) was used to enhance the sample population statistics for the Shadowmatch™ database.

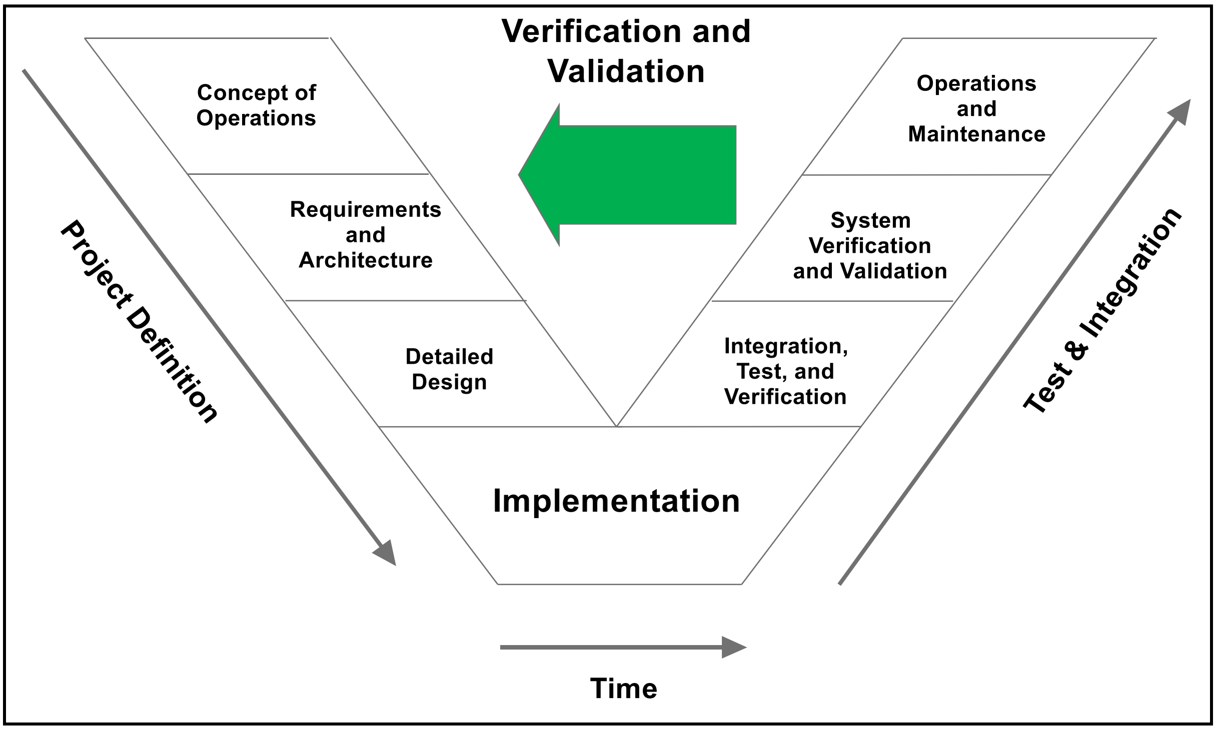

Figure 6.1: Typical Systems Engineering Process (Source: Fick, 2012)

Figure 6.1 describes the various phases associated with the systems engineering process and conforms to the philosophy of “Conceive → Design → Implement → Operate” followed during this thesis:

Conception was effected through the need of finding a suitable assessment process of evaluating general aviation pilots before they enrolled at the flight school. This model would be unique to the helicopter training industry in South Africa and will initially be implemented exclusively at the researched company. The work of Hunter (2002) provided substantial literature substance and statistical construct validation, albeit particularly directed at the assessment of military pilots. The focus areas primarily manifested in the domain of pilots’ *LOC* (Hunter, 2002; Stewart, 2006) and the associated *Risk Perceptions* (Hunter, 2010).

The design phase was executed by considering both quantitative and qualitative methodologies. Firstly, it was necessary to obtain data from South African helicopter industry specialists and doyens in order to establish the pertinent or pressing questions that had to be addressed in this assessment model. DFEs (n = 20) were requested to complete a questionnaire comprising 51 questions. The NWU Statistical Service Department collated the raw data and presented a statistical interpretation thereof. Significant correlations and effect sizes were obtained and the relevant questions were ranked in order of effect. These questions formed the basis of the IAs and were successfully employed in parallel with the Shadowmatch™ software package to evaluate candidate helicopter student pilots.

A small sample population (n = 33) was subjected to both parallel assessments utilising IAs and Shadowmatch™. The Statistical Service Department at NWU once more assisted with the interpretation of raw data and significant effect sizes were once more obtained in evaluating and triangulating the IA versus SM scores.

Implementation was conducted at Henley Air Flight Training school. All flight instructors, as well as a mixed selection of student, private and commercial pilots were subjected to Shadowmatch™ to substantiate and populate the dataset. Instructors were requested to complete the IAs for *ab initio* students that had completed their initial demo flights, and compared to SM results.

Operation was extended to Henley Air and used extensively for continuous pilot evaluation, scrutiny and observation. The input from regular instructor pilots is regarded as a crucial function of the perceived success of the research domain. The real long-term effect of the research methodology will ultimately manifest in an enhanced safety record profile specifically, and the larger body of helicopter pilots in South Africa.

The management of Technology, Innovation, People and Systems (TIPS) was considered throughout the research process and successfully integrated. Shadowmatch™ provided a suitable technological platform for the gathering, collation and categorisation of research data. The innovative and systemic use of people (case studies, interviews and auto-ethnographic tales) provided additional qualitative substance to the mixed methods approach employed for the study.

6.2 CONSEQUENTIAL DISCUSSION

6.2.1 Addressing the Research Problem

Three years of research, literature reviews, in-depth interviews and case studies culminated in the formalisation of the intended research paragon. The aim of the study was to remain academically pure in terms of honouring the research domain within the confines of an inherently focused engineering approach in order to solve the original research problem statement.

Despite the deliberate intention to remain doctrinally sound and contextually true to the more clinical and pragmatic perspectives demanded by an engineering nucleus, it was imperative to concede that the integration of human behavioural aspects would be inevitable in successfully attempting and completing the study. The Research Problem noted in Chapter 1 stated to prove that:

The proposed methodology to identify and categorise the safety culture habits of candidate helicopter pilots would provide reliable and useful results.

The problem was analysed, researched and proven to be valid and reliable in measuring the safety culture habits of candidate helicopter pilots through a double-validation process. The successful documentation and integration of data received from in-depth interviews with field experts, flight instructors and pilots provided qualitative data substance towards ensuring quality data.

The use of Shadowmatch™ software was found to be a further and reliable method in measuring the Overall and Critical Match habits of candidate pilots, and provided suitable scientific evidence for implementation at the flight school. Comparison and integration of the research data through triangulation (Bryman, 2006; Bulsara, n.d.), provided the means to test the hypothesis stated in Chapter 1.

6.2.2 Research hypothesis and aim of the research

The fundamental research hypothesis was identified as:

H_1: If the safety culture habits of helicopter pilots could be measured reliably, the training process for candidate pilots could be optimised.

The definition, identification, assessment and categorisation of safety culture habits proved to be fundamental in establishing a benchmark for further relevant research questions (DFE questionnaire) and in defining the research aims for the study. The use of quantitative (DFE questionnaires) and qualitative methodologies (case studies, interviews and IAs) proved $\mathbf{H_1}$ and confirmed that not only could the safety culture habits of pilots be measured reliably, but the flight training process could be managed and optimised at the same time.

The primary aim of the research study was to determine the habits associated with defining, implementing and sustaining a safety culture within the helicopter flight training environment. This new body of research furthermore aimed to affect a long-term positive result in reducing the incidence of flight incidents and accidents. A further aim was to provide a significant commercial value proposition by providing prospective and existing helicopter pilots, owners and operators with a scientifically founded categorisation model to identify and measure the flight safety culture habits of candidate helicopter student pilots accurately before they commence with formal flight training lessons.

The reality in observing and measuring the envisaged positive result contained within this body of new research resides in the notion that the exact timeframe is undefinable. The net effect will ultimately be witnessed in a reduction in aircraft insurance costs, an increase in aviation industry stature, and credibility of flight schools that have adopted this methodology and an agreeable method of evaluating prospective candidate pilots.

The successful identification, assessment and categorisation of the safety culture habits of candidate pilots presented the challenge to conduct pre-emptive intervention in order to ameliorate desired flight safety culture habits at the time of first contact with new pilots.

Based on the contextual extent of the qualitative research domain wherein the study was conducted, specifically focusing on pilot safety culture habits, a number of further propositions were recorded:

Proposition 1: A predictive pilot categorisation methodology does not exist for private pilots in the South African helicopter industry context, with specific reference to the safety culture habits of candidate helicopter pilots.

This proposition was confirmed after consultation with field experts and role players in the South African aviation industry (2010): (i) CSIR (J. Monk & D. Barker); (ii) CAA (C. Williams); FTSSA (L. Ingham); (iii) TFDC (J. O'Connell); and (iv) DENEL Aviation (P. van Zyl), who encouraged the research design.

Proposition 2: Given the intrinsic high-risk operating ambit, it was realistic and relevant to contemplate the necessity for a methodology to categorise candidate helicopter pilots.

This proposition was found to be true given the high rate of helicopter accidents (Barker, 2012b) and a similar rate of man-machine attrition in the event of helicopter accidents. An immediate and palpable ripple effect of these losses is quantifiable through the local aviation insurance industry.

Proposition 3: A pilot categorisation model will have a positive quantifiable consequence on the existing and future flight safety culture habits within the general aviation industry.

This proposition was unequivocally confirmed though in-depth interviews with aviation field experts and flight instructors. The long-term effect of the implementation of the categorisation model will undoubtedly only manifest over a period of time and by considering other external factors, as noted in section 6.3.

6.2.3 Ensuring data quality

The quality of the data derived from both quantitative (section 3.2) and qualitative (section 3.3) methods was subjected to verification (section 5.2) and validation (section 5.3). The use of in-depth interview results (section 5.1.1) and case studies (section 3.3.1) assisted in conforming with the research methodology requirement for quantitative data (data validity and reliability) (Creswell, 2009) and for qualitative data authenticity, relevance, modifiability and fit techniques were used (section 5.2.3).

6.2.4 Originality and the contribution to the body of knowledge

The originality of the research model resided in the creation of a distinct Designated Flight Examiner (DFE) questionnaire (quantitative) and the further combination with qualitative methods such as case studies, in-depth interviews, 360° feedback sessions and relating auto-ethnographic tales consistent with the safety culture at the researched company. An existing software model (qualitative) was utilised in accordance with the adopted convergent parallel mixed methodology, and assisted in ensuring data quality, verification and validation.

As noted in previous paragraphs, no such categorisation methodology existed for a distinct application in assessing candidate private helicopter pilots, and research originality was hence established. The successful introduction and application of the model at other flight schools is considered pro-active and revolutionary in assisting the aviation industry in reducing flight incidents and accidents.

6.3 LIMITATONS OF THE RESEARCH

The research presented several challenges as limited literature sources were found available for research – specifically within the civilian aviation domain.

6.3.1 Military versus civilian aviation

Military and airline environments have access to unlimited resources when considering suitable applicants and financial support. The general aviation domain has historically been left to its own devices when attracting prospective students.

Few flight schools can afford to dismiss a potential client when personality deficiencies are perceived. The military and airline environment do permit selection of the finest candidates and tend to make unsuccessful candidates expendable.

A fundamental advantage within the military realm is its access to archived incident and accident records (Stewart, 2006). In South Africa, specifically, such information for general aviation is extremely difficult if not impossible to obtain from CAA and to utilise successfully.

6.3.2 Sample size and range restriction

The success of the implemented research methodology will be quantifiable in future by comparing existing flight safety statistics with actual incidents and accidents over a specified period. Hunter (2002) concludes that an accident almost never has only a single cause and that multiple causes usually contribute to any accident.

The research towards developing the categorisation methodology was hampered in particular by the inevitable small sample size of the potential population. Furthermore, in order to remain within the time constraints of the study a number of retrospective pilot evaluations had to be conducted to ensure validity of the sample size. The range of available student and private pilots to be evaluated was small and necessitated the evaluation of effect sizes rather than only correlation values (Ellis, 2010).

A further consideration was the willingness of potential students to become participants. Future assessments will only be utilised on a voluntary and non-coerced basis.

6.3.3 Stability and change over time

The aviation industry, as in the case of mining and nuclear applications, is prone to continuous safety successes and failures. The success in maintaining continuity and accurate predictability of the researched categorisation methodology resides in constantly monitoring and collating pilot data (Stewart, 2006).

Chapter 2 discussed the significance of pilots' Locus of Control and the associated phenomenological theories of Expectancy (Hunter, 2002; Stewart, 2006) and Attribution (Stewart, 2006). Expectancy theory considers not only typical learning theories (Rotter, 1966) and LOC as a non-personality orientation, but rather focuses on a set of outcome expectancies acquired through experience (Stewart, 2006). This philosophy holds true through consistent implementation at Henley Air and other flight schools, thereby expanding the intrinsic experiential reference base of new and established pilots. Attribution theory shares a similar philosophy as the Law of Parsimony (Occam's Razor) whereby scientists tend to piece together fragments of information until arriving at a reasonable explanation or cause (University of Twente, 2012). The stability of the process over time is consequently a function of continuous input, upgrading and renewal of the expanding database of volunteer pilots.

6.3.4 Changing the old and forming new habits

A logical expansion of the noted theories is the eventual change of habits and mind sets within the aviation training industry and to optimise the man/machine interface. The perceived positive changes and founding of a safety climate, from the very first exposure to formal flight training will instil new discipline and safety expectations in student pilots. New habits must determine the desire and inclination towards a more developed internal LOC, self-discipline and focused safety approach to aviation standards.

Finally, the primary limitation of this thesis, research material and ultimately the newly developed methodology is that the programme is in fact *limitless*. The extent and requirement of successful implementation relies heavily on the expansion to other flight schools in South Africa, so as to further ensure that a suitable continuum is maintained for further research. The success lies in not limiting the progression of the research base but by involving stakeholders in the broader South African aviation industry. Therefore this is a pioneering study not selfishly contained, but it is also available for those authentically involved and who are serious about aviation safety and the optimisation of the dynamic between man and machine.

6.4 RECOMMENDATIONS

In an attempt to further contribute to the body of knowledge and to enhance originality of the research work, it is important to provide recommendations for the useful and successful implementation and integration of the research domain in practice. The intention is furthermore to stimulate future discussion, reasoning and formal interaction between helicopter industry stakeholders. The obvious academic, operational and financial worth of the research is apparent through the following recommendations:

6.4.1 Continuous Private Pilot Development (CPPD)

An inherent deficiency observed during years of basic and advanced flight instruction revealed that continuous *mentoring*, *monitoring* and *recurrent training* is severely lacking – specifically at Private Pilot level. The legal requirement for a PPL revalidation interval is two years, with no recurrent training or recency requirements within that period. The only feasible, realistic and diplomatic way of forcing PPLs to maintain a satisfactory level of proficiency is to subject such pilot(s) to regular hire and fly check-flights (or Operator Proficiency Checks – OPC). These OPC flights typically vary in duration, intensity and frequency as required by individual schools.

CPPD was introduced at the company during a particularly eventful period in April 2010. The company suffered severe losses which included its first fatality, two other accidents and a major incident within a seven-day period. The common denominator in 80% of the occurrences related to hire-and-fly pilots and involved irregularities during the landing phases of flight. The fatal accident claimed the life of a hire-and-fly pilot and was attributed to Controlled Flight into Terrain (CFIT) whilst operating in (avoidable or supposedly inadvertent) Instrument Meteorological Conditions.

The other two accidents involved established and more accomplished hire-and-fly pilots who had completed in excess of 100 flying hours on helicopters. Both accidents occurred below 1 metre off the ground whilst attempting to land and resulted in hard landings and extensive insurance cost implications. Immediate intervention was instituted through advanced remedial flight training and individual de-briefing sessions.

CPPD was proposed and implemented within two weeks of these events and aimed to achieve the following:

(a) Creating greater awareness of the inherent dangers of helicopter flight
(b) Instilling a mind-set of proper and thorough planning and execution of every flight undertaken
(c) Improving airmanship, understanding of hazardous flight conditions and adherence to company-specific booking and standard operating procedures
(d) Reducing intervals between OPCs and increase flight proficiency through continuous mandatory recurrent training
(e) Raising awareness of technical issues and helicopter type-specific mechanical and system interfaces, including troubleshooting and technical quizzes
(f) Obtaining comprehensive briefings from field experts on subjects such as aviation human factors, aeronautical decision making, hazardous weather conditions (specifically operations during high density altitude days), seasonal and diurnal changes in local weather, insurance implications and general flight safety case studies
(g) Stimulating interaction, discipline and discussion between private pilots and senior commercial crew members.

An example of a CPPD briefing is found in Annexure J. Take note of the various areas addressed by the subject matter, regulatory, human factors and technical/engineering. Since the inception of CPPD in May 2010, the incidence of hazardous occurrences has sharply declined. A single hard landing incident occurred in October 2010 after a deliberate violation of company hire-and-fly procedures. One of the accident pilots was so deeply traumatised that he terminated his private flying career after the event.

The success of CPPD represents a concerted effort between management, senior flight instructors, quality and safety staff and the private pilots. The result has been a safer flight environment and the cultivation of an entrenched safety culture and safety climate. The CPPD process is of a continuing nature and a prerequisite for any pilot who desires to hire and fly at Henley Air. CPPD is fully endorsed by the insurance company managing Henley Air's fleet policy, the CAA and the Aero Club of South Africa. CPPD is a unique feature of the company's total commitment to safer skies and has not been emulated or equalled within the South Africa helicopter industry.

6.4.2 PDP revision with aviation perspective

Pursuant to the original work in Shadowmatch™ pertaining to the 18 habits identified by De Villiers (2009), a further posit relates to the reformulation of the pertinent Personal Development Programmes (PDPs) for aviation-oriented applicants. Chapter 5.3.3 addresses the generic nature of the existing PDPs in the Shadowmatch™ database and should ideally be reworded and normalised for specific aviation-related questioning and mentoring.

A similar process of customisation can be applied to all the other PDPs for the various behavioural habits (n = 18). It is recommended that the five Critical Match habits for the company be visited first in order to create credibility and provide substance to the assessment process. This proposal necessitates further engagement with the developers of Shadowmatch™.

PDPs serve as the first level of intervention once an assessment has been completed. It is of utmost importance that the PDP identifies, quantifies and relates specifically to the aviation environment that the new student will be entering. Flight schools, and more specifically, approved mentors, now have the opportunity to assess, mentor and manage students with potential latent rogue habits from the very first encounter.

The application of PDPs and mentorship has to be conveyed to the student pilot in a highly diplomatic and non-offensive manner. It is important to continuously emphasise the inherent value of the programme(s) and the ultimate perceived outcome of the process. Students should not be forced or coerced into completing the programme, but rather be encouraged to participate and expand on life skills, and ultimately, flight safety disciplines.

All remaining PDPs will be further developed and refined by the researcher in conjunction with the developers of Shadowmatch™. Both parties are cognisant of the potential commercial value of integrating this categorisation model with Shadowmatch™.

6.4.3 Pursuing the CAA mandate

As the appointed and mandated regulator of the South African aviation industry, the CAA has a mandate to act primarily as *gatekeeper* for all aspects relating to flight safety. However, in South Africa its reputation has been severely tarnished. The transformation of the CAA in 1994 resulted in undeniable ineptness in leadership, management and administration. Any CAA must remain independent of all political and fraternal interest with its sole purpose and intent must be to serve and service aviation safety. Sadly, in South Africa this no longer appears to be the case.

Aviation training standards, quality of peer reviews and functional oversight have been deliberately and patently lowered. This has led to a quantifiable reduction in aviation safety (Williams, 2010). Personal experience has revealed a conscious attempt by the CAA to allow less suitable candidates to eventually pass Commercial Pilot Licences (CPL) despite their continuous failure of the requisite subjects. Verbatim confirmation by CAA officials inferred that a student had written (and passed) his CPL after 360 attempts. As shown by Figure 6.1, the qualification standards have been lowered drastically since *circa* 2006:

Table 6.1: SACAA CPL and Instructor Rating qualifications

PRE-2006	POST-2006
• A total of five sittings allowed to complete the entire CPL examination requirement of 8 subjects (a sitting represents one work week). • A minimum of 3 successful subjects had to be carried within the first sitting. • Pass mark 75% (initially the pass mark was 70% but subjected to negative marking). • Had to complete remaining papers within four sittings and within 12 months from passing the first paper successfully. • Instructor Rating exams were essay-type. Six subjects combined in two separate papers and split over two days.	• Unlimited number of sittings. • No minimum required number of subjects to be written. • Pass mark remains at 75%. • Must complete remaining subjects within 24 months. • Instructor rating exams reduced to multiple choice type questions and no more than an extension of CPL subject matter. • Candidates may attempt a rewrite after 72 hours. Pre-2006 only allowed re-writes 3 times per year.

The obvious lowering in theoretical qualification standards has permeated the calibre of commercial pilots and flight instructors who are fed into the general aviation industry. A once prestigious qualification such as a Grade III Instructor Rating has been diluted to a mockery of intellectual capability. This notion fundamentally describes the failure of the CAA to act as gatekeeper in ensuring suitable standards and qualification criteria, and has reduced South African licensing to the bare minimum.

A previously noted recommendation for CPPD has been fully endorsed by Henley Air's insurance company and has become a prerequisite for any Private Pilot to be able to hire and fly any helicopter at the company. The implementation and utilisation of this research methodology and CPPD is by no means a guarantee of immediate or even mid-term flight safety success, but it does create a mentality of upholding a safety culture, raises continuous cognitive awareness of flight safety hazards and expands technical and theoretical knowledge. Flight proficiency is enhanced through rigid dual instruction sessions.

It is therefore highly recommended that the CAA evaluates this categorisation methodology at various other flight schools and initiates a programme of compiling statistical personality and habit profile data in order to expand the body of knowledge regarding student and private pilot enrolment requirements. A scientific approach towards quantifying actual flight safety statistics would also be conducted more accurately in the event of an incident or accident by comparing student flight safety habits records at the time of enrolment against flight training progress. In accordance with typical Safety Management System requirements and thereby fulfilling a proactive approach to flight safety, the successful use of the categorisation methodology, expansion of PDPs, CPPD and enforcing a more rigorous CAA oversight mandate would contribute to the improvement of the safety record of general aviation in South Africa.

6.5 CONCLUSION AND FINAL PERSPECTIVES

This thesis aimed to demonstrate that it is irresponsible and impetuous that the CAA, flight schools and flight instructors are loathe acceding to the cultivation of pilot safety culture habits in aviation – specifically when considering categorisation assessments of candidate student pilots. Such attitudes would ultimately result in a further financial strain on an industry already crippled by excessive insurance losses.

Ignoring the imperative nature of the findings and recommendations is tantamount to culpability by all role players. A moral and legal obligation resides with all role players and stakeholders to ensure the successful and safe procurement of suitable and behaviourally appropriate pilot candidates into the aviation industry. The study furthermore points towards the necessity for constant organisational renewal. This includes pro-active implementation of Safety Management Systems and ensuring continuous emphasis on the importance of the pertinence of human factors in aviation. The research legacy deposited through this study serves to inspire future students to explore the possible further intervention required to enhance the proactive and parallelised approach to candidate pilot categorisation.

Finally, the research project serves as an acknowledgement to the Da Vinci Institute for allowing this particular multi-disciplinary study. The research was conducted as a continuing effort toward stimulating the Management of Technology, Innovation, People and Systems.

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ANNEXURES

ANNEXURE A1 DESIGNATED FLIGHT EXAMINER (DFE) QUESTIONNAIRE

DFE NAME		**AGE**	
Date		Years in aviation	
Flying hours (h)		Flying hours (a)	
Saaf (y/n)		Instruction hours (h)	

The ultimate Aviator Safety Excellence of prospective civilian helicopter pilots is affected by:

1 – Strongly Disagree	**2 – Somewhat Disagree**	**3 – Unsure**	**4 – Somewhat Agree**	**5 – Strongly Agree**

1	Wealth	1	2	3	4	5
2	Secondary or higher education	1	2	3	4	5
3	Social status	1	2	3	4	5
4	Pilot age/maturity	1	2	3	4	5
5	Submissiveness	1	2	3	4	5
6	Extroverted Communication style	1	2	3	4	5
7	Motivation to achieve	1	2	3	4	5
8	Cautionary disposition	1	2	3	4	5
9	Attention to detail	1	2	3	4	5
10	Conservatism/'no-risk' approach	1	2	3	4	5
11	Perceived self-image	1	2	3	4	5
12	Domain respect: 'normal' ego vs. distorted ego	1	2	3	4	5
13	Declarative openness	1	2	3	4	5
14	No compromise on fundamentals	1	2	3	4	5
15	Constant self-assessment and reflection	1	2	3	4	5
16	Regular self-evaluation (including mental & behavioural health)	1	2	3	4	5
17	Absolute compliance with CAR, CATS and SOP	1	2	3	4	5
18	Deficiency revelation (openness and self-grounding)	1	2	3	4	5
19	Intuition	1	2	3	4	5

Please score your answer of preference using the same scale as above:

1	The notion of "Aviator Excellence" actually exists	1	2	3	4	5
2	"Aviator Excellence" is an acquirable skill	1	2	3	4	5
3	"Aviator Excellence" is an intrinsic part of a candidate pilot	1	2	3	4	5
4	Pilots are born to be pilots	1	2	3	4	5
5	Development is only possible within a formal training environment	1	2	3	4	5
6	I consider myself lucky to still be alive after many years of flying	1	2	3	4	5
7	Any avid potential helicopter should be allowed to fly	1	2	3	4	5
8	The power of a distorted ego presents danger to aviation safety	1	2	3	4	5
9	As a DFE, I can intuitively assess a prospective candidate's potential flying ability before even conduction introductory flight	1	2	3	4	5
10	Fraternal (relational) cultures tend to militate against flight safety	1	2	3	4	5
11	Governing bodies (ATNS, CAA, CAMU) control and advance flight safety	1	2	3	4	5
12	The bodies noted above tend to frustrate the aviation industry	1	2	3	4	5
13	Affirmative acceleration of people of colour jeopardises aviation safety	1	2	3	4	5
14	Aviation should declare itself immune against ideological prescripts (BEE, AA, political interference)	1	2	3	4	5
15	Ab initio flight training at civilian flight schools is adequate and on par with the SAAF	1	2	3	4	5
16	Recurrent training programmes are effectively employed	1	2	3	4	5
17	Recurrent training programmes work in practice	1	2	3	4	5
18	Civilian training is purely provided in pursuit of cash	1	2	3	4	5

Having studied the brief at the end of this questionnaire on the topics noted below, please indicate your choice as regards the effect it could potentially have on the accurate evaluation (during initial contact session and demonstration flight) of prospective helicopter student pilots:

1 Highly insignificant	2 Somewhat Insignificant	3 Unsure	4 Somewhat Significant	5 Highly Significant

1	NASA Task Load Index and cockpit saturation	1	2	3	4	5
2	Workload handling and cognitive overload factors (Cooper-Harper)	1	2	3	4	5
3	First reaction during arousal (Yerkes-Dobson Law)	1	2	3	4	5
4	Cockpit ergonomics	1	2	3	4	5
5	Adherence to procedures and checklists	1	2	3	4	5
6	Situational Awareness	1	2	3	4	5
7	Spatial Disorientation (environment and vertigo)	1	2	3	4	5
8	Attention span and remembering	1	2	3	4	5
9	Effects of intoxication (alcohol and drugs)	1	2	3	4	5
10	Locus of control (internal vs. external)	1	2	3	4	5
11	Language (mother tongue)	1	2	3	4	5
12	Moral health (dishonesty, compromise)	1	2	3	4	5
13	Physical health	1	2	3	4	5
14	Mental health	1	2	3	4	5

BRIEF ON SECTION 3

Affirmative Action (AA)

Affirmative action refers to policies that take factors including race, colour, religion, gender, or national origin into consideration in order to benefit an underrepresented group, usually as a means to counter the effects of historical discrimination. The focus of such policies ranges from employment and education to public contracting and health programmmes.

NASA TLX National Aeronautics and Space Administration Task Load Index.

The NASA TLX is a contemporary evaluation tool devised by NASA and is regarded as a multi-dimensional *subjective* work-load rating assessment instrument. The six typical dimensions that are analysed towards TLX success include mental demand, physical demand, temporal demand, perceived performance, effort and frustration levels. The manifestation of the six TLX dimensions is of paramount importance in assessing the *raw* handling capabilities of the prospective, novice helicopter student.

Cooper-Harper Scale for helicopter handling and related complexities

Whereas the NASA TLX makes a direct assessment of the specific workload dimensions associated with aircraft (helicopter), the handling scale developed by Cooper and Harper represents those qualities or characteristics of a helicopter that govern the ease and precision with which a pilot is able to perform the flying tasks required in support of the aircraft role.

The ultimate achievement is to negotiate a balance between the aircraft's stability (or instability) and the pilot's capability. All pilots, whether a new student or experienced campaigner, are products of their individual backgrounds, training (or lack thereof in this instance) and past experience (again, distinctly lacking with new candidates).

Yerkes-Dobson law of first reaction during arousal

The Yerkes–Dodson law is an empirical relationship between arousal and performance, originally developed by psychologists, Yerkes and Dodson in 1908. The law dictates that performance increases with physiological or mental arousal, but only up to a point. When levels of arousal become too high, performance decreases.

ANNEXURE A2: DFE AND INSTRUCTOR INTERVIEW QUESTIONS

1. Which of the factors noted above would constitute an immediate disqualification for further flight training?

2. What is your definition of Aviator Excellence? What is Aviator Excellence <u>not</u>?

3. More pilots die during a time of modern technology, procedures, controls, advanced instruction and interventional science. Why?

4. Why are so many of your colleagues dead?

5. What is the single most ignored aviation safety imperative by all pilots?

6. Define an aviation safety mentality and conduct.

7. What is your experience and thinking of CAA?

8. What do you currently notice happening in aviation in general and safety specifically?

9. How do you see the future of the helicopter industry?

10. Who do you regard as the consummate helicopter aviator of your time?

11. What are the areas of acknowledged deficiency, historically and currently within the domain of aviation safety?

12. What would you like this research to achieve?

ANNEXURE B1: DFE ASSESSMENT GROUP STATISTICS – DATASET 1

Q	SAAF	N	Mean	Std. Deviation	Std. Error Mean	Mann-Whitney p values	p values	Effect Sizes
S1_1	0	5	2.80	1.643	.735	.827259	.705	0.16
	1	15	2.53	1.246	.322			
S1_2	0	5	2.80	1.095	.490	.294895	.219	0.61
	1	15	3.47	.990	.256			
S1_3	0	5	2.80	1.095	.490	1.00000	1.000	0.00
	1	15	2.80	1.082	.279			
S1_4	0	5	3.60	1.517	.678	.759982	.678	0.18
	1	15	3.87	1.125	.291			
S1_5	0	5	2.40	1.517	.678	1.00000	.919	0.04
	1	15	2.33	1.175	.303			
S1_6	0	5	2.80	1.095	.490	.827259	.771	0.15
	1	15	3.00	1.363	.352			
S1_7	0	5	4.00	.000	.000	.088738	.006	0.83
	1	15	4.53	.640	.165			
S1_8	0	5	3.80	1.095	.490	.930443	.903	0.06
	1	15	3.73	1.033	.267			
S1_9	0	5	4.40	.548	.245	.484992	.352	0.45
	1	15	3.93	1.033	.267			
S1_10	0	5	4.60	.548	.245	.066799	.003	1.08
	1	15	3.13	1.356	.350			
S1_11	0	5	4.00	1.225	.548	.759982	1.000	0.00
	1	15	4.00	.756	.195			
S1_12	0	5	4.00	1.225	.548	.930443	.753	0.11
	1	15	4.13	.640	.165			
S1_13	0	5	3.80	1.095	.490	.759982	.800	0.12
	1	15	3.67	.976	.252			
S1_14	0	5	4.40	.548	.245	.570466	.881	0.07
	1	15	4.47	.915	.236			
S1_15	0	5	4.80	.447	.200	.458124	.312	0.48
	1	15	4.27	1.100	.284			
S1_16	0	5	5.00	.000	.000	.088738	.009	0.79
	1	15	4.20	1.014	.262			
S1_17	0	5	4.20	.447	.200	.694473	.463	0.35
	1	15	3.80	1.146	.296			

ANNEXURE B_2: DFE ASSESSMENT GROUP STATISTICS – DATASET 2

	SAAF	N	Mean	Std. Deviation	Std. Error Mean	Mann-Whitney p values	p values	Effect Sizes
S2_1	0	5	3.60	1.517	.678	.662521	.463	0.31
	1	15	4.07	1.100	.284			
S2_2	0	5	3.40	1.342	.600	.162537	.172	0.75
	1	15	4.40	.507	.131			
S2_3	0	5	3.40	1.342	.600	1.00000	.901	0.05
	1	15	3.47	.915	.236			
S2_4	0	5	2.20	1.095	.490	.930443	.833	0.11
	1	15	2.33	1.234	.319			
S2_5	0	5	4.00	1.225	.548	.458124	.476	0.37
	1	15	3.53	1.246	.322			
S2_6	0	5	3.40	1.342	.600	.406976	.406	0.44
	1	15	2.80	1.373	.355			
S2_7	0	5	2.00	1.225	.548	.861414	.906	0.05
	1	15	2.07	1.033	.267			
S2_8	0	5	5.00	.000	.000	.406976	.347	0.44
	1	15	4.53	1.060	.274			
S2_9	0	5	3.80	.447	.200	.137841	.113	0.77
	1	15	2.73	1.387	.358			
S2_10	0	5	3.80	1.095	.490	.432112	.476	0.37
	1	15	3.40	1.056	.273			
S2_11	0	5	3.00	1.414	.632	.600472	.442	0.33
	1	15	3.47	1.060	.274			
S2_12	0	5	4.20	.837	.374	.726978	.698	0.16
	1	15	4.07	.594	.153			
S2_13	0	5	4.60	.894	.400	.827259	1.000	0.00
	1	15	4.60	.632	.163			
S2_14	0	5	5.00	.000	.000	.861414	.578	0.26
	1	15	4.93	.258	.067			
S2_15	0	5	4.20	.447	.200	.007762	.003	1.61
	1	15	2.40	1.121	.289			
S2_16	0	5	2.00	1.225	.548	.484992	.541	0.27
	1	15	2.33	.976	.252			
S2_17	0	5	3.00	1.581	.707	.359397	.224	0.46
	1	15	3.73	.961	.248			

ANNEXURE B3: DFE ASSESSMENT GROUP STATISTICS – DATASET 3

	SAAF	N	Mean	Std. Deviation	Std. Error Mean	Mann-Whitney p values	p values	Effect Sizes
S3_1	0	5	4.00	.000	.000	.205634	.027	0.64
	1	15	3.47	.834	.215			
S3_2	0	5	4.00	.000	.000	.861414	.550	0.16
	1	15	3.80	1.265	.327			
S3_3	0	5	3.40	1.140	.510	.631171	.617	0.23
	1	15	3.67	.976	.252			
S3_4	0	5	3.00	1.414	.632	.406976	.399	0.38
	1	15	3.53	1.125	.291			
S3_5	0	5	3.60	1.140	.510	.694473	.853	0.09
	1	15	3.73	1.438	.371			
S3_6	0	5	4.80	.447	.200	.336976	.268	0.53
	1	15	4.07	1.387	.358			
S3_7	0	5	4.40	.548	.245	.726978	.485	0.33
	1	15	4.00	1.195	.309			
S3_8	0	5	4.00	1.225	.548	.895830	.690	0.16
	1	15	4.20	.862	.223			
S3_9	0	5	4.20	1.789	.800	.694473	.844	0.07
	1	15	4.33	1.113	.287			
S3_10	0	5	4.40	.548	.245	.097226	.083	0.88
	1	15	3.60	.910	.235			
S3_11	0	5	3.80	1.095	.490	.726978	.720	0.18
	1	15	3.60	1.056	.273			
S3_12	0	5	4.20	.447	.200	.600472	.909	0.05
	1	15	4.13	1.246	.322			
S3_13	0	5	4.00	.707	.316	.694473	.601	0.26
	1	15	3.73	1.033	.267			
S3_14	0	5	4.60	.548	.245	1.00000	.709	0.18
	1	15	4.40	1.121	.289			

ANNEXURE C: DFE ASSESSMENT FREQUENCIES

	S1_1	S1_2	S1_3	S1_4	S1_5	S1_6	S1_7	S1_8	S1_9	S1_10	S1_11	S1_12	S1_13	S1_14	S1_15	S1_16	S1_17	S1_18	S1_19
N Valid	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	2.60	3.30	2.80	3.80	2.35	2.95	4.40	3.75	4.05	3.50	4.00	4.10	3.70	4.45	4.40	4.40	3.90	4.25	4.05
Std. Deviation	1.314	1.031	1.056	1.196	1.226	1.276	.598	1.020	.945	1.357	.858	.788	.979	.826	.995	.940	1.021	.716	.759
Minimum	1	2	1	1	1	1	3	2	2	2	2	2	2	2	2	2	2	2	2
Maximum	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

	S2_1	S2_2	S2_3	S2_4	S2_5	S2_6	S2_7	S2_8	S2_9	S2_10	S2_11	S2_12	S2_13	S2_14	S2_15	S2_16	S2_17	S2_18
N Valid	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	3.95	4.15	3.45	2.30	3.65	2.95	2.05	4.65	3.00	3.50	3.35	4.10	4.60	4.95	2.85	2.25	3.55	2.95
Std. Deviation	1.191	.875	.999	1.174	1.226	1.356	1.050	.933	1.298	1.051	1.137	.641	.681	.224	1.268	1.020	1.146	1.234
Minimum	1	2	2	1	1	1	1	1	1	1	1	3	3	4	1	1	1	1
Maximum	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	4	5	5

	S3_1	S3_2	S3_3	S3_4	S3_5	S3_6	S3_7	S3_8	S3_9	S3_10	S3_11	S3_12	S3_13	S3_14
N Valid	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	3.60	3.85	3.60	3.40	3.70	4.25	4.10	4.15	4.30	3.80	3.65	4.15	3.80	4.45
Std. Deviation	.754	1.089	.995	1.188	1.342	1.251	1.071	.933	1.261	.894	1.040	1.089	.951	.999
Minimum	2	1	2	1	1	1	1	2	1	2	2	1	2	1
Maximum	5	5	5	5	5	5	5	5	5	5	5	5	5	5

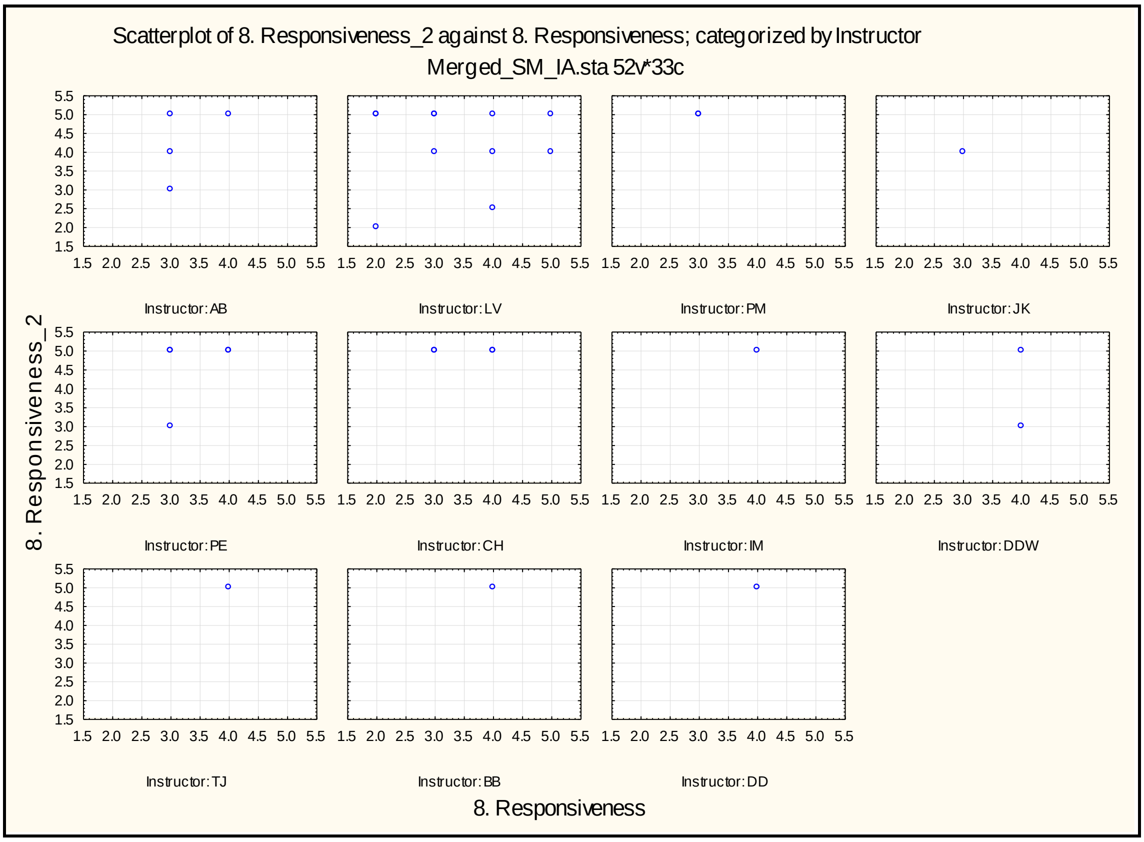
		Age	Years	Heli	F/W	Instr.
N	Valid	20	20	20	20	20
	Missing	0	0	0	0	0
Mean		56.05	36.80	8110.05	6541.90	4002.50
Std. Deviation		8.630	9.865	3645.376	6280.852	3025.946
Minimum		39	17	1221	0	465
Maximum		68	50	18200	19000	13600

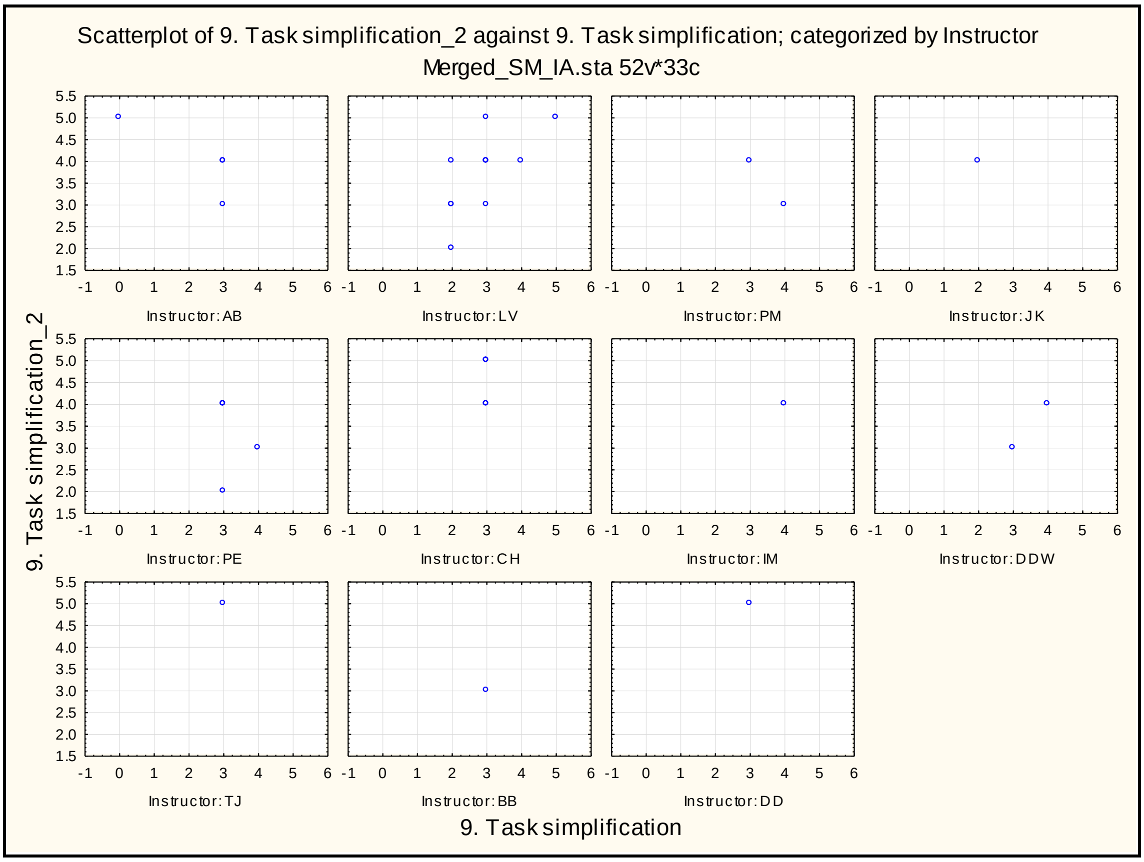
ANNEXURE D: T-TEST FOR DEPENDENT SAMPLES (N = 33). MARKED DIFFERENCES SIGNIFICANT AT P < 0.05) FOR IA AND SM

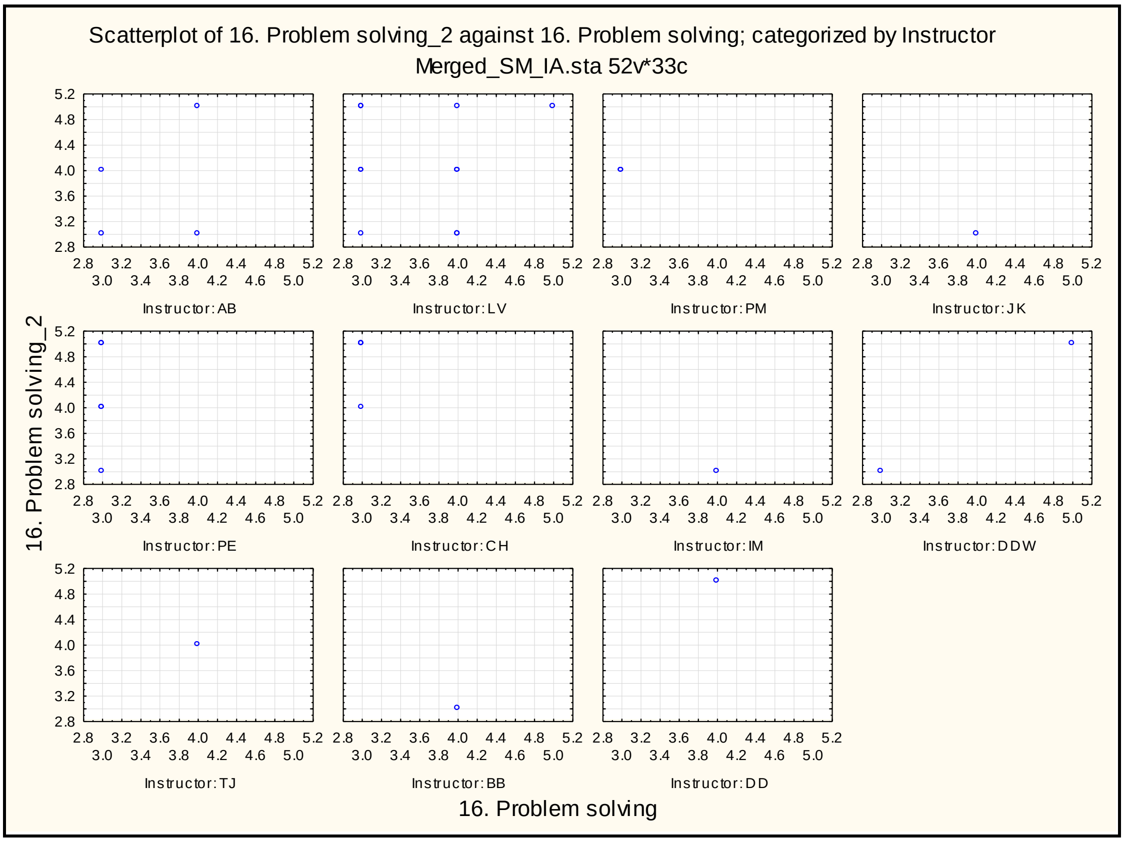
Variable	**Mean**	**Std. Dev.**	**N**	**Diff.**	**Std. Dv. Diff.**	**T**	**df**	**p**	**Confidence - 95.000%**	**Confidence +95.000%**	**Effect Size**
8. Responsiveness (IA)	3.454545	0.753778									
8. Responsiveness (Shadowmatch)	4.500000	0.866025	33	-1.04545	1.063335	-5.64796	32	0.000003	-1.42250	-0.668412	1.2072
16. Cognition	3.484848	0.870388									
16. Cognition	3.530303	0.769937	33	-0.045455	1.077929	-0.24224	32	0.810141	-0.427672	0.336763	0.0522
4F. Frustration	2.939394	0.933387									
4F. Frustration	3.30303	1.103541	33	-0.363636	1.453835	-1.43684	32	0.160469	-0.879144	0.151871	0.3295
4A-F. Task-Load Index	2.875758	0.559593									
4A-F. Task-Load Index	2.231818	0.825172	33	0.643939	0.906725	4.079684	32	0.000280	0.322429	0.965450	0.7804
8. LOC	2.909091	1.155520									
8. LOC	2.787879	0.280354	33	0.121212	1.192623	0.583848	32	0.563416	-0.301673	0.544098	0.4324
9. Task simplification	2.969697	0.847233									
9. Task simplification	3.848485	0.833712	33	-0.878788	1.166125	-4.32908	32	0.000138	-1.29228	-0.465298	1.0372
10. Resilience	3.303030	0.809508									
10. Resilience	3.909091	1.011300	33	-0.606061	1.273268	-2.73434	32	0.010102	-1.05754	-0.154579	0.7487
11. Change management	3.242424	0.791766									
11. Change management	2.727273	1.125631	33	0.515152	1.438776	2.056832	32	0.047931	0.004984	1.025319	0.4577
12. Frustration	3.151515	0.833712									
12. Frustration	3.303030	1.103541	33	-0.151515	1.481579	-0.58747	32	0.561009	-0.67686	0.37383	0.1373
13. Team inclination	3.121212	1.0234									
13. Team inclination	2.818182	0.46466	33	0.303030	1.045372	1.665222	32	0.105631	-0.067643	0.673703	0.2961
Variable	Mean	Std. Dev.	N	Diff.	Std. Dv. Diff.	T	df	p	Confidence - 95.000%	Confidence +95.000%	Effect Size
14. Self-motivation	3.606061	0.704423									
14. Self-motivation	3.545455	1.063335	33	0.060606	1.344884	0.258874	32	0.797391	-0.416269	0.537481	0.057
15. Routine	3.545455	0.794155									
15. Routine	2.69697	0.809508	33	0.848485	1.003781	4.855816	32	0.00003	0.492560	1.204410	1.0481

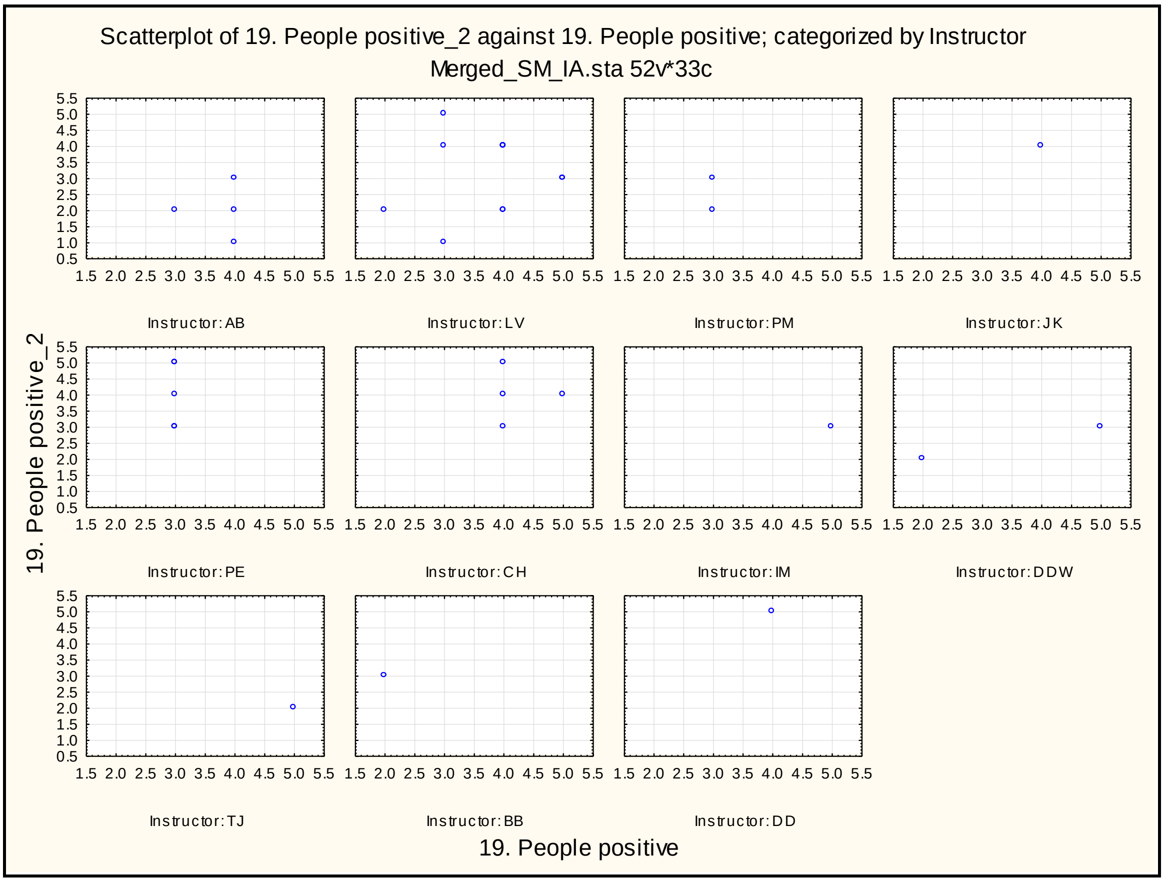
Variable	Mean	Std. Dev.	N	Diff.	Std. Dv. Diff.	T	df	p	Confidence -95.000%	Confidence +95.000%	Effect Size
16. Problem solving	3.484848	0.618527									
16. Problem solving	4.060606	0.826869	33	-0.575758	1.031695	-3.20587	32	0.003049	-0.941581	-0.209935	0.6963
17. Responsiveness	3.303030	0.683961									
17. Responsiveness	4.606061	0.747470	33	-1.30303	0.983770	-7.60883	32	0.000000	-1.65186	-0.954201	1.9051
18. Innovation	3.333333	0.645497									
18. Innovation	3.242424	0.867118	33	0.090909	1.071320	0.487467	32	0.629251	-0.288965	0.470783	0.1048
19. People positive	3.666667	0.889757									
19. People positive	3.181818	1.157976	33	0.484848	1.416889	1.965744	32	0.058056	-0.017559	0.987256	0.4187
20. Discipline	3.515152	0.870388									
20. Discipline	4.242424	0.751262	33	-0.727273	1.068665	-3.90942	32	0.000451	-1.10620	-0.348341	0.8356
22. Conflict	3.272727	0.761279									
22. Conflict	3.454545	1.063335	33	-0.181818	1.50944	-0.69196	32	0.493956	-0.717042	0.353406	0.171
23. Altruism	3.242424	1.199747									
23. Altruism	3.121212	1.243925	33	0.121212	1.883441	0.369701	32	0.714040	-0.546627	0.789051	0.0974
24. Self-confidence	3.303030	0.769937									
24. Self-confidence	4.272727	0.839372	33	-0.969697	1.131505	-4.92308	32	0.000025	-1.37091	-0.568483	1.1553

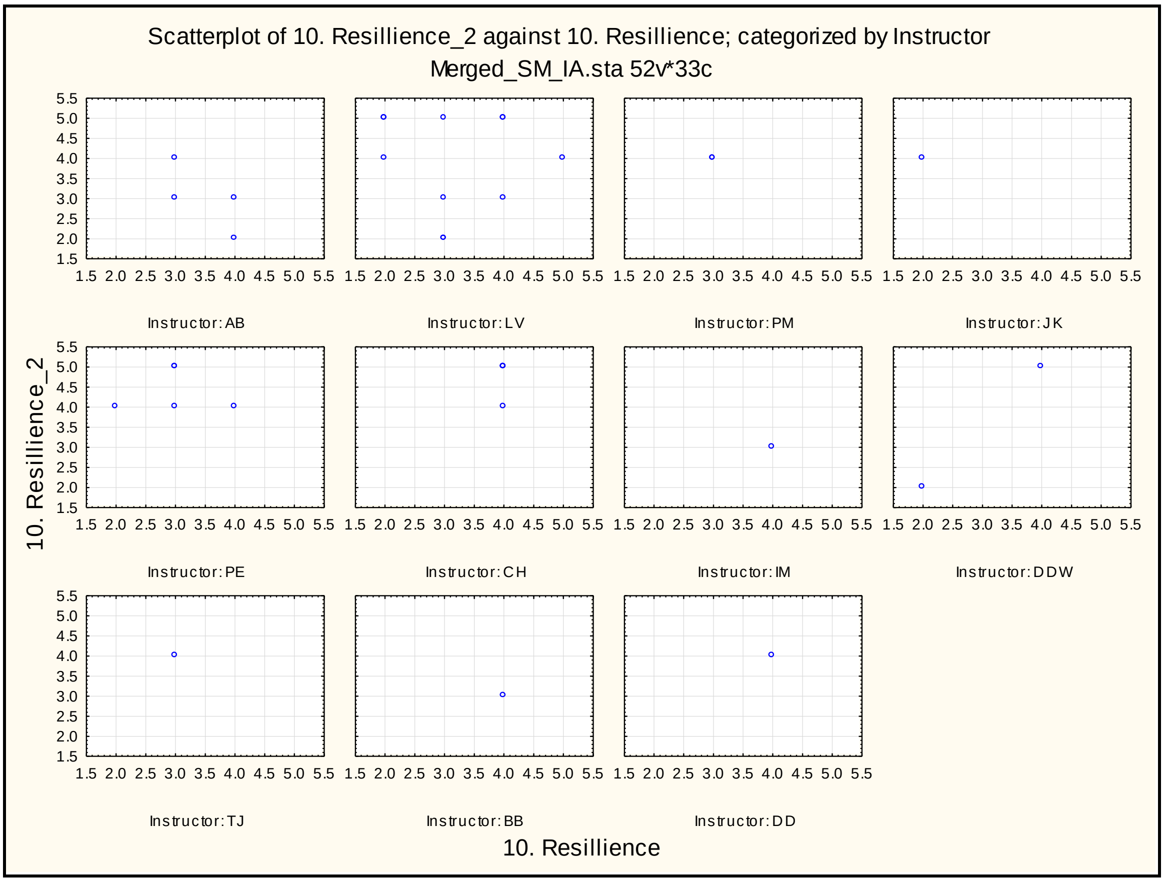
ANNEXURE E: SCATTER PLOTS FOR FIVE CRITICAL MATCH HABITS




Scatterplot of 9. Task simplification_2 against 9. Task simplification; categorized by Instructor
Merged_SM_IA.sta 52v*33c
9. Task simplification_2
Instructor: AB
Instructor: LV
Instructor: PM
Instructor: JK
Instructor: PE
Instructor: CH
Instructor: IM
Instructor: DDW
Instructor: TJ
Instructor: BB
Instructor: DD
9. Task simplification


Scatterplot of 16. Problem solving_2 against 16. Problem solving; categorized by Instructor
Merged_SM_IA.sta 52v*33c
16. Problem solving_2
16. Problem solving
Instructor: AB
Instructor: LV
Instructor: PM
Instructor: JK
Instructor: PE
Instructor: CH
Instructor: IM
Instructor: DDW
Instructor: TJ
Instructor: BB
Instructor: DD


Scatterplot of 19. People positive_2 against 19. People positive; categorized by Instructor
Merged_SM_IA.sta 52v*33c
Instructor: AB
Instructor: LV
Instructor: PM
Instructor: JK
Instructor: PE
Instructor: CH
Instructor: IM
Instructor: DDW
Instructor: TJ
Instructor: BB
Instructor: DD
19. People positive_2
19. People positive


Scatterplot of 10. Resillience_2 against 10. Resillience; categorized by Instructor
Merged_SM_IA.sta 52v*33c
Instructor: AB
Instructor: LV
Instructor: PM
Instructor: JK
Instructor: PE
Instructor: CH
Instructor: IM
Instructor: DDW
Instructor: TJ
Instructor: BB
Instructor: DD
10. Resillience_2
10. Resillience

ANNEXURE F: IA BRIEFING SHEET AND FORM

To be completed by flight instructor			
SURNAME		NAME	
AGE		DOB	
CONTACT n°		GENDER	
PREVIOUS FLYING EXPERIENCE	Y/N	HIGHEST ACADEMIC QUALIFICATION:	
SHADOWMATCH™ COMPLETED?		SHADOWMATCH™ REPORT RECEIVED	
For office use only			
OVERALL MATCH SCORE		CRITICAL MATCH SCORE	
OM BENCHMARK SCORE		CM BENCHMARK SCORE	
OUTLYING HABIT(S)		RESULT	

RECEPTION & PRE -FLIGHT ASSESSMENT	N°	ASPECT	DESCRIPTION/DEFINITION
	1	Personal presentation	Appropriate flight attire, shaved and presentable
	2	Demeanour/attitude	Positivism, excitement and gusto
	3	General approach to introductory flight	Eager, bored or uninterested
	4	Verbal & non-verbal fluency	Speech and body language
	5	Instructor's intuition/gut feel	Instructor's first impression
	6	Interest in basic subject matter	Knowledge of helicopter, setup, company
	7	Technical questioning/challenges	Helicopter aerodynamics and systems
	8	Responsiveness	Participative vs. uninterested
	9	Language proficiency	Spoken language and communication skills
	10	Wind direction: noticed/relevance questioned	Observed by student or shown by instructor
	11	Helicopter parking orientation noticed	Observed by student or shown by instructor
	12	Active runways/other traffic observed	Observed by student or shown by instructor
	13	Attention and interest during pre-flight	Questioning and interest
	14	Basic understanding of dynamic and ancillary components	Questioning and interest
	15	Use and understanding of checklist	Participation and basic knowledge

	16	*Cognition and understanding of concepts*	*Basic aerodynamics, flight controls and systems*
	17	*Interest/understanding of start and warm-up procedures*	*Understanding of logical workflow and procedural challenges*

IN-FLIGHT	*1*	*Signs of nausea*	*Observed or stated queasiness and/or vertigo*
	2	*Spatial (dis)orientation*	*Sense of direction/airfield/JHB CBD/GFA*
	3	*General handling skills (Cooper-Harper scale)*	*Instructor to asses various aspects during manoeuvres*
	a	*Level 10*	*Major deficiencies and control will be lost during flight*
	b	*Level 7-9*	*Major deficiencies and considerable to intense pilot control required*
	c	*Level 4-6*	*Minor to tolerable deficiencies and adequate control performance*
	4	*Task load appreciation and execution (NASA TLX):*	
	a	*Mental demand*	*Simple arithmetic problems; gauge locations; lookout*
	b	*Physical demand*	*Control manipulation. Feel. External wx factors*
	c	*Temporal demand*	*Hands & feet on controls. Corrective reaction times*
	d	*Effort*	*Ease or effort required to perform all the noted aspects*
	e	*Performance*	*Use of RT & ATC. Student's achievement vs. failure modes*
	f	*Frustration levels*	*S&L within first 5 minutes of flight. Hover ability*
	5	*Arousal response (Yerkes-Dodson)*	
	a	*Performance during deliberate arousal*	*Moderate or steep bank induced by instructor*
	b	*Performance during arbitrary arousal*	*Notable increase or decrease in handling*
	c	*Changes in voice patterns*	*Cockpit silence or varying speech patterns*
	d	*Severe gripping of controls*	*Obvious anxiety and subsequent control gipping*
	e	*Increase in heart rate and*	*Perspiration, fidgeting or obvious*

		skin conductance	discomfort noticed
	f	Complete departure (hands & feet) from the flight controls.	Upon arousal, partial or complete control forfeiture
	6	Understanding and use of radio (RT) and procedural words	Level of familiarity or discomfort with RT
	7	Attention span	Ability to repeat similar instructions: lookout focus
	8	Situational awareness	Other traffic, circuit pattern, adverse weather
	9	Cockpit ergonomics	Comfort, physical size, doors on/off
	10	Aeronautical Decision Making (ADM) – basic construct	Exposure to basic decision making: runway crossing, airspeeds, closure rates, etc.
POST-FLIGHT & DE –BRIEF	1	Conservatism	Self-explanatory
	2	Motivation to achieve	Self-explanatory
	3	Self-evaluation capability/self-assessment prospects	Student ability to recognise own deficiencies
	4	Attention to detail	Self-explanatory
	5	Aviation excellence potential	General aptitude to aviation
	6	Recurrent training affinity	Assessment of recurrency understanding, regular dual checks, proficiency maintenance
	7	Distorted ego evident	Obvious inflated/under-developed ego
	8	Internalised locus of control	Internal (self-controlled) vs. External (blame mentality, “never my fault” mentality)
	9	Simplification of tasks	Ability to reduce potential complex scenarios to simplified problems
	10	Resilience	Tendency to continue trying vs. giving up too soon
	11	Change management and acceptance	Ability to adapt to changing operating environment and following instructions
	12	Frustration management	Ability to convert frustration into positive outcome
	13	Team vs. Individual inclination	Scoring guide: Individual low – Team high
	14	Self-motivation	Self-explanatory
	15	Routine: understanding and implementation	Systematic approach to structure and instructions
	16	Problem solving (basic)	Acceptance of challenges and successful execution
	17	Responsiveness	Student’s reaction time/assessment rate

	18	*Innovation*	*Ability to identify better alternatives/solutions*
	19	*People positive behaviour*	*Ability to embrace other people within context*
	20	*Discipline*	*Ability to work under extreme levels of discipline*
	21	*Conceptual capabilities*	*Handling of abstract abilities, judging approach speeds; anticipating runway crossing*
	22	*Conflict handling*	*Handling opposing interests or opinions*
	23	*Altruism*	*Ability to assist without reciprocity (pushing helicopter, discarding used oil can)*
	24	*Self-confidence*	*Ability to act with conviction and assertiveness*
	25	*Task efficiency*	*Self-explanatory*
	26	*Leadership*	*Ability to act as leader within aviation context*
	27	*Attitude*	*General approach to life and task at hand*
	28	*Personal standards observed vs. mediocrity*	*Self-explanatory*
	29	*Acceptance of authority*	*Ability to embrace instructor's authority and command*
	30	*Compromise*	*Note any signs of obvious 'short-cuts' and compromise on standards and procedures*

PHASE 1: STUDENT RECEPTION & PRE-FLIGHT

N°	*ASPECT*	*SCORE*				
		1	*2*	*3*	*4*	*5*
1	*Personal presentation*					
2	*Demeanour/attitude*					
3	*General approach to introductory flight*					
4	*Verbal & non-verbal fluency*					
5	*Instructor's intuition/gut feel*					
6	*Interest in basic subject matter*					
7	*Technical questioning/challenges*					
8	*Responsiveness*					
9	*Language proficiency*					
10	*Wind direction: noticed/relevance questioned*					
11	*Helicopter parking orientation noticed*					
12	*Active runways/other traffic observed*					
13	*Attention and interest during pre-flight*					
14	*Basic understanding of dynamic and ancillary components*					

15	Use and understanding of checklist					
16	Cognition and understanding of concepts					
17	Interest/understanding of start and warm-up procedures					
18						
19						
	Instructor remarks:	Date				
	Chief Pilot/CFI remarks:	Date				

PHASE 2: IN-FLIGHT						
N°	ASPECT	SCORE				
		1	2	3	4	5
1	Signs of nausea					
2	Spatial (dis)orientation					
3	General handling skills (Cooper-Harper scale)					
A	Level 10 (Major deficiencies and control will be lost during flight)					
b	Level 7-9 (Major deficiencies and considerable to intense pilot control required)					
C	Level 4-6 (Minor to tolerable deficiencies and adequate control performance)					
4	Task load appreciation and execution (NASA TLX):					
A	Mental demand (location of CBD and airfield. Simple arithmetic problems)					
B	Physical demand (Control manipulation. Feel. External wx factors)					
C	Temporal demand (Hands & feet on controls. Corrective reaction times)					
D	Effort (effort required to perform all the noted aspects)					
E	Performance (Use of RT & ATC. Student’s achievement vs. failure modes)					

F	Frustration levels (S&L within first 5 minutes of flight. Hover ability)					
5	Arousal response (Yerkes-Dodson)					
a	Performance during deliberate arousal					
B	Performance during arbitrary arousal					
c	Changes in voice patterns					
d	Severe gripping of controls					
e	Increase in heart rate and skin conductance					
f	Complete departure (hands & feet) from the flight controls.					
6	Understanding and use of radio (RT) and procedural words					
7	Attention span					
8	Situational awareness					
9	Cockpit ergonomics					
10	Aeronautical Decision Making (ADM) – basic construct					
12						
13						
	Instructor remarks:	Date				
	Chief Pilot/CFI remarks:	Date				

PHASE 3: POST-FLIGHT AND DE-BRIEF						
N°	ASPECT	SCORE				
		1	2	3	4	5
1	Conservatism					
2	Motivation to achieve					
3	Self-evaluation capability/self-assessment prospects					
4	Attention to detail					
5	Aviation excellence potential					
6	Recurrent training affinity					
7	Distorted ego evident					
8	Locus of control during manoeuvres					
9	Simplification on tasks					
10	Resilience					
11	Change management and acceptance					
12	Frustration management					
13	Team vs. Individual inclination					
14	Self-motivation					
15	Routine: understanding and implementation					
16	Problem solving (basic)					
17	Responsiveness					

18	*Innovation*					
19	*People positive behaviour*					
20	*Discipline*					
21	*Conceptual capabilities*					
22	*Conflict handling*					
23	*Altruism*					
24	*Self-confidence*					
25	*Task efficiency*					
26	*Leadership*					
27	*Attitude*					
28	*Personal standards observed vs. mediocrity*					
29	*Acceptance of authority*					
30	*Compromise*					
31	*Overall impression of student*					
32						
33						
	Instructor remarks:	*Date*				

ANNEXURE G: SM VS. IA CORRELATION DATA FOR ALL INSTRUCTORS (N = 11)

SM ↓vs. IA →	8. Responsiveness	16. Cognition	4F. Frustration	4A-F. Task-Load Index	8. LOC	9. Task simplification	10. Resilience	11. Change management	12. Frustration	13. Team inclination	14. Self-motivation	15. Routine	16. Problem solving	17. Responsiveness	18. Innovation	19. People positive	20. Discipline	22. Conflict	23. Altruism	24. Self-confidence	26. Leadership
8. Responsiveness_2	0.096268	0.150857	-0.148483	0.039873	0.176846	0.305998	0.364215	0.291355	0.272176	0.466212	0.267155	-0.030497	0.091615	0.151390	0.181448	0.206375	0.072699	0.433925	0.305963	0.110665	0.123415
16. Cognition_2	0.449239	0.307942	-0.075205	-0.107333	-0.124853	0.179608	0.571045	0.258574	0.429737	0.327193	0.682328	0.428941	0.357816	0.376967	0.513703	0.316675	0.342853	0.411253	0.353311	0.045536	0.434580
4F. Frustration_2	-0.068927	0.085218	0.007486	-0.087586	-0.013878	-0.057943	0.162737	-0.073860	-0.147706	-0.001490	-0.149881	-0.138668	-0.138920	-0.248369	-0.183899	0.100352	-0.057327	-0.227696	-0.113264	-0.017620	-0.335673
4A-F. Task-Load Index_2	-0.055875	-0.165016	0.222317	0.212040	-0.147894	0.004094	0.050015	-0.064318	-0.314858	0.098586	-0.173134	-0.260353	0.089593	0.107195	0.138136	-0.105660	-0.299225	-0.127244	-0.076956	0.002705	0.155084
8. LOC_2	-0.257811	-0.088301	-0.202444	-0.102300	-0.102411	-0.051944	0.152894	-0.002493	-0.443088	-0.136142	0.053521	-0.218698	-0.100820	-0.058912	0.101398	-0.012877	-0.077777	-0.283791	-0.182455	0.135549	-0.161676
9. Task simplification_2	0.298390	0.259242	-0.376271	-0.297371	-0.319079	0.092693	0.487132	0.094905	0.178089	0.207677	0.421092	0.040914	0.239973	0.126174	0.230885	0.477660	0.237071	0.165205	0.349930	-0.150369	0.140744
SM ↓vs. IA →	**8. Responsiveness**	**16. Cognition**	**4F. Frustration**	**4A-F. Task-Load Index**	**8. LOC**	**9. Task simplification**	**10. Resilience**	**11. Change management**	**12. Frustration**	**13. Team inclination**	**14. Self-motivation**	**15. Routine**	**16. Problem solving**	**17. Responsiveness**	**18. Innovation**	**19. People positive**	**20. Discipline**	**22. Conflict**	**23. Altruism**	**24. Self-confidence**	**26. Leadership**
10. Resillience_2	-0.113475	0.134822	-0.079035	0.011578	-0.008098	0.085863	0.034497	0.112609	-0.213800	-0.010527	0.053430	-0.142200	-0.064312	-0.200888	-0.148753	0.061239	0.030939	-0.120249	-0.141253	0.032343	-0.360448
11. Change management_2	-0.104177	0.049680	0.089549	-0.026403	0.062744	0.147140	0.178679	-0.102442	-0.235562	-0.091277	-0.088273	-0.144311	-0.019617	-0.200901	-0.234011	0.003106	0.067294	-0.215644	-0.105608	0.189654	-0.238651
12. Frustration_2	-0.068927	0.085218	0.007486	-0.087586	-0.013878	-0.057943	0.162737	-0.073860	-0.147706	-0.001490	-0.149881	-0.138668	-0.138920	-0.248369	-0.183899	0.100352	-0.057327	-0.227696	-0.113264	-0.017620	-0.335673
13. Team inclination_2	0.065962	0.052021	0.030932	0.140145	0.131220	0.077124	0.108525	0.090630	0.043102	0.106274	-0.109253	-0.083753	-0.055405	-0.094995	-0.184258	0.111190	0.026818	0.144974	0.204191	0.043518	-0.335800
14. Self-motivation_2	0.020679	0.016077	0.052275	0.199303	-0.029973	0.050274	0.148800	0.033053	-0.232870	-0.131006	-0.118276	-0.339273	-0.299438	-0.333309	-0.232133	-0.038003	0.038644	-0.219896	-0.224830	-0.125416	-0.563281
15. Routine_2	0.113936	0.170104	0.051871	0.164052	0.078323	-0.106119	0.221154	0.160450	0.184318	0.118361	0.225121	0.177791	0.097224	-0.028616	0.101430	0.015651	0.143599	0.172110	-0.167608	-0.167313	0.092185
16. Problem solving_2	0.416509	0.299822	-0.174748	-0.004379	0.033333	0.145539	0.331259	0.033572	0.104714	-0.000095	0.281831	-0.039278	-0.063103	-0.031900	0.238801	0.223723	0.312674	0.134938	0.035268	-0.086930	-0.161998
SM ↓vs. IA →	**8. Responsiveness**	**16. Cognition**	**4F. Frustration**	**4A-F. Task-Load Index**	**8. LOC**	**9. Task simplification**	**10. Resilience**	**11. Change management**	**12. Frustration**	**13. Team inclination**	**14. Self-motivation**	**15. Routine**	**16. Problem solving**	**17. Responsiveness**	**18. Innovation**	**19. People positive**	**20. Discipline**	**22. Conflict**	**23. Altruism**	**24. Self-confidence**	**26. Leadership**
17. Responsiveness_2	0.155109	0.215104	-0.029453	0.120800	0.102078	0.327577	0.457584	0.297033	0.168607	0.381150	0.334245	0.029944	0.167760	0.126278	0.149757	0.138841	0.127459	0.312215	0.218200	0.076864	0.070757
18. Innovation_2	-0.051401	0.178916	-0.066136	-0.015775	0.023344	0.209449	0.213836	-0.042643	-0.027020	-0.026537	0.039122	-0.176924	-0.162533	-0.154494	0.047385	0.031951	-0.106453	0.001237	-0.053542	-0.005531	-0.272677
19. People positive_2	0.110255	0.082753	-0.024975	0.072234	0.167519	0.143993	0.110713	-0.318235	-0.325184	-0.013757	-0.145544	-0.147042	0.013129	-0.040478	-0.032342	0.054606	-0.002855	-0.286276	-0.034532	0.104236	-0.056765
20. Discipline_2	-0.018892	0.025309	-0.072868	0.030320	0.027186	-0.171156	0.188948	0.097264	-0.172182	-0.178280	0.014342	0.033594	-0.168680	-0.123437	-0.060604	0.093991	0.069935	-0.122296	-0.112473	-0.165198	-0.387769
22. Conflict_	0.139196	-0.0062	0.117288	0.023310	0.145488	0.010905	0.108728	-0.373115	-0.1872	-0.088664	-0.169841	-0.016	-0.046851	-0.125254	0.000887	0.002654	-0.0945	-0.356	-0.185	0.123031	-0.00452

SM ↓vs. IA →	8. Responsiveness	16. Cognition	4F. Frustration	4A-F. Task-Load Index	8. LOC	9. Task simplification	10. Resilience	11. Change management	12. Frustration	13. Team inclination	14. Self-motivation	15. Routine	16. Problem solving	17. Responsiveness	18. Innovation	19. People positive	20. Discipline	22. Conflict	23. Altruism	24. Self-confidence	26. Leadership
2		46							06			190					56	347	344		4
23. Altruism_2	-0.162503	-0.113592	0.144927	0.061647	0.148207	-0.061084	-0.057921	-0.163649	-0.319371	-0.120988	-0.194187	-0.089747	-0.213719	-0.138113	0.051019	-0.183156	-0.178551	-0.312237	-0.242863	0.064482	-0.263476
24. Self-confidence_2	0.031987	0.049952	-0.032081	0.139112	0.096847	0.149026	0.229450	0.002301	-0.229735	-0.121988	-0.049033	-0.015159	-0.093955	-0.171841	-0.241031	0.169469	0.233760	-0.178379	0.019441	0.024529	-0.278224
SM ↓vs. IA →	**8. Responsiveness**	**16. Cognition**	**4F. Frustration**	**4A-F. Task-Load Index**	**8. LOC**	**9. Task simplification**	**10. Resilience**	**11. Change management**	**12. Frustration**	**13. Team inclination**	**14. Self-motivation**	**15. Routine**	**16. Problem solving**	**17. Responsiveness**	**18. Innovation**	**19. People positive**	**20. Discipline**	**22. Conflict**	**23. Altruism**	**24. Self-confidence**	**26. Leadership**
26. Leadership_2	0.188692	0.191004	0.041231	0.258631	0.148043	0.233516	0.209278	0.104537	-0.086923	0.025996	-0.014025	-0.204724	-0.177900	-0.184195	0.006003	0.099467	0.070767	0.007772	-0.052459	0.012979	-0.376609

ANNEXURE H: SM VS. IA CORRELATION DATA FOR INSTRUCTOR #8

SM ↓vs. IA →	8. Responsiveness	16. Cognition	4F. Frustration	4A-F. Task-Load Index	8. LOC	9. Task simplification	10. Resillience	11. Change management	12. Frustration	13. Team inclination	14. Self-motivation	15. Routine	16. Problem solving	17. Responsiveness	18. Innovation	19. People positive	20. Discipline	22. Conflict	23. Altruism	24. Self-confidence	26. Leadership
8. Responsiveness_2	-0.080077	0.362319	-0.251208	-0.063405	-0.672521	0.365835	-0.425873	-0.087103	-0.251208	0.357122	-0.036264	0.200504	0.501428	0.005495	-0.095362	-0.046117	-0.139033	0.184162	-0.610027	0.123219	0.199637
16. Cognition_2	0.356840	0.712858	0.242675	-0.147458	-0.354658	0.703211	-0.023321	0.210963	0.242675	0.560612	0.325300	0.222629	0.826111	0.500298	0.522028	0.243856	-0.055556	0.117202	-0.155081	0.290144	0.626783
4F. Frustration_2	-0.691096	-0.183224	-0.299597	0.132397	0.366232	-0.617355	-0.030457	0.045919	-0.299597	-0.305062	0.143382	0.177959	-0.394403	-0.383015	-0.310801	-0.375696	0.106240	-0.109695	0.113924	-0.126308	-0.170535
4A-F. Task-Load Index_2	-0.692206	-0.270679	-0.247142	0.196797	0.289269	-0.654769	-0.190606	-0.155205	-0.247142	-0.434994	0.095916	0.355020	-0.355575	-0.465834	-0.517042	-0.165563	0.098531	0.244932	0.036099	-0.090052	-0.162113
8. LOC_2	0.005309	-0.191138	-0.350006	0.067574	-0.475155	-0.127878	-0.422393	-0.491050	-0.350006	-0.122336	-0.726722	-0.193489	-0.150510	-0.327522	-0.490005	-0.097281	-0.137685	0.048594	-0.368025	-0.094972	-0.444520
9. Task simplification_2	0.358596	0.453817	0.012606	0.039219	-0.079519	0.685772	0.121467	0.561086	0.012606	0.279567	-0.186555	-0.367519	0.253917	0.453096	0.278192	0.329351	-0.356202	0.166248	-0.229430	0.257226	0.208377
SM ↓vs. IA →	8. Responsiveness	16. Cognition	4F. Frustration	4A-F. Task-Load Index	8. LOC	9. Task simplification	10. Resillience	11. Change management	12. Frustration	13. Team inclination	14. Self-motivation	15. Routine	16. Problem solving	17. Responsiveness	18. Innovation	19. People positive	20. Discipline	22. Conflict	23. Altruism	24. Self-confidence	26. Leadership
10. Resillience_2	0.070602	0.784900	0.156491	-0.023772	-0.335078	0.513934	-0.097752	0.317430	0.156491	0.391641	0.052443	0.148515	0.598058	0.317058	0.153465	0.221136	0.071651	0.304833	-0.175009	0.654856	0.336822
11. Change management_2	0.161932	0.280502	-0.022341	-0.347522	0.145786	-0.209719	0.325701	0.309464	-0.022341	0.122336	-0.175691	-0.042718	-0.025510	0.203289	0.188464	-0.246945	0.257185	-0.255755	0.324877	0.379888	0.068388
12. Frustration_2	0.677259	0.498815	0.002445	-0.646608	-0.555804	0.372854	0.075194	0.103291	0.002445	0.662777	-0.086531	0.121287	0.688520	0.467244	0.467822	-0.132682	0.061415	-0.193985	-0.180009	0.343020	0.471550
13. Team inclination_2	0.495024	0.166741	0.039819	0.152430	0.037893	0.194872	0.193880	0.061538	0.039819	-0.030662	-0.413664	-0.108329	0.138108	0.294392	0.078098	0.270084	-0.289098	0.084615	0.053437	0.063477	0.068563
14. Self-motivation_2	0.426001	0.726107	0.196654	-0.397087	-0.137102	0.426010	0.434180	0.685772	0.196654	0.528072	0.183851	0.140372	0.541516	0.630893	0.495130	0.017734	0.184697	-0.020781	0.069602	0.707373	0.520943
15. Routine_2	-0.041633	0.447700	0.060829	-0.222362	-0.299030	-0.162949	-0.049883	-0.137880	0.060829	0.000000	-0.328768	0.243845	0.100020	0.049816	-0.130543	-0.063570	0.555112	0.167963	0.256247	0.558547	0.000000
16. Problem solving_2	0.055402	0.321196	-0.124334	0.337455	-0.174665	0.224179	0.106209	0.160128	-0.124334	-0.127657	-0.455556	-0.041954	0.005324	0.188562	-0.183551	0.166585	-0.119277	0.202829	-0.084752	0.198206	-0.071362
17. Responsiveness_2	-0.050567	0.233935	-0.184162	0.372607	-0.173226	0.061538	-0.181125	-0.202564	-0.184162	-0.122649	-0.645850	-0.297275	-0.076727	-0.096244	-0.211620	-0.010003	-0.145851	-0.117949	-0.035624	0.000000	-0.342814
SM ↓vs. IA →	8. Responsiveness	16. Cognition	4F. Frustration	4A-F. Task-Load Index	8. LOC	9. Task simplification	10. Resillience	11. Change management	12. Frustration	13. Team inclination	14. Self-motivation	15. Routine	16. Problem solving	17. Responsiveness	18. Innovation	19. People positive	20. Discipline	22. Conflict	23. Altruism	24. Self-confidence	26. Leadership
18. Innovation_2	0.019231	0.377639	-0.123311	0.172334	-0.058674	0.007941	-0.229103	-0.317620	-0.123311	-0.063303	-0.382933	0.057213	0.203286	0.035064	0.039009	0.074863	-0.115606	0.010587	0.133962	-0.131050	0.106163
19. People positive_2	0.175654	0.273754	-0.109502	0.140333	-0.303146	0.176923	-0.227044	-0.123077	-0.109502	0.122649	-0.555111	-0.249409	0.179029	-0.022646	-0.146118	0.045014	-0.200545	-0.020513	-0.226470	0.222169	-0.205688
20. Discipline_2	0.260819	0.716888	0.179838	-0.402375	-0.455484	0.345195	0.060607	0.304584	0.179838	0.576697	0.240408	0.416471	0.751920	0.392294	0.266840	-0.004951	0.268130	0.152292	-0.153653	0.754027	0.509027
22. Conflict_2	0.468410	0.403165	-0.248867	-0.566170	-0.395172	0.038462	-0.028062	0.020513	-0.248867	0.551920	-0.288231	0.027712	0.511511	0.226455	0.297275	-0.370116	-0.065112	-0.394872	-0.185756	0.222169	0.274251
23. Altruism_2	0.167354	0.322763	-0.173607	0.000000	-0.369649	0.241851	-0.343385	-0.143599	-0.173607	0.241010	-0.587362	-0.398515	0.196002	-0.038937	-0.037129	-0.036856	-0.202158	-0.143599	-0.262513	0.155918	-0.202093
24. Self-confidence_2	-0.199606	-0.209048	-0.363346	0.411320	0.064960	-0.194872	-0.168370	-0.071795	-0.363346	-0.337284	-0.731252	-0.488741	-0.485935	-0.328360	-0.503857	-0.057518	-0.325561	-0.043590	-0.183211	-0.095215	-0.617065
26. Leadership_2	0.119402	0.359228	-0.082525	0.297332	-0.155749	0.227571	-0.104498	0.065020	-0.082525	-0.059810	-0.585652	-0.179366	0.089798	0.093867	-0.216222	0.258537	-0.215914	0.272585	-0.141461	0.309546	-0.133739

ANNEXURE I: PSYCHOLOGIST INTERVENTION REPORT (3 PILOTS)

Suzelle du Plessis

Industrial Psychologist

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Career planning • Coaching • Development (Supervisory & Leadership) • Psychometric Assessments • Recruitment

I was asked to have interventions with three of the pilots from Henley Air in order to provide mentorship on their Personal Development Programs (PDP's). Each candidate had two sessions of an hour each.

Herewith a short report on the discussions we had:

Pilot A (rank 91)

Instructor "A" completed the shadow match questionnaire and was required to complete a Personal Development Program (PDP) on "Propensity to hand-off". He and I had two sessions whereby we discussed and completed the PDP.

We discussed extensively the delegation of responsibilities or tasks. By the nature of his work Pilot A can't delegate a lot of his work as he works as a consultant and is therefore required to do a lot of the work himself. As a pilot he can't delegate his role as an instructor either. He did mention that he tends to give free reign to his trainees too soon.

By the time of our second session he identified tasks that others can perform on his behalf. He also sub-contracted someone to assist with data capturing. This will now save him a lot of time.

I am happy with what Pilot A learned from this experience although his type of work does not allow for him to delegate a lot of tasks or authority at the moment. We explored options should he find himself in such a position in future.

Pilot B (rank 79)

The candidate completed the shadow match questionnaire and was asked to complete a PDP on Leadership.

He was open to the discussion and did a thorough study of the PDP. Pilot B has a thorough understanding of what Leadership entails as he is the owner of a business. We discussed all the sections thoroughly.

Unfortunately the candidate couldn't get hold of the book by Tom Peters, but nevertheless he continued with the study to the best of his ability. Lance also took the time to interview Meyer Gelbart, (ex CEO of Alliance Pharmaceuticals) on his views on Leadership and managing. Through this Pilot B gained some extra insight into Leadership.

Pilot B also asked people to complete the questionnaire on his leadership style and it became evident that the area he needs to improve on is to empower other people.

I am satisfied that Pilot B has a good understanding of what Leadership entails. He placed a lot of effort into the PDP.

Pilot C (rank 70)

Pilot C was asked to complete a PDP on Individual Inclination

At first he was somewhat hesitant to complete this questionnaire and attending the intervention as he felt that he has the ability to work quite well as an individual. We discussed the incident he had and what he could've done differently. We also discussed what he did after the incident, like having a dual-check with the Chief Flying Instructor afterwards.

Our second session was more constructive. Pilot C managed to identify areas in his work where he asked for assistance and what the other party did to help him.

We also discussed the areas he does not feel confident in doing on his own, like an auto-rotations to the ground with run-on landings. He feels that he needs a little more experience.

He also identified situations or areas he needs to handle and identified the challenge or reason he did not feel comfortable about handling it on his own. He identified action plans going forward.

Pilot C felt that this specific topic wasn't applicable to him but we managed to identify areas for discussion.

He identified the fear that his mistakes might cause permanent damage (in aviation) and the fact that he does not want others to think that he is incompetent when he makes mistakes as his main reasons for not working independently.

Suzelle du Plessis

Industrial Psychologist – PS0088935

ANNEXURE J: EXAMPLE OF CPPD PRESENTATION

HENLEY AIR

CPPD Workshop #3

9 March 2011

CPPD WORKSHOP #3

- H & F Procedures
  - Own documents (license, medical, excess)
  - Bookings (2 days in advance)
  - Base Check Currency
  - Mission Profile (nav. log, pax, landings, fuel)
  - Company Docs. (autho. sheet, pax indemnity)
  - Flight Following procedures
  - Post Flight and defects
  - Refer to Flowchart

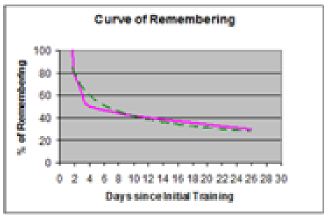
CPPD WORKSHOP #3

- Base Checks
  - 30-day recency: minimum 1 hour
  - 3-monthly, regardless of recency (on-type)

- Hire & Fly limitations (R44)
  - 0 – 20 hours: pilot + 1 pax
  - 20 – 60 hours: pilot + 2 pax
  - > 60 hours: pilot + 3 pax (subject to approval)

CPPD WORKSHOP #3

- Contrary to popular belief, the greatest rate of forgetting occurs within the first twenty four to forty eight hours after the learning episode [Transport Canada, 2007].



- Ohio State University has carried out extensive research into the phenomenon of *Remembering*, or perhaps more apt, "*Forgetting*" of tutored information.

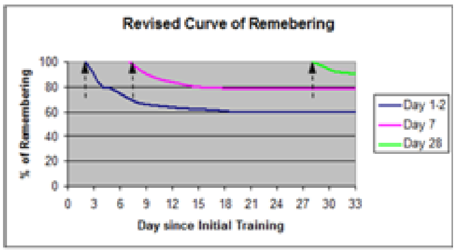
CPPD WORKSHOP #3

Learning and retention curve is initially very steep and that students will remember less than 70% of what was learned in the previous 2 days. Furthermore, if no further reviewing is undertaken, approximately only 40% of the lesson will be remembered.

In order to maintain a retention level of at least 70%, revision is required within 2 days of the original lesson. After the second tutorial event the (magenta) curve flattens out rapidly which denotes a greater retention span, but tends to confirm that the 70% retention level is reached after a further 7 days. A further intervention ensures a significantly flattened (green) curve and a 70% retention level is maintained for up to 28 days. The yellow arrows indicate the ideal time of recurrent training to sustain a 70% retention level [Transport Canada, 2007]

Example: initial training ➔ 50 minutes
1st review (day 2) ➔ 15 minutes
2nd review (day 7) ➔ 10 minutes
3rd review (day 28) ➔ 5 minutes

The reality found in the two curves and the quoted examples, serves to confirm that technical and practical recurrent flight training should be an absolutely non-negotiable feature of recurrent training programmes. This holds true for private pilots, particularly due to the lack of continuous proficiency and maintenance of flying proficiency standards.



CPPD WORKSHOP #3

- FAA / NTSB sample of 100 accidents (http://www.avhf.com/html/Research/Flight_Review/Introduction2.asp)
- Spike noticeable just after flight review / Base Check. Remainder is Normal Distribution
- Possible causes?
- Simplest is that pilots are just flying more immediately following the flight review. Basically, more exposure (more flying hours) leads to more accidents.
- Another explanation is that pilots feel more confident following the review, and will go out into conditions that they would not have ventured into prior to the review.
- Corrective measures?
- First, answer a few questions about your flight time immediately before and following your last flight review.
- Second, read a few typical aviation scenarios and tell yourself how risky they seem to you.
- BE CAREFUL – surviving the flight review does not make you into Charles Lindbergh. [Dr David Hunter, 2007]

CPPD WORKSHOP #3

- A flex plate, used to accommodate slight movements in the drivetrain between the engine and transmission in a Robinson R22 helicopter failed in fatigue on take-off, causing the helicopter to crash and resulting in extensive damage. Failure was due to fatigue and no metallurgical or material defect or deficiency was found which would have caused initiation. It is recommended that all R22 flex plates are changed at 500 hours to prevent any recurrence.

- By: Tim Carter, C.Eng FIMMM http://www.caa.co.za/resource%20center/accidents%20&%20incid/reports/2010/8777.pdf
- Photos: Athol Buchan

CPPD WORKSHOP #3

Failed flexplate and drivetrain assembly

ANNEXURE K: BELL 222 – COMPLEX HELICOPTER CHECK-LIST

BELL 222

WARNING MESSAGES

ENG 1/2 OUT	Engine NG below 52% ± 2%.	Verify engine condition. Accomplish applicable Single engine emergency procedures.
ROTOR BRAKE	Rotor brake engaged	Check rotor brake handle in off detent. If light remains illuminated, correct problem before Engine start. In-flight — VFR — Check rotor brake handle in Off detent**. Land as soon as possible.**
BATTERY TEMP	Battery overheating	Turn BAT OFF: **Land as soon as possible**
XMSN OIL TEMP	Oil temperature above 110°C.	Reduce power; verify fault on XMSN OIL Temperature gauge. **Land as soon as possible.**

ANNEXURE L: PERSONAL DEVELOPMENT PROGRAMME

Phase 1

Make an appointment with your mentor and discuss the process and the way in which you will approach and successfully meet all the outcomes of the programme. Your mentor will sign off each phase and the completed programme should be placed in your personal file in order to keep a record of your self-development progress. What you will do during this programme is to compile two lists of positive relationship abilities you have as well as two lists of relationship frustrations experienced by those with whom you interact. You will work through the lists and identify your three strongest relationship assets and your three weak areas. You will then embark on a plan to focus on the positive aspects and eliminate the negative ones.

Phase 2

Without talking to anybody, list the five positive relationship attributes you believe you show when working with others. Put it in a different way, in your own opinion, what are the five things you do that should be experienced by others as positive building blocks towards a meaningful relationship with them.

Note my five relationship positives and then make an appointment with your mentor and do the following with him/her. Discuss each of the above positive relationship attributes with the aim of giving each a name that is short but clearly descriptive (please don't discuss the validity of the listed relationship positives).

Phase 3

List the names of 5 people you really like. They should be individuals with whom you have a positive, open and friendly relationship; people that might be on your fan-club list. Make an appointment of 20 minutes with each person. During this meeting you have to ask them to help you with your self-development plan. Before you make the appointment, read through the interview and stick to the wording in the Interview Outline exactly. At the end of the interview you will ask them to list something for you, put it in an envelope and put it on your mentor's desk, or if this is not possible, mail it to your mentor. Your mentor will keep this and open it with you when you've reached the stage of compiling the second list. (You are still busy with the first list). The Interview Outline looks like this:

Interview #__

With: (Name no.1 on the above list) ________________________________

Date: _________________________Time: __________________________

Read the following to the person you're about to interview after you've greeted and sat down". I'm doing a personal development programme that will enable me to focus my energy when working with people. I have selected you as an important person on my road of development. I'm trying to identify the positive aspects in my behaviour that contribute towards positive relationships with others. Can you think of about five things I do that are positive relationship building blocks?"

Write them down: Behaviour Positives from____________________(name).

You've done extremely well by interviewing these people. Make an appointment of at least one hour with your mentor and prepare for the meeting by doing the following:

Carefully read through all the lists of Behaviour Positives gathered from your five interviews. See if you can identify the ones mentioned by all your interviewees. If for example, friendliness has been identified by all five the interviewees, put friendliness as one of the top Relationship Positives. In other words, list those Relationship Positives mentioned by the majority of your interviewees. List the five Relationship Positives as per the list received from your interviewees. Discuss these with your mentor. (If you find it difficult to identify the top five Relationship Positives, ask your mentor for some assistance.) In the second column next to this list, re-write the list as per Phase 2. You now have two lists of Relationship Positives next to each other. Discuss the following with your mentor regarding this information:

1. Did the people you interviewed see Relationship Positives that you didn't see?

2. Now that you know how they see you, which three Relationship Positives are the most important to focus on?

3. What have you learnt?

Phase 4

Discuss the commonalities and differences between the way the interviewees see your five Relationship Positives and the way you see them. Decide which three of all these positives are the most natural to you and write them down. Build one sentence that will motivate and remind you of these three Relationship Positives. Write this sentence down to be a one-year fixture at four places you visit regularly and make it your personal people management motto.

Conclude your session with your mentor by asking if he/she has received the feedback from the five people you asked to help you identify your Relationship Negatives. If there are still some outstanding, follow them up and make sure that your entor gets their feedback before your next appointment.

Phase 5

This appointment can only take place once your mentor has received all the feedback from the selected five individuals. You also need to prepare for the meeting by guessing what they will have on their lists of Relationship Negatives regarding yourdealings with the people around you. Compile a list of what you think they wouldhave identified and take it with to your appointment with your mentor. The first thing you have to do when you meet with your mentor is to work through this list. Discuss why you think each one of these negatives will be on the interviewees' lists. Try to find how they became part of your way of dealing with people. This might take some time. Is it possible that one of your parents or perhaps an older brother or sister or even a teacher behaved this way and you might have copied this behaviour? Do you think that perhaps this behaviour will get people to react in a certain way? Once you've discussed everything on your list, read through the five lists that were handed to your mentor. Identify those mentioned by the majority of your respondents and list them. The most important **Relationship Negatives** are those ones mentioned by most of your respondents. Compile a list of the five top ones and write them next to your own guess list.

Phase 6

This is your last meeting for this development programme. Again, it may be a very personal and tough one. You will learn a great deal and your insights will give you new perspectives on the way other people react to what you do. Go back to Phase 5 to the list where you noted your views and the views of the respondents. Discuss the following with your mentor:

1. How are people likely to react when you behave in this manner?
2. How do you feel when you behave this way?
3. What picture of your personality do you leave behind when you've done this?
4. How do you feel when someone else does this to you? What is your motivation to do this? Why do you do it?
5. How can you prevent this behaviour?

The greatest lesson you can learn from this exercise is the fact that life will treat you the way you treat other people. How would you like life to treat you? Make a serious effort to cut these Relationship Negatives out of your life. Remember to treat other people in the same way you would like to be treated.

ANNEXURE M: VALIDATION OF SHADOWMATCH™

Statement of experiment

Assertion: Shadowmatch™ asserts that by having an individual complete a list of tasks (in the format of a questionnaire-based worksheet) Shadowmatch™ can discriminate the level or degree to which habits are embedded in the behaviour of an individual as per a set of defined behaviour categories.

The requirement is to design an experiment by means of which the above assertion can be tested with a view towards validation. The experiment consists of the following:

1. Inviting eight 'experts' to complete a total of 36 Shadowmatch™ worksheets profiling 18 separate behaviour categories such that 18 result in a score of 70 or more (demonstrating the presence of a habit imbedded in the behaviour of an individual) and such that 18 result in a score of 10 or less (demonstrating the absence of a habit embedded in the behaviour of the individual).

2. The eight experts were not told in advance which behaviour pattern they would profile. Once seated, each was provided with access codes to complete a Shadowmatch™ worksheet and each was randomly assigned a separate behaviour category with a definition of that behaviour category.

3. For each behaviour category, an expert was tasked to complete two Shadowmatch™ worksheets.

   i. One: complete a worksheet, consistently selecting for each question the answer that they (the tasked expert) felt best described behaviour that was consistent with the behaviour definition supplied, and,

   ii. Two: complete another worksheet, consistently selecting for each question the answer they felt was most anti/contra the behaviour as per the behaviour definition.

Interpretation and its reasoned basis

In considering the appropriateness of the above experimental design, it is needful to forecast all possible results of the experiment and to have decided without ambiguity what interpretation shall be placed upon each result. In this instance, we set out the possibilities as per the mathematics of permutations and combinations for the 18 results out of 36 total tests that targeted a score of 70 or more. In determining the full set of possible permutations, it is noted the order does not matter and a particular result can only be used once. Consequently, the number of possible combinations is the binomial coefficient:

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$

where for example 3! = 3 x 2 x 1 = 6;

For our calculation, n = 36 and k = 18. There are a total of 9,075,135,300 (just over 9 billion) possible sets of answers ranging from all 18 targeted behaviour categories scoring 70 or more to all 18 targeted behaviour categories scoring less than 70. At best, the experts can complete the worksheets so consistently as per the behaviour definitions that all 18 targeted behaviour categories result in a score of 70 or more. In terms of probability, experts without any faculty of discrimination against the definitions would emulate this result (all 18 scoring 70 or more) in one trial out of 9,075,135,300*. The complete set of probabilities is enumerated in the Table 1 following:*

Table 1: Full set of possible results (normal distribution curve)

Behaviours Scoring 70+ out of 18	Behaviours Scoring less than 70	Frequency	Significance	Confidence
18	0	1	0.00000001%	99.99999999%
17	1	324	0.00000357%	99.99999643%
16	2	23,409	0.00025795%	99.99974205%
15	3	665,856	0.00733715%	99.99266285%
14	4	9,363,600	0.10317863%	99.89682137%
13	5	73,410,624	0.80892044%	99.19107956%
12	6	344,622,096	3.79743204%	96.20256796%
11	7	1,012,766,976	11.15980030%	88.84019970%
10	8	1,914,762,564	21.09899743%	78.90100257%
9	9	2,363,904,400	26.04814498%	73.95185502%
8	10	1,914,762,564	21.09899743%	78.90100257%
7	11	1,012,766,976	11.15980030%	88.84019970%
6	12	344,622,096	3.79743204%	96.20256796%
5	13	73,410,624	0.80892044%	99.19107956%
4	14	9,363,600	0.10317863%	99.89682137%
3	15	665,856	0.00733715%	99.99266285%
2	16	23,409	0.00025795%	99.99974205%
1	17	324	0.00000357%	99.99999643%
0	18	1	0.00000001%	99.99999999%

The test of significance

In relation to test of significance, we can conclude that something is demonstrated experimentally when we can conduct an experiment in such a way that it will rarely fail to give us a result that can be interpreted against a statistical significance score. Table 1 above details all the possible results of the experiment as pertains to demonstrating a habit embedded in the behaviour of an individual (that is a score of 70 or more resulted for the behaviour category targeted). It is noted that the sum of the frequency above equals the total number of possible combinations of 9,075,135,300. The significance score is calculated as: (frequency divided by 9,075,135,300).

In deciding the level of significance to use, we want to avoid high degrees of success that can result from mere chance. Hence we target a level of significance of 0.01 for a 99% plus confidence index in our results.

The Null Hypothesis

Our exploration of the full set of possible results of the experiment has resulted in a statistical test of significance by which the actual results can be divided into two classes of opposed interpretation. The two classes of results which can be distinguished by our test of significance are one (forthwith referenced as the 'null hypothesis'): the hypothesis that the experts' collective efforts to discriminate the presence of a strong habit as well as the absence of a habit embedded in an individual's behaviour as per a set of behaviour definitions are not enabled by the Shadowmatch™ worksheet, and two (forthwith referenced as the alternative hypothesis): the hypothesis that the experts' collective efforts to discriminate the presence of habits (strong and absent) embedded in an individual's behaviour as per behaviour definitions are enabled by the Shadowmatch™ worksheet. It is noted that this experiment ('validation of Shadowmatch™') has been created to give the evidence a chance to disprove the null hypothesis and not to prove or establish it.

It is tempting to argue that if the validation of Shadowmatch™ (the experiment) can disprove the null hypothesis, we must consequently be able to prove the opposite hypothesis namely that experts can discriminate the presence of habits embedded in an individual's behaviour as per a set of definitions using the Shadowmatch™ worksheet. However, this opposite hypothesis is ineligible as a 'null hypothesis' because it is inexact. If we would add the words 'always be able to discriminate the presence of a habit embedded', we would then have an exact hypothesis that can operate as a 'null hypothesis'.

But it is easy to see that this hypothesis can be disproved by a single failure whilst never being proved by any finite number of experiments. From this example, it is clear that the 'null hypothesis' must be precise and unambiguous in order for it to supply the basis of the 'problem of distribution', for which the 'test of significance' is the solution.

Randomisation: The Physical Basis of the Validity of Shadowmatch™

We have discussed that the validation of Shadowmatch™ entails testing the null hypothesis that the Shadowmatch™ worksheet does not enable experts to discriminate the presence of an embedded habit. We have also assigned, as appropriate to this hypothesis, a frequency distribution of occurrences, based on the equal frequency of the 9,075,135,300 possible ways of assigning the results of 36 Shadowmatch™ worksheets to two habit sets (embedded and absent) of 18 behaviour areas each. This is in fact the frequency distribution for a classification by pure chance.

We have now to consider the physical conditions of the experimental design required to substantiate the assumption that, if the link between experts being able to use the Shadowmatch™ worksheet and behaviour definitions to model the degree of habits embedded in an individual's behaviour is absent, the results of the experiment conducted will be completely controlled by the laws of chance. It is easy to see how the physical conditions of the experiment can deliver results not completely controlled by the laws of chance. For example, if, for each question in the Shadowmatch™ worksheet, an expert had a choice between two answers highlighted in different colours to consistently indicate the absence or presence of a habit embedded in the behaviour set under modelling, then the obvious difference in the format of the question answers would ensure that a set of both high scores and low scores result. This would happen in 50% of all trials and the sets would either be all right or all wrong and the test of significance would be meaningless.

In this particular instance, we needed to take the precaution of randomisation to guarantee the validity of the test of significance against which to decide the experiment results. This was done through behaviour sets being randomly assigned to each of the eight experts. For each specific behaviour area the expert was required to complete a Shadowmatch™ worksheet to model both the presence and absence of a habit embedded in an individual's behaviour as per the behaviour definition. The worksheet targeting a specific behaviour could only be completed once by the expert in question. Second attempts at modelling the behaviour are not a part of the experiment results – first attempts only have been included.

With respect to any additional refinements that can be made to increase the sensitivity of the experiment, we now have in place the description of a valid experiment as well as the test of significance by which to determine its result. It remains for us to translate the hypotheses into numerical constructs, to present the actual results of the experiment and to conclude on the validity of Shadowmatch™.

Hypotheses H_o and H_a and Rejection Rule H_o

Null Hypothesis:	H_o: Shadowmatch™ does not discriminate the presence of habits embedded in an individual's
Alternate Hypothesis:	H_a: Shadowmatch™ does discriminate the presence of habits embedded in an individual's behaviour.

We want a 99% chance of discriminating the presence of habits embedded in an individual's behaviour. Hence, the level of significance for the hypothesis test is 0.01 (or 1%). If you reference Table 3.10 earlier, you will see that the significance scores for a total of 13 to 18 tests scoring greater than or equal to 70 are all less than 0.01 (1%) and thus within the 0.01 significance level.

Given Table 2, a significance level of 0.01, the fact that the same logic applies to the results targeting scores of 10 or less, we can establish the following rejection rule:

Reject H_o: If 13 or more of the 18 worksheets completed to show the presence of a strong habit embedded in an individual's behaviour score greater than or equal to 70.

OR

If 13 or more of the 18 worksheets completed to show the absence of a habit embedded in an individual's behaviour score less than or equal to 10.

The Experiment Results

The expert group of eight could successfully replicate the presence /absence of behavioural habits as is presented in table 3.11 below. (Manipulating the results equal to or above 70% should be seen as 100% successful and creating a result of less than or equal to 10% in order to anticipate the absence of a behavioural habit, that should also be seen as 100% successful).

Table 2: Experiment Results (36 results made up of two sets of 18)

No	Habit.	Forced High	Count of Successful	Forced Low	Count of Successful
1	Propensity to own	71%	1	19%	
2	Propensity to hand-off	64%		13%	
3	To simplify	70%	2	9%	1
4	Resilience	83%	3	-23%	2
5	Propensity to change	70%	4	3%	3
6	Frustration handling	73%	5	-6%	4
7	Team inclination	96%	6	4%	5
8	Individual inclination	72%	7	6%	6
9	Self-motivation	81%	8	-2%	7
10	Routine	55%		12%	
11	Problem solving	79%	9	-6%	8
12	Responsiveness	88%	10	3%	9
13	Innovation	83%	11	-14%	10
14	People positive	85%	12	-14%	11
15	Discipline	69%		12%	
16	Conflict handling	67%		3%	12
17	Altruism	80%	13	-10%	13
18	Self confidence	78%	14	-9%	14

Conclusion

Set one produced 14 scores of 70 or more and set two also produced 14 scores of 10 or less. As this is greater than the 13 limit as specified in rejection rule H_o, we **reject** the null hypothesis that Shadowmatch™ does not discriminate the presence of habits embedded in an individual's behaviour and accept the alternate hypothesis (H_a) that Shadowmatch™ does discriminate the presence of habits embedded in an individual's behaviour with a significance of 0.01. This means that Shadowmatch™ gives a user of Shadowmatch™ a 99% probability of discriminating the presence of habits embedded in an individual's behaviour as per the Shadowmatch™ behaviour definitions.

Participants

1. Guy Krige:	Independent Business Consultant
2. Erna Gerryts:	Independent Control Group Participant
3. Theo Bezuidenhout:	Independent Sport and Counselling Psychologist
4. Madi du Toit:	Deloitte
5. Nelius Volschenk:	Deloitte
6. Pieter de Villiers:	Shadowmatch™ Representative
7. Lizette Bester	Shadowmatch™ Representative
8. Hestie Byles:	Psychologist University of Pretoria

Habits Interpreted against a Point Scale

The calculator in Shadowmatch™ is such that the relative score can vary from the extreme low – even a minus score in the extreme instances – to a very high score. The following framework of points is an indication of what a low and a high score will be:

- Less than 10 points is a very low result.
- Between 10 points and 30 points is a low result but not radically low.
- Between 30 and 50 points indicates a non-radical but strong result.
- Between 50 and 75 points is a strong to radically strong result.
- More than 75 points is a radically strong result.

Although the purpose of this validation is not to interpret these results, it is important to indicate how these points are interpreted as a relative indicator of the behavioural habits and the level to which the specific habit are defined. The example will be Problem Solving as a habit. Shadowmatch™ defines Problem Solving as follows:

Problem Solving: This is the habit of engaging with challenges on a conceptual, social and practical level and successfully managing these difficulties/challenges towards resolving them. People with a strong embedded habit of problem solving easily becomes intrigued by challenges and riddles to be resolved.

The results on problem solving will indicate the following problem solving behavioural preferences:

Less than 10 points: This result will indicate that the individual has a low inclination towards problem solving. He/she will rather find alternative ways of dealing with the problem, this might vary from handing it to somebody else to resolve, ignoring it, solving it when he/she is part of a team or even living with the problem without ever resolving it. The individual will only engage with problems under very specific circumstances.

Between 10 and 30 points: This indicates that the individual will engage with a problem, not as a personal adventure and a choice, but when necessary. It might even be that the individual will engage with the problem if it is easy to resolve or if it presents something of special interest or even if it is related to a unique skill that the person has.

Between 30 and 50 points: This individual will engage with problems with relative ease. He/she will be selective in the type of problems he/she prefers to resolve but for the majority of day to day problems the individual will engage with the problem with relative comfort.

Between 50 and 75 points: This individual – for whatever reason – finds meaning in tackling and resolving problems. Although he/she might still be selective in the type of problem he/she prefers to resolve, he/she will engage with the majority of problems in life with the purpose of resolving them. These individuals might even find some form of personal fulfilment in solving problems. It is a habit for them to engage with challenges in order to get a solution.

More than 75 points: These individuals find it difficult to walk away from any problem. In the extreme they tend to become so involved with a problem that it might even influence their normal day to day lives. They can become hooked on a problem and engage with it over long periods of time in order to resolve it. They have a very prominent habit towards engaging with problems, they might even feel frustrated if they are faced with a problem that cannot be resolved. In the extreme, these people might become so intrigued with problems and problem solving that they will start a hobby that entails problem solving.

All the habits tracked by Shadowmatch™ are more or less in the same weighting framework as indicated above with regards to Problem Solving. The cut-off points are not absolute, they are soft borders. It must also be emphasised that Shadowmatch™ does not measure the way people think, their feelings, temperaments, tastes, moral character, beliefs, expectations, desires, values, or their personalities. It identifies behavioural patterns or habits that could best be described as follow:

A habit is an action that repeats itself with no (or minimal) conscious planning. It repeats itself when the situation is conducive to such behaviour and the person has a goal of fulfilling his/her need in some way by doing what he/she normally does. This action can then become a habit.

When is Behaviour a Habit?

3. Any behavioural pattern can become a habit. When is behaviour habit? What else do we need to know about habits?
4. Any behaviour that repeats with minimal/no planning can be a habit.
5. Habits are learnt behaviour.
6. Habits are associated with some meaningful goal/purpose.
7. Habits are formed through repetition.
8. Habits are very predictable.
9. Any behaviour can become a habit. (Getting up early, solving problems, working alone or disengaging when frustrated)
10. Habits are extremely difficult to break.
11. When an individual cannot freely live by his/her habits, he/she finds it extremely difficult to function properly.
12. People living their lives along well established habits show highly predictable behaviour. The opposite is also true.
13. All habits are not equally well established.
14. Habits can transcend contextual boundaries. (A habit developed in one context can manifest in another context without a clear link to the environment where the habit has been developed).
15. Habits are always attached to some kind of meaningful purpose for the individual. This purpose might be something like avoiding discomfort, being successful and being efficient.
16. Habits can form pairs or tandem habits. This happens when two or more behavioural types that are related to each other are well developed. E.g. People Positive Behaviour and Altruism. When these two habits are strong, they contribute to each other and the behaviour becomes more prominent.