Developing Proficiency in Air Transport Pilots: The Case for the Introduction of Non-Technical Skills in Basic Pilot Training Programmes

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Abstract

This study examines the differences between the skills and competencies of New Zealand flight school graduates and the types of skills and competencies believed to define a proficient air transport pilot. In New Zealand the training of professional pilots is directed towards meeting the requirements laid down by the New Zealand Civil Aviation Authority for the licensing of professional pilots. However, some evidence suggests that competence for licensing purposes does not necessarily meet the requirements of the airlines and the types of skills that they require as a prerequisite to airline training. Although not clearly defined, this shortfall has been recognised for several decades and traditional thinking is that extra flying experience gained as a general aviation pilot will develop the skills necessary for entry into airline pilot training.

The importance that pilots of differing experience levels attach to technical and non-technical skills and their perception of the training effectiveness of those skills and how deficiencies in those skills contributed to aircraft accidents was explored by a four stage study including: i) a review and analysis of flight test results obtained from graduate pilots on a university air transport pilot programme; ii) the analysis of responses to questionnaires supplied to three pilot groups within the New Zealand aviation industry; iii) the analysis of air transport aircraft accidents and their primary and contributing causes; and iv) interviews with qualified airline pilots working for New Zealand airlines.

The results indicated that throughout the spectrum of experience and qualifications, from student pilot to airline pilot, the technical skill of aircraft handling was highly valued and the training in this skill was considered by all pilots to be satisfactory. In contrast, while non-technical skill deficiencies were found to be primary or contributing factors in many aircraft accidents, less importance was attached to non-technical skills by all pilot groups. The training effectiveness of these skills was rated as only moderately effective or of minimal effectiveness.

The findings are discussed and recommendations are made for the improvement of basic flight training. In addition, a model is proposed for the fast tracking of flight school graduates into the airline training schools. Several areas for future research are also proposed.

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Dedicated to

Nicholas, Katharine, Jenny, and Nina

"every post a winning post"

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Introduction

The study explores the skills that airline pilots use to carry out their duties and the way those skills are developed during basic flight training and the early stages of a pilot's flying career. It examines how expertise is developed as a pilot's career progresses and the extent to which deficiencies in these skills contribute to airline accidents and incidents. Comparisons are made with other professions and similarities are discussed with several common themes for skill development identified as having relevancy for the aviation industry.

A news release from the International Civil Aviation Organisation (ICAO) in June 2007 announced significant increases in profits and traffic for the world airlines in 2006 (International Civil Aviation Organisation, 2007). The release reported improved capacity management in North America (a region which accounts for 34 per cent of the world's total scheduled airline traffic) and buoyant traffic conditions in Europe, Asia/Pacific, and the Middle East during 2006. The high growth environment reported in this news release and other factors, including airline de-regulation in China and India, resulted in an unprecedented demand for air transport pilots on a world wide scale. Flight training providers, civil aviation authorities and airlines around the globe were challenged to respond appropriately to this demand and efficiencies in pilot training were called for. The traditional pathway to the right hand seat of an air transport aircraft through an extended apprenticeship as a general aviation pilot came into question as the best way of serving the needs of the industry. More effective and efficient pilot training was required (Robinson, 2007). A revolutionary new licensing system for airline pilots, the multi-crew pilot licence, (MPL) was proposed by ICAO with trials beginning in Europe and Australia (Schroeder & Harms, 2007). Prior to the introduction of the MPL, changes to the conventional commercial pilot training curriculum to include multi-crew cooperation training became mandated by the UK CAA (London Metropolitan University, 2007). In order for New Zealand to remain competitive as a flight training provider and to efficiently supply well trained flight crew for its own airlines it has become imperative that this country also adapts to the rapidly changing training environment.

This study reviews professional pilot training in New Zealand and the way that newly licensed flight school graduates achieve a sufficient level of proficiency for entry into the air transport industry. It examines the competencies associated with proficiency in air transport pilots and the adequacy of the training provided for those competencies at basic pilot training level. It also explores how the perception of the value of these competencies and their training effectiveness changes with time and flight experience, and the relationship between those factors and air transport aircraft accidents. The study focuses on the New Zealand air transport environment where the needs of the industry are influenced in part by the country's isolated geographic position, small population, and high reliance on air transport.

Section 1. The Study Context

1.1 An Historical Overview

In the 1980s, in response to concerns expressed by the New Zealand aviation industry, the Director of Civil Aviation in New Zealand initiated a number of actions to improve the efficiency and effectiveness of flight crew training and certification. These actions resulted from the perceived need to improve the standardisation of flight crew testing and examination and in the wake of several overseas air transport disasters where a lack of good pilot decision making and cockpit resource management was identified as a contributing factor (Crook & Hunt, 1988).

The need for change in the way flight training and testing was conducted in New Zealand was recognised by the then Civil Aviation Division of the Ministry of Transport, and Massey University researchers were engaged to undertake a feasibility study for new pilot licensing specifications on behalf of the Civil Aviation Division (CAD). The researchers observed that while the individual quality and competency of New Zealand professional pilots was exceptionally high there was a need for a re-specification of pilot competency as the role of the pilot had changed from being the operator of a machine to that of being a manager of complex, highly automated systems, as a result of the introduction of a new generation of jet air transport aircraft (Hunt & Ashcroft, 1984).

In an earlier report to the Director of Civil Aviation, Crook (1982) recommended the introduction of a competency-based Private Pilot Licence curriculum in place of the existing hours based curriculum. Crook recognised that New Zealand was lagging behind the United Kingdom in that the Royal Air Force had adopted a systems approach to flight training in which student pilots were fully apprised of the instructional objectives and expected outcomes of each flight training sortie. In comparison with the RAF flight training, the Royal New Zealand Air Force pilot training was relatively unchanged from the Second World War pilot training models. A consequence of this was a flow-on effect in civil aviation pilot training. The RNZAF Central Flying School (CFS) had the responsibility of providing instructor training to civilian flying instructors through a Royal New Zealand Aero Club (RNZAC) training scheme. The scheme involved annual instructor camps whereby civilian instructors received refresher training from their RNZAF counterparts. This scheme served to perpetuate a well-entrenched wartime model of flight training which was successful at mass producing military pilots in times of national emergency but which took little or no account of the needs of the civil aviation industry (C. Crook, personal communication, 12 December 6th, 2007).

As a result of the Crook (1982) report and the Hunt and Ashcroft (1984) study, the CAD authorised further studies into the status of aviation training and licensing both in New Zealand and overseas. Following on from the Hunt and Ashcroft (1984) New Zealand report, the CAD commissioned an international review of pilot training. This review was conducted by Hunt and Crook in 1985 and involved visiting and studying the personnel licensing systems of the United States, Canada, and England. They concluded that there was a need for a new approach to flight training which incorporated human factors. There was also recognition that this was a major concern in international aviation circles and not just a New Zealand problem (Hunt & Crook, 1985). One finding of the review was that there was widespread agreement that the present pilot training curriculum had changed little from the one which had been in operation 40 years earlier and no longer served the needs of the aviation industry adequately (Hunt & Crook, 1985).

In a further initiative, the CAD contracted the New Zealand Council for Educational Research (NZCER) to undertake Project SAFE, an acronym for Systems Approach to Flying Evaluation. This study evaluated a competency-based system of flying instruction for the ab initio to first-solo stage of flight training (Livingstone, Reid, Croft, & St George, 1986). The SAFE project showed that it was possible to design standardised flying lessons leading up to the first solo flight which would ensure that the student pilot acquired a comprehensive repertoire of aircraft handling and manoeuvring skills. Such skills were identified as a necessary pre-condition for procedural flying and a pre-requisite for the development of pilot decision-making (Crook, 1999). Project SAFE encountered difficulties associated with research in an aero club environment. Crook observed that many of the student pilot subjects did not continue with their flight training for a variety of reasons and the small numbers of student pilots who remained were insufficient to achieve statistically significant results. In addition, a lack of resources and a low priority assigned by CAD hindered the study (Crook, 1999).

Building on these studies, a new research and development programme called Human Resources Development in Aviation (HURDA) was undertaken jointly by the CAD, the New Zealand Aviation Industry, and Massey University. The stated goal of the HURDA programme was to:

> *"Provide the New Zealand Aviation Industry with valid and reliable tests and examinations for flight crew licensing, on demand, from 1 April 1991".*
>
> (Crook & Hunt, 1988 p.1)

While the 1984 SAFE project used behavioural task analysis to establish the competencies for ab initio pilots training in the pre-solo flight stage, HURDA went a step further and used cognitive task analysis as a basis for flight crew standards development (Crook, 1999). While behavioural task analysis may be sufficient for analysing psychomotor and perceptual-motor tasks of a non-critical nature, cognitive task analysis is considered more appropriate for a large number of aviation tasks where performances are difficult to observe or verbalise or where the task is highly cognitive in nature (Seamster, Redding, & Kaempf, 1997). Crook observed that the CAD decision through the HURDA programme to apply cognitive task analysis in civil aviation was farsighted and commendable. The first comprehensive text on cognitive task analysis in aviation was published in the United States in 1997 so the HURDA programme pre-dated this by some 13 years (Crook, 1999)

Some of the anticipated long term effects of the HURDA programme included:

- Significant increases in the competence of flight crew at all licence and rating levels

- A reduction in accident rates attributable to flight crew error
- A significant improvement in aviation safety and productivity
- The emergence of New Zealand as a centre of excellence for all levels of flight crew education and training

(Crook & Hunt, 1988)

Unfortunately the HURDA programme was initiated at a time when the CAD itself was undergoing a period of restructuring as a result of the Swedavia-McGregor Report (1988). Crook (1999) reported that the effects of the restructuring had some adverse consequences not only for the CAD but the entire aviation industry in New Zealand. As a result of this and of a change of Government in 1990 the HURDA project was discontinued and a lot of flight crew curriculum development work was lost (Crook, 1999).

Hunt (1994), in reviewing some of the limitations of the existing traditional pathway to airline employment taken by newly qualified commercial pilots entering the airline industry through the general aviation industry, observed that airline entry often required little more than a Commercial Pilot Licence (CPL) and some ill-defined flight experience nominated by a particular airline. Candidates entering the airlines from a general aviation background displayed six typical characteristics:

- the students were trained not educated in aviation;
- there was an assumption that flight hours logged equalled experience;
- the experience gathering process was slow and unproductive;
- there was a lack of standardisation;

- there was a single pilot orientation;
- there was highly variable discipline due to the unsupervised nature of general aviation.

(Hunt, 1994)

The characteristics identified by Hunt (1994) showed that little progress had been made in the years since the HURDA programme had been abandoned and the New Zealand flight training industry was still using the same training model recognised in the reports of the 1980s.

1.2 Pilot Training in the New Millennium

The pilot training deficiencies identified by Hunt and Crook (1985) and Hunt (1994) continued to feature as industry concerns into the new millennium. Hunt (2000) reported the deficiencies in basic air transport pilot training more specifically:

- a widespread practice of providing flight instruction sequences independent of theoretical knowledge which should underpin the practice;
- no standardisation of the flight experience;
- single pilot orientation;
- primary focus on visual navigation;
- little requirement for procedural experience;
- little requirement for experience in advanced flight and navigational technologies;
- significant gap between the “CPL” entry level and competencies required for initial transition to air transport operations.

(Hunt, 2000)

An independent Government review of the New Zealand Civil Aviation Authority (CAA), found that while the large air carrier sector in New Zealand was serving the country well with a good safety environment there was a poor safety record among the smaller commercial and general aviation communities (Spruston & O'Day, 2001). As a result of the Government review, the CAA published a discussion paper called "Towards 2005" citing deficiencies in flight instruction, pilot skill deficiencies, and unstructured pilot training as the main areas of concern (NZCAA, 2001). Also reported in the discussion paper were skill and knowledge gaps between the graduates of flight schools and the skill and knowledge requirements of the New Zealand aviation industry. Although not elaborating on the specific nature of the skill and knowledge deficiencies, the report reflected many of the deficiencies identified by Hunt and Crook (1985) and Hunt (1994; 2000).

Concerns about present day pilot training standards were not confined to the New Zealand aviation industry. In 2003 a survey of European air transport operators conducted jointly by the Guild of Air Pilots and Air Navigators (GAPAN) and the European Pilot Selection and Training Group (EPST) determined that:

- many new pilots lacked knowledge of commercial aviation operations and/or the realities of an airline career;
- the gap between European pilot licence training and airline entry requirements had widened due in part to the low entry standards for Commercial Pilot Licence (CPL) training;
- there was an urgent need for a CPL training syllabus that addressed the requirement to handle and operate a two crew jet aircraft.

The survey concluded that aircraft handling skills together with the non-technical skills of team working, leadership, personality and customer awareness were the most important attributes and characteristics for success in an airline pilot career (GAPAN/EPST, 2007).

Further indications of basic pilot training deficiencies came from the American Federal Aviation Administration (FAA). In a flight instructor training module prepared for inclusion in FAA-approved flight instructor clinics the FAA observed:

> *The current flight training system has changed very little over the last 60-70 years. A private pilot trained to the standards outlined in the Civil Aeronautics Regulations, circa 1940 would likely do well in most of the operations required in today's practical test. This is because many of the basic skills needed to pilot an aircraft have changed very little……however the development of new techniques and rapidly evolving airspace systems has outpaced current training methods.*
>
> (Federal Aviation Administration, 2005 p.8)

It is interesting to compare the FAA (2005) observations with those of Hunt and Crook (1985) twenty years earlier. The observations indicate a lack of change in basic flight training over that period:

> *"Aviation has experienced rapid and massive technological advances since the end of the second world war; however, no comparable developments have taken place in the basic training programmes for pilots or flight instructors……..little change from what was in operation 40 years ago".*
>
> (Hunt & Crook, 1985, p.8)

The FAA (2005) training document noted that the FAA and the flight training community had over a century's worth of experience to draw on when determining how best to train pilots. The observation was made that:

> *While the military and airline communities have leveraged this experience, the general aviation community has been slow to make use of the lessons learned. What has resulted from the GA community's failure to adapt? In the vast majority of fatal GA accidents, the root causes were found to be a lack of situational awareness and poor decision making. Currently, pilot training standards focus less on these factors, and more on the development of mechanical, or "stick and rudder skills." While such skills must never be neglected, most fatal accidents are not a result of deficiencies in these areas.*
>
> (Federal Aviation Administration, 2005 p.9)

1.3 The Research Problem

While the projected outcomes of the HURDA programme have never been fully achieved, the goals and objectives remain relevant to the present day. The HURDA plan, together with the work of various researchers, identify differences between CPL graduate standards and the competencies required for initial transition to air transport operations (Hunt & Crook, 1985; Hunt, 1994; 2000; GAPAN/EPST, 2003). A similar gap between the skill and knowledge needs of the New Zealand aviation community and the actual skills and knowledge demonstrated was also identified in the New Zealand CAA discussion paper (Spruston & O'Day, 2001). The purpose of this study is to establish more specifically the nature of the skill and knowledge gap between flight school graduates standards and airline entry requirements.

The remaining sections of this chapter will examine how skill is developed both in the general learning environment and in the context of pilot training. The literature on the development of skill and expertise in a variety of professions will be reviewed to determine similarities and differences between different occupations and to identify common threads. Airline proficiency training programmes will be examined in detail to identify the competencies that define proficient airline pilot performance.

Section 2. Skill Development in Basic Flight Training

In the previous section mention was made of the skill and knowledge gap that exists between the graduates of New Zealand flight training organisations and the requirements of the airlines that ultimately employ the graduates. Hunt (1994) described how flight experience was gained, often in a protracted and inefficient way, as newly graduated pilots entered the general aviation industry and served there for a number of years until they could achieve the airline entry experience requirements. This section explores the widely held assumption that the skill and knowledge gap is somehow addressed by gaining extra on-the-job experience. The CAA prescribed flight experience requirements are also examined to determine their influence on basic flight training programmes, as well as a sample of airline entry experience requirements. Finally an analysis is made of the present CAA part 61 CPL flight test requirements .to examine how the emphasis on technical skills in flight tests influences flight training.

2.1 Flight Experience as a Measure of Pilot Skill

In aviation, pilot skill has traditionally been linked to the amount of flying experience accumulated. Pilots are required by law to log every flight they make and to present a properly maintained logbook when undergoing flight tests for the gaining, upgrading, or maintenance of flying qualifications. Unlike most occupations, the pilot's working life is carefully recorded in terms of hours and minutes in the air. The pilot's logbook contains a complete record of the pilot's work experience (NZCAA Rule Part 61A-29, 2007). For licensing purposes Civil Aviation Authorities stipulate minimum flight experience requirements as prerequisites for the issuing of pilot qualifications (CAA Rule Part 61A to G, 2007). The pilot's logbook is also proof of flight experience, as potential employers require a minimum number of hours flight experience either as pilot in command, co-pilot, or on a certain type of aircraft, or flying operations. Based on the assumption that flight experience is an indicator of skill and knowledge, the more hands-on experience the pilot has accumulated the more proficient he or she is likely to be.

The requirement for recording flight time makes it easy to make simple comparisons between flight experience and proficiency levels. In this respect novice pilots can expect to achieve their first solo flight after a minimum of about 8 to 12 hours total flight experience (though this figure can be considerably higher), a private Pilot Licence (PPL) can be gained with about 50 hours total flying experience (NZCAA Part 61D, 2007), while the first professional pilot qualification, the Commercial Pilot Licence (CPL), can be gained with a minimum of 200 hours (NZCAA Part 61E, 2007). The top professional licence for pilots is the Airline Transport Pilot Licence. This qualification can be obtained after 1500 hours of experience (NZCAA Part 61F, 2007).

The minimum experience requirements for obtaining flying instructor qualifications range from 200 hours total flight experience for the most basic qualification, the C category instructor rating, 500 hours including 200 hours of flight instructional experience for a B Category, while the top A category instructor rating requires 1250 hours total experience including 750 hours flight instruction (NZCAA Part 61G, 2007). During their working lives professional aviators typically accumulate flying experience at the rate of several hundred hours per year. FAA rules permit flight crew members to log a maximum of 1000 hours a year on commercial operations. Making a conservative estimate, airline pilots who have spent the greater part of their working life employed as a professional pilot will retire having logged between about 10,000 flying experience at the lower end of the scale and in excess of 25,000 hours flying experience at the upper end (Federal Aviation Administration Rule Part 121-471, 2008)

Experience requirements for pilots entering the airlines are also quite variable. Inspection of a pilot recruitment website suggests that the qualifications and experience requirements for employment by a sample of New Zealand and Australian airlines are quite variable but indicates that most operators require at least 1000 hours total experience. Table 1.1 shows typical technical qualifications and experience requirements for airline employment.

Table 1.1. *Airline entry requirements*

Company	Qualification	Total Experience (hours)	Multi-Engine Experience
Eagle	CPL	1000	200
Mount Cook	ATPL theory	1500	
Air National	ATPL theory	500	100
Skytrans		1500	300
Skippers	ATPL theory	1900	500
Rex	ATPL theory	800	350
O'Connor	ATPL	1000	500

Constructed from information retrieved 8th January 2008 from http://www.jobseeker.pilot.staffcv.com/public/login.asp?pb=true

Table 1.1 shows that the airline entry experience requirements are considerably in excess of the minimum experience required for the issue of a Commercial Pilot Licence. The actual hours required by airlines when recruiting pilots will vary according to supply and demand, with airlines lowering their experience requirements in times of expansion and high pilot demand. In times of low or modest pilot demand, higher hours are expected and as competition increases among the pilot population for access to the limited positions available, flight hours logged becomes an important part of the selection criteria. The expectation is that on graduating from basic flight training the aspiring airline pilot will enter the general aviation industry and accumulate experience in the very environment that the CAA review identified as having a poor safety record, before gaining entry to the superior safety environment enjoyed by the major airline (Spruston & O'Day, 2001).

The concept of flight experience increasing pilot capability may oversimplify the development of a complex set of piloting skills. In a study on the components of car driving skills, Duncan et al. (1991) observed that driving skill experience alone was no guarantee of driving expertise. Good feedback on car handling skills helped novice drivers to perform better than more experience drivers who had not received feedback. In the teaching profession, Britzman (1987), cited in Pinnell, DeFord & Lyons, (1995) proposed that the assumption that experience equated to expertise was a myth and experience needed to be critically examined if any value was to be gained from it (Pinnell et al., 1995). As argued by Hunt (1994), there is no certainty that increased experience will always bring increased skill and knowledge because no allowance is made for the nature of the experience nor the manner in which it is accumulated. Often new pilots are left to their own resources to gain experience in an unstructured way with little or no additional training, supervision, or feedback. The quality of the operational experience gained in this manner may be significantly less than a smaller amount of operational experience gained under close supervision.

2.1 The Focus of New Zealand Professional Pilot Training

The traditional training focus in General Aviation has been on the technical aspects of flight and an individual pilot's aircraft handling skills. The less clearly defined criteria of resource management, decision making and other human factor issues have only recently been recognised as important indicators of overall pilot performance (Freedman, 1998). The emphasis on technical skills can be seen by inspection of the NZCAA flight test requirements for the commercial pilot licence. When the NZ CAA Rule Part 61E requirements for the Commercial Pilot Licence flight test are examined and a list of the individual flight test items compiled as they appear on the flight test proforma it is possible to classify each test item as either a technical or non-technical skill (NZCAA AC61-5, 2007). The technical skills involve all the 'stick and rudder' skills associated with the actual control of the aircraft together with the additional skills associated with the physical operation of the aircraft systems. Non-technical skills covered in the CPL flight test include those skills and activities associated with the successful management of the flight excluding control and systems manipulation. Table 1.2 shows the Part 61 Commercial Pilot Licence flight test items and skills classified as technical or non-technical skills.

Table 1.2 *Part 61 CPL Flight Test – Technical and Non-technical Skills*

Test item	Technical Skills	Non-technical skills
Personal preparation		√
Aircraft documents	√	
Weather	√	
Aircraft performance	√	
Fuel management	√	
Aircraft loading	√	
Pre-flight	√	
Passenger briefing		√
Engine start	√	
ATS procedures		√
Taxiing and brakes	√	
Engine checks	√	
Pre take-off checks	√	
Normal take-off	√	
Crosswind	√	
Short field	√	
EFATO	√	
Climbing	√	
Straight and level	√	
Medium turns	√	
Climbing turns	√	
Steep turns	√	
Maximum rate turns	√	
Stalling	√	
Descent	√	
Instrument flight	√	
Forced landing	√	
Low flying	√	
Approach and landing	√	
R/T procedures		√
Lookout		√
Flight orientation		√
Pilot judgement		√

Table 1.2 demonstrates how New Zealand flight training for CAA Rule Part 61 pilot qualifications involves learning both technical and non-technical skills or as they are called respectively, 'hard' and 'soft' skills. The table shows that the Part 61 flight test for the Commercial Pilot Licence is composed of approximately 90% of technical skills such as aircraft handling within clearly defined performance criteria with non-technical skills such as airmanship making up the balance of the test. Preparing for a career as a professional pilot as opposed to just gaining a licence or rating involves the acquisition of a large portfolio of non-technical skills. Van Avermaete (1998) defined non-technical skills as those skills referring to the pilot's attitudes and behaviours in the cockpit which were not related to the actual control of the aircraft and its systems, or standard operating procedures. This study argues that while technical skills are important and continue to develop with experience, it is the non-technical skills, developed as a result of pilot education and flight experience, which differentiate the professional aviator from the recreational or amateur pilot.

The current licensing models based on Annex I of the Chicago Convention of 1945, emphasise the accumulation of flight time as a key predictor for experience and the development of technical skills (Hunt, 2000). In order to develop the appropriate skills, a paradigm shift is needed from the traditional Rule Part 61 focus on training directed to achieving the technical competencies prescribed for a professional pilot licence to a broader base of competencies, including non-technical skills which are directed towards training for a career as a professional aviator.

Section 3. Skill Development in the General Learning Environment

Developing skill is a progressive process involving the investment of time and effort. The possibility of a skill and knowledge gap in New Zealand pilot training and the expectation that skill and knowledge will develop with increasing flight experience has been explored in previous chapters, as well as the importance of non-technical skills as a characteristic of professional pilots, as proposed by Van Avermaete (1998). The purpose of this chapter is to examine the skill development process in a more generic sense. A range of literature on skill development was reviewed covering a period of 35 years and several key characteristics identified.

3.1 Skill Development

During the acquisition of a skill a student progresses through several distinct stages during the learning process. The Collins English Dictionary (Butterfield, 2003 p.1513) defines skill as *"something, especially a trade or technique, requiring special training or manual proficiency"*, or *"ability acquired by training"*, and suggests that skills result from interventions such as training, education, or repeated practice rather than personal characteristics or abilities. Supporting this definition, Proctor and Dutta (1995) observed that skills are behaviours that are acquired as a result of practice and repetition and are goal orientated and economical of effort.

Earlier researchers argued that skill development proceeded in phases. Fitts and Posner (1967), in considering the acquisition of everyday life skills such as car driving, identified three phases of skill development. These included an initial cognitive phase, where the individual learns the underlying structure of the activity, an 'associative' phase, where an acceptable level of performance is achieved, and an 'autonomous' phase, where the individual can achieve an effortless performance in a speedy manner. In a seminal study of chess players, Simon and Chase (1973) proposed a 10 year rule to expertise based on the observation that no modern chess player had reached international standard in less than 10 years of playing[1]. The 10 year rule was supported by Ericsson, Krampe, & Tesch-Romer (1993) who observed a similar time span in such diverse activities as musical composition, sport, science, and arts. Glaser (1976) also proposed that skill develops in a series of stages with the student progressing through several distinct stages during which the following behavioural changes may occur. The student will initially be slow and awkward. As experience is gained there is an improvement in speed, accuracy, and performance. The students' confidence will increase as attention is shifted from isolated variables to broader and more complex patterns.

In later research, Dreyfus and Dreyfus (1980) observed that skills are both acquired and developed. Skill acquisition can be the result of imitation or trial and error or, more efficiently through training and instruction. According to Dreyfus and Dreyfus, the acquisition of skill involves four basic mental functions; recollection, recognition, decision making, and awareness. During the

[1] Simon and Chase (1973) noted that it was very rare for a person to reach Grandmaster status in chess with less than 10 years of intensive, fulltime study.

development of a skill, changes take place to these four basic functions. Dreyfus and Dreyfus proposed five stages of skill development; novice, competent, proficient, expert, and master. With each stage of development the four basic mental functions change from a primitive form to a sophisticated form, the attainment of which is a prerequisite to progression to the next stage. Dreyfus and Dreyfus observed that when progressing from novice to expert, the student's experience changes in three general areas of skilled performance. There is a movement from a reliance on abstract principles to using past experiences as paradigms, their perception of demanding situations changes from being a compilation of equally relevant 'bits' to being more of a complete whole in which only certain parts are relevant. Finally a general area of performance is reached when the learner becomes a performer, standing no longer outside the situation but being fully integrated into the situation.

Klein and Hoffman (1993) described novices as beginners in the learning process who have little experience of the situation in which they are expected to perform. The novice learns initially to identify features in the task world that can be recognised without situational experience and are limited to context free rules. This results in behaviour that is limited and inflexible. Advanced beginners, can with assistance, begin to recognise recurring, meaningful situational components. They need assistance to help set priorities and as they operate on general guidelines are only beginning to recognise recurrent, meaningful patterns. Competency is achieved when individuals can see their actions in terms of long-range goals or plans. As a competent performer, the individual is able to consciously formulate, evaluate, and modify goals and, while lacking in speed or flexibility, has a sense of mastery and the ability to cope with and manage a variety of types of situations. Klein and Hoffman identified two additional levels of skilled performance; proficient and expert. The proficient performer recognises situations and knows what events are typically associated with the situation. The proficient performer can also recognise when the situation is atypical and can modify plans and goals appropriately. The expert, drawing on a large background of experience, can intuitively and accurately focus on the problem without recourse to rules, guidelines and maxims, and his or her performance is fluid and flexible and highly proficient. The characteristics of the different levels of expertise from novice to expert are described in Table 1.3.

Table 1.3 *Levels of Expertise*

Novice
Beginners have little experience of the situation in which they are expected to perform. Their initial learning about the situation is in terms of objective attributes-those that are measurable. These are features of the task world that can be recognised without situational experiences. Novices are limited in their understanding to context free rules that guide action-this means their behaviour is limited and inflexible.

Advanced beginner

They have coped with enough real situations to note (or have had pointed out to them) recurring, meaningful situational components. At this level, understanding of aspects of the situation is limited to global characteristics that reflect prior experience in actual situations. Advanced beginners need help setting priorities, because they operate on general guidelines and are only beginning to perceive recurrent, meaningful patterns.

Competent

Performers at a journeyman's level can see their actions in terms of long-range goals or plans. They are consciously aware of formulating, evaluating, and modifying goals-plans. The competent performer is able to generate plans in terms of current and contemplated future aspects that are most important, and those that are not. The competent performer lacks the speed and flexibility that emerges at higher levels of expertise but has a sense of mastery and the ability to cope with and manage a variety of types of situations

Proficient

Proficient performers perceive situations as wholes, rather than in terms of situational components. Their performance is guided by 'maxims." Perception is key. The perspective is not thought out but "presents itself" based upon experience. The proficient performer has learned what typical events to expect in a given situation and how plans need to be modified in accord with these events. This also means that she or he can recognise when the expected typical picture does not materialise and can modify plans and goals accordingly. Situational aspects stand out as more or less important in *this* situation.

Expert

Expert performers no longer rely on analytic principles (rules, guidelines, maxims) to connect their understanding of the situation to an appropriate action. The expert, with an enormous background of experience, has an intuitive grasp of each situation and zeros in on the accurate region of the problem without wasteful consideration of a large range of unfruitful, alternative diagnoses and solutions. The performer is no longer aware of features and rules, and his or her performance becomes fluid and flexible and highly proficient.

From *Seeing the Invisible: Perceptual-Cognitive Aspects of Expertise* (p.203) by G.A. Klein and R.R. Hoffman, 1993, Hillsdale New Jersey: Lawrence Erlbaum Associates

Ericsson et al. (1993) found that acquiring expertise is a long term process that requires many years of gradual, steady improvement. They observed that even the performance of child prodigies in music and chess, whose performance was vastly superior to that of their peers, continued to develop past the age of physical maturity. When considering performance development in sport, Ericsson et al. observed that the highest level of performance in vigorous sports occurs in the mid to late 20s age group and for the arts and science, over a decade later in the 30s and 40s. Experience and duration of involvement in a domain is not, however, on its own a guarantee that superior performance will be achieved. Ericsson (2002) observed that a century of laboratory research has revealed that effective performance development depends on three things; focused goals, feedback that enabled a comparison to be made between actual performance and desired performance, and sufficient opportunity for repetition so that the desired performance standards can be achieved.

Earlier in this chapter reference was made to the work of Fitts and Posner (1967) who proposed that everyday life skills develop in three stages: an initial cognitive stage; an associative stage; and an autonomous stage. According to Fitts and Posner the autonomous stage is characterised by the achievement of an effortless performance in a speedy manner. In a later study, Ericsson (2002) proposed that the autonomous stage can be gained in as little as 50 hours of practice for most recreational activities. Ericsson observed that at this point increased experience will not necessarily ensure increased accuracy. The individual, having experienced an initial steady improvement in performance through the expenditure of effort, reaches a performance level, which is found acceptable and loses conscious control over intentionally modifying or changing it. To progress further it is necessary for the individual to avoid the arrested development associated with the attainment of automaticity by deliberately acquiring and refining cognitive mechanisms to support continued learning and improvement. To improve performance it is necessary to avoid complete automisation by seeking higher performance goals through deliberate practice and reflective analysis. This observation by Ericsson supports the argument that the accumulation of flight hours in an unstructured and unfocused way does not necessarily result in improved pilot proficiency.

One of the criticisms of *ab initio* pilot training and pre-requisite experience for airline employment made by Hunt (1994) was that:

> *Criteria for the award of a private or professional licences and minimum hours prior to airline type training are based on prescribed flight hours. Little attention is paid to how those hours might have been achieved, nor the types of environment or human factor conditions which might be required to optimise acceptable performance. The broader disciplines for problem solving, decision making, and multi-crew performance are absent.*
>
> (Hunt, 1994 p.5)

Similarly a problem area identified in the CAA Toward 2005 Aviation Safety Plan (NZCAA, 2001) was one of inadequate industry supervision in New Zealand. It was reported that:

> *Guidance and supervision is lacking during a pilot's early development, and there is an absence of formal training after licence issue. Instructor supervision is inadequate and retention levels are not good. There is a lack of supervision in the private owner sector and there are deficiencies in airmanship, decision-making and skills.*
>
> (NZCAA, 2001 p.2)

3.1 Developing Expertise in Academic Domains

An alternative view of the development of expertise is offered by Alexander (2003), who recognised that much of the research of the 1970s and 1980s on expert/novice theory centred on the problem solving performance of experts with the primary goal of determining the characteristics and actions of experts and incorporating these features in the training of "non-experts". According to Alexander, there has been extensive research in expert/novice theory but this has not translated into educational practice.

Alexander (2003) proposed a model known as the Model of Domain Learning (MDL). The MDL identifies three stages of expertise development: acclimation, competence, and proficiency/expertise as well as two forms of subject matter knowledge; domain knowledge, which is the breadth of knowledge that the individual possesses about a particular field, and topic knowledge, which is the depth of knowledge that an individual possesses or develops about specific domain topics. As the individual progresses towards expertise, the model emphasises the qualitative and quantitative changes in their knowledge database (Alexander, 2003). Similarly, qualitative and quantitative changes in the individuals' surface-level and deep-processing strategies during text based learning were observed by Alexander. The model also proposes two forms of interest in expertise development. These include individual interest which is the investment that the learner has in a particular domain or part of it, and situational interest, which is the arousal of interest by events or features of the environment.

According to Alexander, acclimation is the initial stage of domain expertise. During this stage the learner is orientating to a complex and unfamiliar domain. The learner has limited and fragmented knowledge and is hampered in his or hers ability to discern between accurate and inaccurate and relevant and tangential information.

During the next stage of development, the competence stage, the learner experiences quantitative and qualitative changes to his or her knowledge base. Alexander observed that the competent individual was able to demonstrate a foundational body of domain knowledge and that the knowledge was cohesive and principled in structure. Competent learners were able to apply a mix of surface-level and deep-processing strategies. There was an increase in the individual's personal interest in the domain and less dependence on situational features in the environment.

Moving from the competence stage to the proficiency/expert stage, Alexander (2003) observed the development of a synergy between the components which marks the transition from competence to expertise. The knowledge base of the expert is both broad and deep and the expert is able to bring new knowledge to the domain. The expert is able to employ deep-processing strategies to push the boundaries of the domain by questioning, investigating and researching. Alexander also observed that the expert has a very high level of individual interest in the domain which allows the expert to maintain a high level of engagement over extended periods of time. While the MDL as proposed by Alexander was developed for high school students in the general academic domain, she emphasises that the journey towards expertise is on-going:

> *Even those who have attained the knowledge, strategic abilities, and interests indicative of expertise cannot sit idly by as the domain shifts under their feet. We, thus, do a disservice to learners by conveying the idea that learning some set body of facts or procedures is the educational end. Rather, those skills and processes are but the means that allow learners to thrive within academic territories that are challenging and uncertain.*
>
> (Alexander, 2003 p.12)

3.2 Developing Expertise – A View from the Accounting Profession

In a paper on competency based standards for professional accountants, Birkett (1993) describes competency as the way in which individual attributes such as knowledge, skills, and attitudes are drawn on in performing tasks in a particular work context. Neither contextual task performance nor individual attributes constitute competence; it is the relationship between them that does. Competence, thus, cannot be observed, though it can be inferred from task performance (in context) or individual attributes or both (Birkett, 1993). Figure 1.1 illustrates the competency model proposed by Birkett.

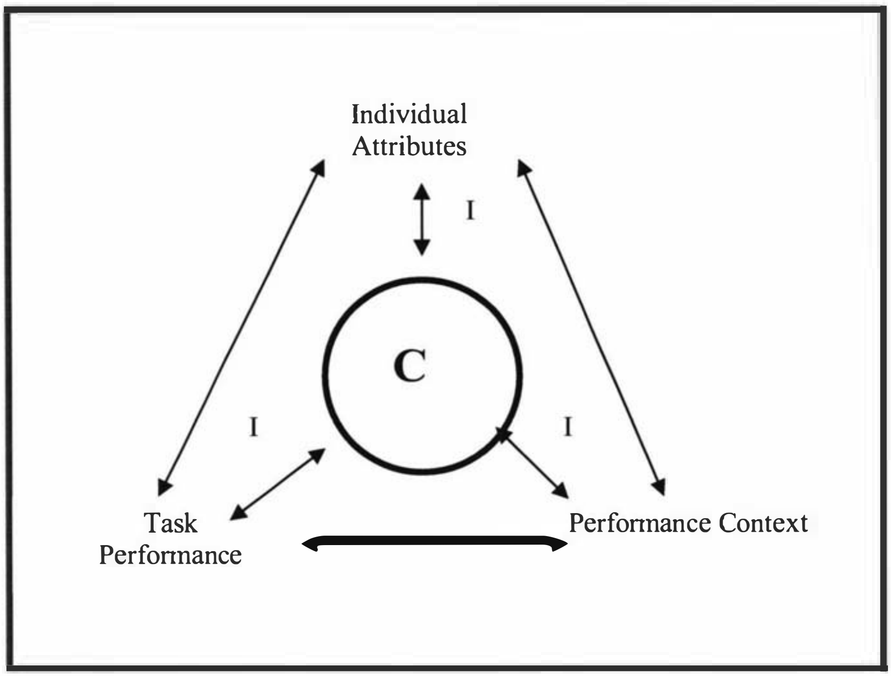

Figure 1.1 Birkett's Competency Model

From *"Competency Based Standards For Professional Accountants in Australia and New Zealand"* by W.P.Birkett, 1993, (p.4). Link Printing Pty Ltd, Sydney

Birkett defined competency as the demonstration of the successful negotiation of a range of task/context configurations through the selective use of individual attributes. This required the use of different individual attributes depending on the type of task or the context of the task. The individual attributes referred to by Birkett included both cognitive skills and behavioural skills. Cognitive skills include technical skills, analytic/constructive skills, and appreciation skills (the ability to make complex and creative judgements in situations of ambiguity). Behavioural skills include personal skills, interpersonal skills and organisational skills. Together these sets of skills comprise what Birkett described as a skills taxonomy. The skills taxonomy demonstrates a high dependency on technical and personal skills at the early stages of the individual's career and with an increasing emphasis on analytical/ constructive skills and finally appreciative and organisational skills at more advanced career stages. Figure 1.2 shows how these skills are derived.

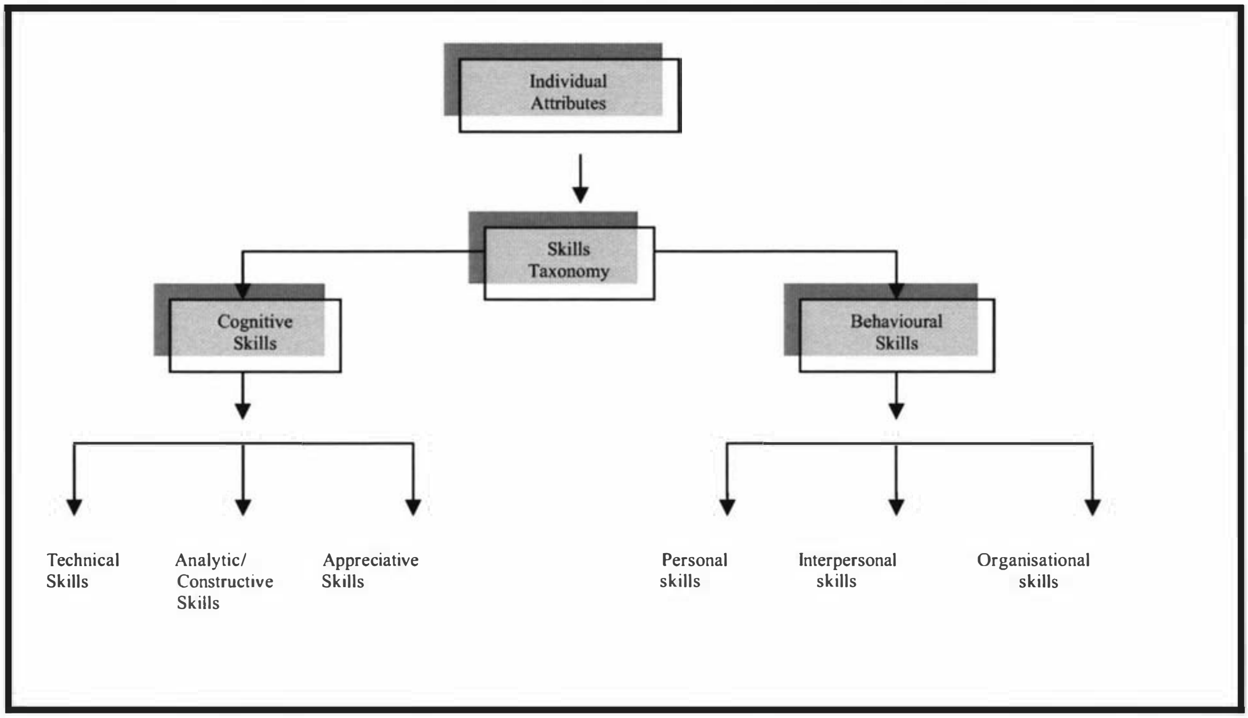

Figure 1.2 Birkett's skill taxonomy
From *"Competency Based Standards For Professional Accountants in Australia and New Zealand"* by W.P.Birkett, 1993, (p.15). Link Printing Pty Ltd, Sydney

For the professional accountant role, Birkett (1993) proposed a schema which tracked career progression (in terms of experience gained) and hierarchy (in terms of expertise levels) within the occupation. The schema identified several key stages of the accountant's professional development. The novice is a person without situated experience who is undergoing formal education. At the end of the formal educational period the novice enters the category of 'advanced beginner' – a person who has had some situated experience and can be used as a resource in pursuing a role. At the other end of the scale is the expert – a person described by Birkett as being able to utilise significant experience, gained across a wide range of situations. In between these extremes, Birkett proposed two other categories – the proficient practitioner, a person with less experience than the expert, in terms of significance and range, and the competent practitioner, who was described as a person who has sufficient experience to be autonomous in planning the performance of a role, but insufficiently experienced to have built up a repertoire of plans to fit the range of situations that might be encountered within an element of competency. Birkett identified the 'competent practitioner' as being the entry point to the profession of accounting. This is illustrated in Figure 1.3.

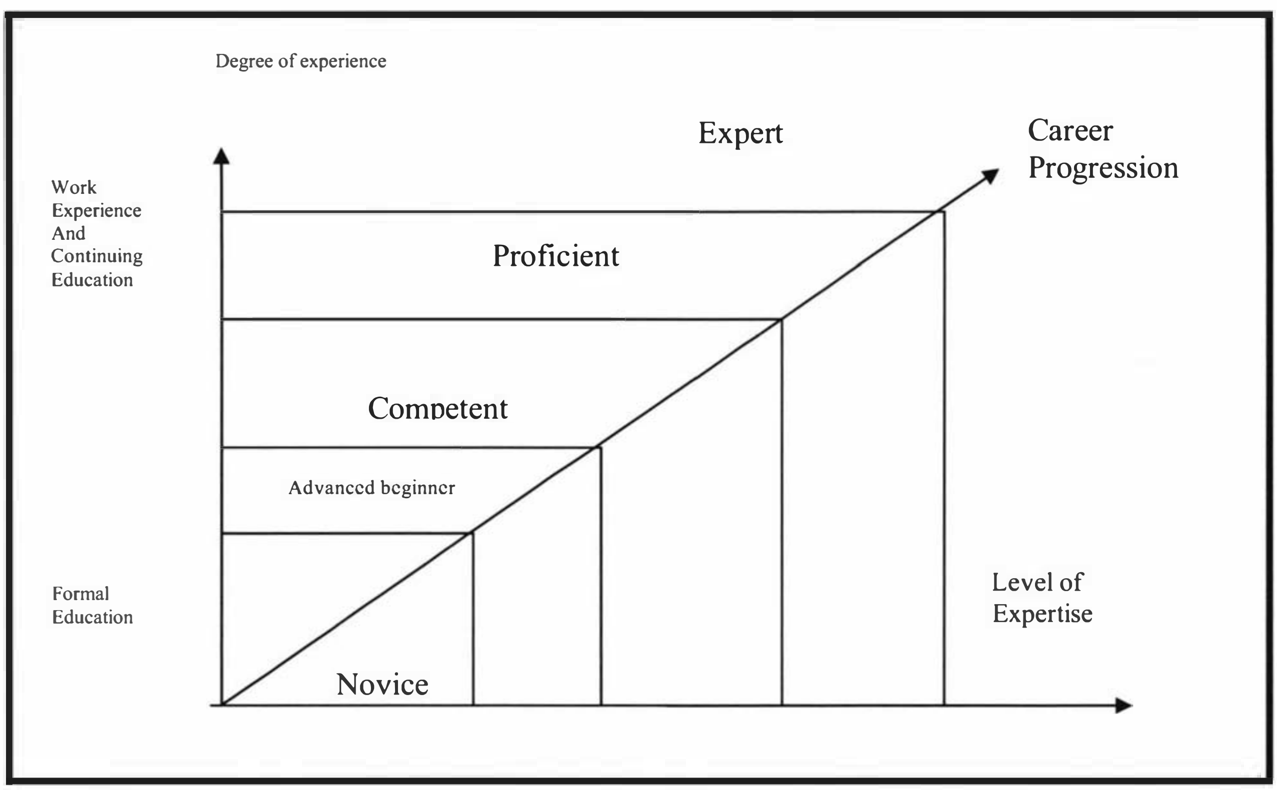

Figure 1.3 Birkett's Career Progression and Hierarchy

From *"Competency Based Standards For Professional Accountants in Australia and New Zealand"* (p.16) by W.P.Birkett, 1993, Link Printing Pty Ltd, Sydney

The schema proposed by Birkett is of particular interest in the pilot training field as it demonstrates how experience and continuing education are related to career progression and how the state of expertise cannot be a fixed or finite condition as such a person will need to continue to grow and develop to keep up with changes within the domain as new fields of knowledge and skill develop.

3.3 Conclusion

This section demonstrates that the acquisition of skill is a progressive process. The literature indicates that in any endeavour involving the development of skilled performance, there are distinct stages which can be defined as novice, advanced beginner, competent, proficient, and expert. For the professional in any discipline, progression through these stages involves not only the element of time but also requires a strategic focus based on sound formal education and continuing education, work experience and feedback. Of importance in the aviation sphere is the relatively short time required to attain a state of autonomy where the pilot's performance peaks and further development is arrested. To move beyond this state total autonomy must be avoided by deliberately acquiring and refining cognitive mechanisms to support continued learning and improvement (Ericsson, 2002). This has important implications for flight school graduates who aspire to a career as a professional pilot. In the aviation context the development of expertise is similar to the examples discussed in the literature. Simply stated the evidence suggests that aviation skills will also conform to the following:

- it is a progressive process which takes time with the trainee pilot passing through several stages during the learning process;

- there must be a solid base of formal education to begin with then the opportunity for continuing education as experience is gained under actual working conditions;

- there must be adequate feedback to enable the new pilots to assess their performance against specific performance standards;

Section 4. Flight Training and Assessment: Developing the Professional Pilot Skills

In the previous section, the development of skill in the general learning environment was examined. A review of the literature revealed that skills, once acquired, develop in stages, and time and repetition brings about fundamental changes to basic mental functions which define the stage of expertise the individual has reached. There was agreement in the literature that the journey from competency to proficiency and expertise required three basic items: time, focused goals, and feedback. The purpose of this section is examine the progression from competency to proficiency during the pilot's career and how the development of skills gained during basic flight training and in the general aviation environment prepares the student for the role of professional pilot, and eventually to a career as an airline pilot.

4.1 The Stages of Skill Development

During their career, professional pilots progress through several distinct levels of skill development, starting as a novice at a flight training school and, possibly after many years of experience, becoming an acknowledged expert in some defined branch of the profession for example an airline pilot (Fallucco, 2002). This developmental process is not unique to aviation but applies to the development of any craft or skill. The student pilot at a flight school is licensed to operate as a pilot once their performance, as defined by the prescribed licencing standard, has been assessed as competent (NZCAA Rule Part 61E, 2007). While an assessment of 'competent' ensures that the pilot can operate a light aircraft safely, it does not necessarily mean that the pilot is capable of operating that aircraft at the level of performance expected for commercial air transport operations or even to be selected by an airline to undergo role training as an airline pilot. To progress past this point the assessment of 'proficient' as defined by Birkett (1993) is more appropriate for entry into airline training. A clear distinction between the two skill levels is required.

4.2 Competent Pilot Performance

An everyday definition of competence as *"adequately qualified or capable,"* suggests a minimum rather than a high standard of performance (Allen, 1991 p.232). Klein and Hoffman (1993), when describing levels of expertise, refer to the competent performer as being a journeyman displaying the following characteristics:

> *While lacking the speed and flexibility that is associated with higher levels of expertise, the competent performer is able to formulate long-range goals and plans, is consciously aware of formulating, evaluating, and modifying goals or plans, is able to prioritise plans according to level of importance and has a general sense of mastery and is able to cope with a variety of situations.*
>
> (Klein & Hoffman, 1993 in Rabinowitz, 1993, p. 206).

Applying the Klein and Hoffman journeyman analogy (Table 3.1), the competent pilot would be one who is able to handle an aeroplane within the manoeuvre limits prescribed by the licensing authority and act as pilot in command of a light aircraft on single pilot IFR flights. Birkett (1993) provides a definition of a competent practitioner as one who has sufficient experience to be autonomous in planning the performance of a role but who lacks the experience to build a repertoire of plans to fit the range of situations that might be encountered. This definition might also apply to a newly licensed pilot with limited experience. Epstein and Hundert (2002) provide a wider perspective on professional competency within the medical profession. As with the examples provided by Klein and Hoffman, and Birkett (1993), the definition proposed by Epstein and Hundert can be applied to the role of the professional pilot. Epstein and Hundert define professional competence as:

> *"The habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values, and reflection in daily practice for the benefit of the individual and community being served"*
>
> (Epstein & Hundert, 2002 p.226).

Hagar and Gonczi (1996) observed that competency could be viewed in several very different ways. If competency is considered to be the achievement of a certain performance there is a tendency to think of it as the achievement of a series of discrete task descriptions. This is what Hagar and Gonczi call the behavioural or 'checklist' approach. According to Hagar and Gonczi the 'checklist' approach may ignore higher level competencies such as planning and reacting to contingencies with the result that these may be omitted from training and assessment programmes. Another more generic view of competency described by Hagar and Gonczi is the possession of a series of desirable attributes including knowledge of appropriate sorts, skills and abilities such as problem solving, analysis, communication, pattern recognition, and attitudes of appropriate kinds. This generic view of competence can be incorporated in training and assessment programmes.

This view is supported by the definition of Epstein and Hundert (2002) who described professional proficiency in medical practitioners.

Hagar and Gonczi (1996) warned, however, that even this generic model is open to criticism. The generic approach to competency training and assessment focuses on each of the separate attributes. While this approach may be seen as a way of capturing the less predictable variety of non-routine work roles it has attracted severe criticism on the grounds that assessing attributes in isolation from actual work practice bears little relation to future occupational performance. As competence in the desirable attributes nominated by Hagar and Gonczi is highly context dependent any attempt to teach and assess the attributes in isolation from actual work situations can result in the further problem of transfer to the actual work context. In response to the criticisms concerning the generic approach, Hagar and Gonczi proposed an integrated conception of competence which they described in terms of knowledge, abilities, skills, and attitudes in the context of a carefully chosen set of realistic professional tasks. These tasks must be central to the practice of the profession according to Hagar and Gonczi.

The behavioural or checklist approach was described by Hagar and Gonczi (1996) as being the most widely held view of competence where work is broken down into a series of relatively simple, repetitive tasks which are performed in a standard, unchanging way. The task in effect becomes the competency. This approach ignored the connection between tasks, underlying attributes that may be crucial to performance, and the reality of the complexity of performance in the real world. In basic flight training, this behavioural approach is applied in the flight tests and assessments prescribed by regulatory authorities such as the NZ CAA. Candidates for licences and ratings are required to demonstrate competency in a series of discrete performances e.g. steep turns, stalling and recovery, bad weather low flying, and executing a forced landing without power. The performance of each task is assessed as satisfactory or unsatisfactory against a checklist of performances pertaining to the test. This behavioural approach to assessment influences the way in which flight instruction takes place as a good deal of the instructional time is devoted to teaching and improving individual performances in preparation for the final flight test. In some cases, the perceived preferences and idiosyncrasies of individual examiners influence the training so that the candidate can demonstrate the expected behaviour during the test. When using the integrated approach, competence is seen as a construct inferred from the performance of complex and demanding tasks in a holistic rather than a discrete or independent context, such as in a typical work situation. The competency standards included the notion that the worker or student must take into account the varying contexts in which they are operating. According to Hagar and Gonczi the integrated approach provided a balance between misguided extremes of fragmenting the occupation to such a degree that its character is destroyed by the analysis or adhering to a “rigid, monistic holism” that rules out all analysis (Hagar & Gonczi, 1996, p17). They state that:

> *When competence is conceptualised via the integrated approach in terms of knowledge, abilities, skills and attitudes displayed in the context of realistic professional tasks, the scope for assisting educational providers is greatly enhanced. Rather than recommending the adoption of narrow forms of competency-based training, the integrated approach, by also emphasising requisite knowledge, abilities, skills and attitudes, offers powerful guidance for improvement of traditional courses in respect of content, teaching strategies and assessment procedures.*
>
> (Hagar & Gonczi, 1996 p.17).

In pilot training, the integrated approach to competency changes the emphasis from teaching the individual, distinct tasks aimed at satisfying a checklist of items in a flight test to the much more comprehensive and holistic goal of operating an aircraft in the context of a particular role or operation. For example aircraft handling tasks such as steep turns, stalling, climbing and descending become ‘aircraft performance management’ in the context of air transport operations.

4.3 Proficient Pilot Performance

As discussed in the previous section the development of expertise is a progressive process which proceeds through a series of stages from beginner to expert and requires a focus on sound initial formal education and the accumulation of work experience together with continuing education. Klein and Hoffman (1993) argued that proficient performers have achieved a level of expertise that is characterised by their perception of whole situations rather than components of situations. Because of this the performer can intuitively anticipate the events that are associated with a given situation and can modify actions speedily and efficiently if these events do not materialise. Overall the performance is quick, efficient, and not prone to error. In aviation, the proficient performer is an experienced, skilled pilot, who has the capability to act as a productive, professional pilot. Birkett (1993) suggested that for a pilot to progress from being a competent performer to being a proficient performer, further skill development in terms of education and work experience is required.

The accumulation of experience alone, however, may be insufficient to guarantee development of skilled performance. Seamster et al. (1997) observed that deliberate and effortful practice is also required. For the competent commercial pilot this suggests that experience in terms of accumulated flight hours alone is not necessarily going to ensure entry into an airline as a first or second officer. According to Seamster it is the nature of the experience that is important and further advanced practice may be needed to raise the pilot's skill level to that of a proficient performer.

4.4 The Expert Pilot

Although often referred to in this study in generic terms and frequently used in everyday conversation, the term 'expert' is not normally used to describe the highest performance levels in pilots. In Klein and Hoffman's (1993) skill taxonomy, the highest level of performance, expert performance, is a fluid, flexible, highly proficient performance resulting from substantial experience. An alternative view is provided by Gardner (2002). After examining extraordinary performance in individuals, Gardner defined experts as individuals who perform at the top level of their domain but who make no effort to alter the domain. For the purpose of this study, the focus is on in the development of expertise as a process rather than the actual state of being an expert. In this context, the construct of proficiency suggests a state of usefulness or fitness for purpose rather than as a superlative implying expert or extraordinary levels of performance.

4.5 The Development of Expertise during Pilot Training

The aspiring airline pilot's progression from the left hand seat of a light training aircraft to a first or second officer's station and eventually the left hand seat in an airline transport aircraft involves the development of critical skills through distinct phases of the training and experience gathering process (Fallucco, 2002). The three phases of student development recognised by Fitts and Posner (1967) and supported by Birkett (1993) included a cognitive phase, where the student dealt primarily with distinct items of knowledge, an associative phase where this knowledge was organised and transformed into efficient procedures and an autonomous phase where, after considerable practice and rehearsal procedures could be performed with an increasing degree of speed and accuracy. Of the three phases, Seamster et al. (1997) claimed that the autonomous phase formed an important basic element of aviation performance. The autonomous phase was associated with rapid execution and economy of effort, where mental resources are freed up allowing the individual to multi-task.

In New Zealand, pilots undergo flight tests at various stages of their training for the issue of licences and ratings. These tests are conducted by the state licencing authority, either the CAA or by the CAA's designated examining agency, Air Service Licensing (ASL). Flight tests are designed to determine the candidate's competency at performing a number of critical aircraft handling manoeuvres and their knowledge of the aircraft systems. There is an emphasis on 'stick and rudder' skills with clearly defined, easily recognised, performance parameters to guide the examiner. The overall assessment is one of pass/fail (NZCAA Flight Test Standards Guide, 2005). The flight tests are designed to assess the pilot's competency and fitness to hold a licence or rating. They provide feedback to instructors and other trainers involved with the pilot's training, and they give a wider, longer term view of the quality of the training programme from which changes and improvements can be made (NZCAA Flight Test Standards Guide, 2005). They do not however test the candidate's ability to carry out the functions and responsibilities of the licence in an operational environment. These characteristics are expected to develop as experience is gained in flight operations. The general aviation pilot will be subject to annual or six monthly competency checks but these largely concentrate on aircraft handling skills and are similar to a commercial pilot or instrument rating flight test conducted in an operational setting.

The licensing authority ensures that a newly licensed pilot has reached the standard of being a competent performer and has achieved a level of performance where aircraft handling is largely autonomous and the pilot has sufficient spare capacity to attend basic operational matters (Seamster et al., 1997). Airlines generally expect a higher standard of skill and experience at the entry level and will look for a degree of proficiency, supposedly gained through additional flight experience, in their new aircrew employees (Fallucco, 2002). The New Zealand CAA clearly defines the expected flight test standards for pilot licence candidates. Civil Aviation Rules Part 61.153(a)(7) (NZCAA Rule 61, 2007) and Part 61.203(7) (NZCAA Rule Part 61, 2007) state that for both the Private Pilot Licence and the Commercial Pilot Licence the candidate will:

> *"Demonstrate to a flight examiner general knowledge of and the ability to perform competently, (writers emphasis) those normal and emergency flight manoeuvres applicable to the type of aircraft in which the applicant is being tested; and ability to comply with air traffic services practices and procedures"*
>
> (NZ CAA Rule Part 61, 2007)

The notion of the autonomous phase as the basic stage of aviation performance (Seamster et al. 1997) is suggested in a review of pilot training carried out by Sinclair (2002a). Sinclair independently reviewed the performance of School of Aviation students at Massey University in a multi-crew environment. After testing 65 ATP Programme students on their final flight tests, Sinclair (2002b) reported that while the newly qualified pilots, assessed as competent according to the NZ CAA prescription, were capable of operating single pilot, IFR on private operations, their level of skill at that point was inadequate for multi-crew air transport operations. Sinclair recorded deficiencies in IFR procedures, multi-crew navigation, pilot decision-making, and crew resource management, all of which fell short of the standard required for airline operations. Hunt (2000) argued that the typical competent pilot product of the flight schools needs considerably more skill development to even begin training in an airline. Hunt observed that the gap between the entrance qualification for air transport operations, the Commercial Pilot Licence, and the realities of sophisticated operations systems is large. Hunt attributed this to a lack of extensive and relevant academic and technical knowledge, non standardised flight experience, and the lack of a legal requirement for the delivery of a formal course of ground instruction. In New Zealand the existing pilot licensing legislation results in flight school graduates who are able to safely operate a light aircraft within handling limits defined by the NZ CAA. The new pilot having been assessed as competent to hold a licence will have developed sufficient skills to perform at a journeyman's level in the capacity of pilot in command on single pilot IFR private operations. In order to undertake further general aviation commercial activities such as VFR charter flights, parachute dropping and sight-seeing flights, more training and experience may be required to reach a level of proficiency appropriate to the role. The observations of Sinclair (2002) and Hunt (2000) suggest that a pilot who is assessed as competent for commercial pilot licensing purposes may be insufficiently skilled to begin flight crew, aircraft type rating, and operational training within an airline training system. In order to be attractive to an airline employer, the prospective airline pilot must progress in skill level to the proficient level of performance. The process of becoming proficient involves gaining more skills and experience but the mere accumulation of more flying hours may not necessarily result in any useful gains in proficiency. It is argued that to be effective, the gaining of further flight hours must be accomplished in a structured manner and include regular, dedicated practice with a focus on airline operations and with a conscious effort to expand the knowledge base particularly as it applies to air transport operations.

4.6 Implications

Competency and proficiency in pilot training represent two distinct levels of aeronautical skill. In general conversation the terms are often used loosely and interchangeably. In the aviation context, when establishing pilot skill and performance levels, it is essential that both constructs are clearly defined, with competency being the minimum licensing standard, and proficiency the desired operational standard for employment in a particular domain. Competency suggests that a sufficient level of autonomous performance has been reached enabling the pilot to begin to develop new domain specific skills; proficiency is the state where the pilot has gained sufficient domain related skills to effectively function in a particular role.

Section 5. Developing Proficiency in the Airline Environment

In the previous section it was shown that newly qualified general aviation pilots, trained and competent in accordance with CAA Rule Part 61 requirements, were assessed as being able to function satisfactorily in a single pilot IFR environment on private operations. Their level of skill at that point was not sufficient for multi-crew or air transport operations (Sinclair, 2002). This section focuses on airline selection, training and assessment. It shows how the competent, technically skilled, single pilot graduate of the general aviation flight school needs to develop crew and task orientated skills to operate effectively as a pilot in the airline environment.

5.1 Individualism and Technical Proficiency in Early Airline Programmes

It has been claimed that about 70% of aircraft accidents and incidents are caused not by deficiencies in technical abilities, but by the lack of successful team functioning in demanding situations (Klampfer, Hausler, Fahnenbruk, & Naef, 2000). Prior to the 1980s, airline training followed the general aviation basic flight school model with training and assessment being focused on the pilot's technical skills with specific performance parameters being defined, for example, maintaining height and heading with no more than a 50 foot deviation in altitude and ten degrees deviation in heading (Goldsmith & Johnson, 2002). In the early days of airline operations the stereotypical air transport pilot was an individual who embraced such personality traits as independence, bravery, machismo, and calmness under stress. It has been suggested that these types of individuals were attracted to aviation and in return were sought after by potential employers (Helmreich & Foushee, 1993). With the introduction of more complex aircraft into airline service in the late 20^{th} century, provision was made for a co-pilot to provide support for the pilot, reduce workload and decrease the likelihood of human error. The pilot operating in this role, however, was regarded as part of a redundancy system and employed as back-up rather than as a team member; as observed by Helmreich and Fouchee, it was very much a secondary role. Even with the introduction of the co-pilot role, training and evaluation continued to focus on the technical proficiency of the individual pilot. Helmreich and Fouchee observed that during initial selection and training for the airlines, aptitude and performance standards developed for single-pilot operations were used. The aviation community operated on the assumption that well-trained and technically competent individuals would automatically be able to function safely and efficiently as a crew in complex environments (Helmreich & Fouchee, 1993). A different perspective on airline pilot stereotyping in the early days of jet transport, identified superior technical proficiency as the prime factor in assessing a pilot's ability to perform safely (Taggart 1994). Pilots possessing this attribute were held in great esteem and were deemed to possess the 'right stuff'. However, as Taggert observed, accident statistics at the time pointed to inadequacies in leadership, communication skills, crew coordination and decision making as the common factors in a majority of airline accidents, not a lack of the 'right stuff'.

5.2 The Emerging Importance of Crew Training in Airline Training Programmes

In 1975, Northwest airlines in the USA received approval from the FAA to trial a new type of simulator based training programme known as Line Oriented Flight Training (LOFT). The LOFT programme was proposed as an alternative means of compliance for the FAA mandated airline recurrency training programme (Taggert, 1994). In 1978 FAA regulations were amended to allow LOFT to be part of any airline's initial and recurrent training programme. The introduction of LOFT was seen as a significant step in airline training and as Taggert observed it signalled the recognition of crew coordination problems as a major cause of airline incidents and accidents. A definition of LOFT proposed by the UK Civil Aviation Authority in 2002 in its CAP 720 described the training as:

> *"Aircrew training which involves a full mission simulation of situations which are representative of line operations, with special emphasis on situations which involve communications, management and leadership".*
>
> (UKCAA, 2002, chap. 4 p.13)

UK CAA (2002) warned that LOFT should not be used as a method of checking and assessing the performance of individuals, but rather as a validation of training programmes and operational procedures. The advantage of LOFT as proposed by UK CAA was that it presented aircrews with scenarios of typical daily operations in their airlines with reasonable and realistic difficulties and emergencies introduced to provide training and evaluation of flight deck management techniques.

On an industry wide basis in the USA, acceptance of LOFT as part of an airlines training programme was initially slow. Further FAA and industry initiatives in the 1980's were needed before a Notice of Proposed Rule Making (NPRM) was developed to address the issues of crew and cockpit resource management (Taggert, 1994). According to Taggert, the FAA saw LOFT as a first step towards more complete crew training. Initially the focus of LOFT training was still on the individual crew member and not on the crew itself as the unit of training. As a result of a series of accidents in the 1980's which were not attributable to any specific mechanical failure, United Airlines in the USA introduced a Command/Leadership/ and Resource Management programme (C/L/R) and offered it commercially to other operators (Taggert). Again the industry in the USA was slow to respond but international carriers such as KLM began their own human factors courses and other airlines introduced command courses for captains as part of their upgrade training (Taggert).

The gradual acceptance of the need for formal crew training both by government and the industry led to the introduction of Cockpit Resource Management (CRM) training (UK CAA, 2002). A definition provided by UK CAA of cockpit resource management (now called crew resource management) is the effective use of all available resources such as equipment, procedures and people, to achieve safe and efficient flight operations. A CRM training programme consisted of three distinct phases according to UK CAA. The first phase was an awareness phase where CRM issues were defined and discussed. This was followed by a practice and feedback phase where trainees gained experience with CRM techniques and finally a continual reinforcement phase where CRM principles were reviewed on a long term basis. The vehicle for the second and third phases of CRM training was LOFT (UK CAA, 2002). In 1990 the FAA issued an advisory circular on CRM and comprehensive CRM training became industry standard practice. At the same time as they introduced the advisory circular on CRM training the FAA issued a Special Federal Air Regulation (SFAR) to introduce a new qualification programme for airlines, the Advanced Qualification Programme (AQP) (Taggert, 1994). The AQP was a flexible training, qualification and evaluation programme that allowed individual operators to develop their own crew training programmes to suit the requirements of the operator (Tomanio, 2001). According to Tomanio the single most distinguishing feature of the AQP was that of proficiency based training. With proficiency base training the training was continued until the student reached the prescribed standard. There was no 'fail' grade.

The main components of an AQP were:

- a formal course in CRM;
- a data collection and validation programme;
- the use of crew concept for training and checking;
- the Integration of LOFT for all crew members.

(Taggert, 1994)

In 1993 the UK CAA followed the example of the FAA and introduced a requirement for UK public transport aircraft operators to provide training in CRM for their crews. An additional requirement followed in 1995 mandating formal recurrency training (RAeS, 1996). Unlike the FAA, the actions of the UK CAA were prompted, not by a history of aircraft accidents but by a perception of unsatisfactory training standards observed during a period of airline pilot recruitment (RAeS). These included:

- a lack of intermediate training to prepare pilots experienced only in light propeller driven aircraft for the higher speeds of turbine powered aircraft. Consequently pilots lacked situational awareness;

- a lack of multi-crew co-operation training whereby those who operated mainly as a single pilot continued to act in single crew style on multi-crew transport aircraft, causing disruption to flight deck efficiency;

- a lack of formalised training in standard operating procedures (SOPs). This was causing confusion between crew members and allowing hazardous situations to arise, even for crews experienced in multi-crew operations.

(RAeS, 1996)

In addition to CRM training, the UK CAA introduced a requirement for all pilots to complete a Multi-Crew Co-operation Course (MCC) prior to obtaining a type rating on a multi-pilot aircraft for the first time. The MCC was designed to introduce pilots, who hitherto were used to operating in single-pilot environments, to the experience of operating an aircraft as a member of a crew (UKCAA LASORS, 2007).

5.3 Assessing Flight Crew Performance

Historically pilots were expected to demonstrate proficiency in a small set of critical flying manoeuvres and knowledge of aircraft systems. Under programmes such as the AQP, airlines began to assess aircrew performance in more complex and ill-defined environments (Goldsmith & Johnson, 2002).

The primary means of proficiency evaluation in the AQP was the Line Operational Evaluation (LOE) described in Advisory Circular (AC) 120-35C (Federal Aviation Administration, 2004). The evaluation was a non-jeopardy (no fail) assessment of an individual's ability to demonstrate technical competence and CRM skills appropriate to fulfilling job requirements in a full mission scenario environment (FAA). The LOE was conducted in a flight simulator by trained examiners who were not part of the crew. It followed closely a normal LOFT detail in that it was conducted in a line environment with a complete crew and using real world scenarios and real time. If performance deficiencies were observed additional training or instruction were given until the AQP standard was met (FAA). Two other sources of data used to support CRM training programmes were the Line Operational Safety Audit (LOSA) programme and the Non Technical Skills (NOTECHS) programme.

Developed from a project initiated by the University of Texas, LOSA was a process whereby trained observers collected actual data about crew behaviour and situational factors on normal air transport flights (University of Texas, 2004).

Using a checklist developed by the University of Texas, LOSA provided a valid picture of system operations that could guide organisational strategy in safety, operations, and training. LOSA also identified superior performances which could also be included in CRM training programmes (Helmreich, Klinect & Wilhelm, 1999). Central to LOSA was the concept of Threat and Error Management (TEM). Flight Crew were trained to recognise threats and avoid errors and to detect and manage errors as part of their CRM training. The model consisted of three components, external threats; internal threats; and the behaviours or actions by the crew to deal with the threats. The external threats were events, risks, and errors that existed in the operating environment. Combined with internal threats, such as crew dysfunction and technical malfunction, the outcome was dependent on what CRM skills the crew had developed and had at their disposal for resolving the threats. The skills involved both error detection and management behaviours, and threat recognition and error avoidance behaviours, both of which were components of non-technical skill categories. Figure 1.4 illustrates a TEM model proposed by Helmreich et al. (1999).

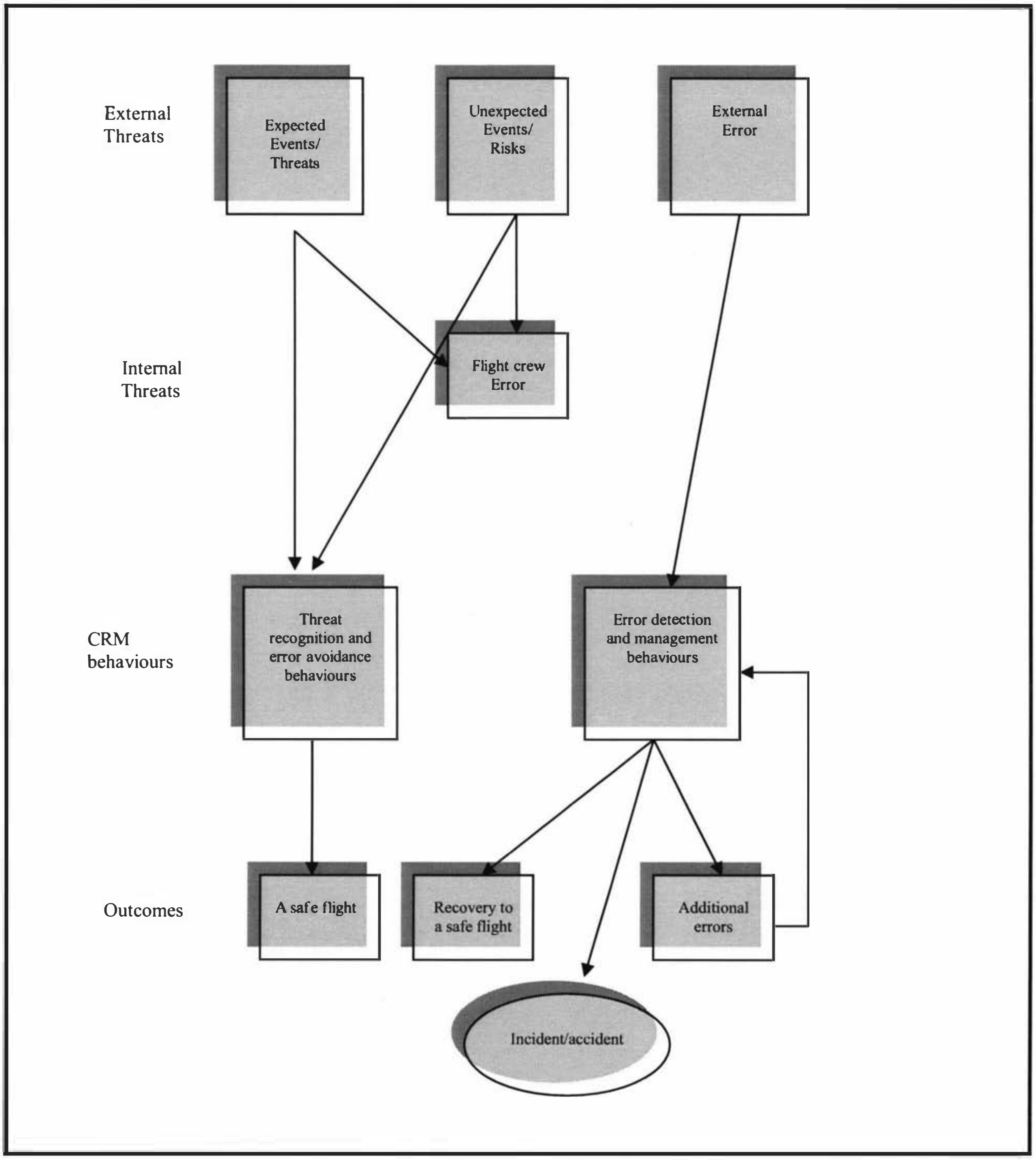

Figure 1.4 Threat and Error Management Model

From: Helmreich, R.L. (in press) Culture, threat and Error: Assessing System Safety. In *Safety in aviation: The management commitment*: Proceedings of a Conference. London: Royal Aeronautical Society

The NOTECHS evaluation process reflected different regulatory requirements as promulgated in the European Joint Aviation Requirements (JAR) JAR Ops NPA 16 which states:

> *The flight crew must be assessed on their CRM skills in accordance with a methodology acceptable to the Authority and published in the Operations Manual. The purpose of such an assessment is to provide feedback to the individual and serve to identify retraining; and be used to improve the CRM training system.*
>
> (Klampfer et al., 2001 p.24)

While the European NOTECHS system used similar behavioural markers to those developed by the University of Texas (UT) and used in LOSA, an important difference was that the UT LOSA focused on the performance of flight crews as a unit whereas NOTECHS focused on the performance of the individual crew member functioning in a crew environment (Klampfer et al., 2001). For the purposes of this study, the skill development of the individual pilot operating in the flight training or the single pilot, general aviation environment, is considered. Individual crew member behaviour, as assessed by the NOTECH model, was considered more appropriate than the crew behaviour model proposed by the University of Texas. The NOTECHS model focuses on the performance of individuals in a team rather than the UT model which focuses on the performance of the team as a whole. The focus on individual rather than team performance follows the pattern of skill development during initial pilot training and subsequent single-pilot experience gained in the general aviation environment.

5.4 The Impact of Pilot Shortages on Airline Training

As early as 1993 a study by the United States Department of Transportation projected a shortage of qualified airline pilots which could affect the future availability of commercial air transportation in the United States. The study concluded that the expansion of airline capacity together with retirements from the existing airline pilot force and a reduced pool of ex military pilots would result in a national shortage of qualified pilots through to 2010 (US Department of Transportation,1993).

Since this study began, the world aviation scene has undergone dramatic changes. Initially it stagnated because of the deteriorating world economic climate, then during the 1990s and later in 2001 it again faltered under the threat of international terrorism and the impact of travel restrictions resulting from the far reaching serious acute respiratory syndrome (SARS) virus epidemic. While this had a negative effect on the predicted growth of air transportation, the trend soon reversed early in the new millennium triggering an unprecedented demand for air travel, particularly in China and India. An article in the India Times cited an International Air Transport Association (IATA) report of a 42% increase in passenger carrying capacity for Asia-Pacific based airlines in the 2007 year. Additionally North American carriers had increased capacity by 11% for the same period while European carriers had increased capacity by 29% (India Times, 2007).

This growth stimulated a corresponding demand for airline pilots to the extent that shortages of suitably trained pilots were being experienced. Hinton (2006) predicted a worldwide requirement for 17,000 new pilots each year and unless training capacity was increased there would be a shortfall of 40,000 pilots over the following ten years.

With the drying up of the traditional supply of ex-military pilots the major airlines looked to the smaller regional airlines as a source of pilots. This flow-through demand affected the regional airlines' training resources and general experience levels (U.S. Department Of Transportation, 1993). As the supply of ex-military trained pilots entering the airlines decreased a valuable dimension of pilot training was lost to the industry (Knittel, 2001 cited in Fiorino, 2001). Knittel observed that military pilots were well trained in stick and rudder skills and as officers they were also trained in leadership and management. According to Knittel, civilian pilots were not trained in all of these skills and would benefit from training in the skills which were traditionally part of military officer cadet programmes.

Another perspective was provided by Esser (2001) cited in Fiorino (2001) who observed that military trained pilots had undergone psychological testing during selection and had CRM concepts instilled in them during basic training in order to deal with the stress placed on teamwork in the military environment. According to Esser civil-trained pilots were not substandard but they were slower to train as they had more skills to acquire than military trained pilots.

5.5 Entry Level for an Airline Pilot Career

The traditional entry path into an airline career was normally through the general aviation industry. Karp (1996) observed that the typical flight-time building path for a new pilot in the U.S.A. involved first flying as a flight instructor, and then as a regional pilot. The path normally took six to eight years prior to applying to a major airline (Karp, 1996). While Karp was writing from a United States perspective, the observations are likely to apply to the New Zealand pilot. Karp observed that the historical emphasis on flight hours as an airline pilot selection criterion was efficient only if given an adequate supply of commercial pilots. Given an abundant supply of pilots the airlines could select from the more experienced general aviation pilots who in turn would be replaced by low experienced graduates from the flight schools. Karp proposed that there was a need for proficiency-based flight training programmes to ensure a supply of suitably trained pilots in times of high demand.

5.6 Proficiency Based Flight Training

Mangold and Neumeister (1995) defined proficiency-based flight training as training directed towards specific proficiency objectives identified by an airline and focused on a range of conditions and contingencies that might be faced by pilots working within a carrier's operational domain. Under the Advanced Qualification Programme, pilots were trained to a standard of proficiency on specific objectives within an approved curriculum. The airline determined the terminal proficiency objectives together with associated performance standards.

These were approved by the FAA and became regulatory requirements for the individual carrier. The AQP became the approved means for the carrier to propose Terminal Proficiency Objectives (TPO) as well as additions, deletions, or changes as required to maintain a high degree of aircrew proficiency tailored to the operator's line requirements (Longridge, 1997).

There appears to be a difference between the performance of a pilot who has undergone proficiency based training, and one who has accumulated experience but has not been exposed to focused training. Seamster, Redding and Kaempf (1997) observed that a higher level of performance was attained by pilots who developed expertise through effortful practice to refine skills when compared with pilots who had accumulated experience as commercial pilots but with no focused training or practice. According to Seamster et al. expertise emerges through multiple cycles of skill development involving three distinct phases identified by Ackerman (1992): a cognitive phase, working primarily with discrete bits of knowledge; an associative phase, organising knowledge and transforming it into more efficient procedures, and an autonomous phase, automating or compiling procedures to increase speed and accuracy. According to Seamster et al. (1997), the development of expertise in a domain takes about ten years. Seamster (1997), citing Ericsson and Charness (1994), claimed that the developmental nature of expertise involved: an introductory period of about a year with modest performance improvements; an extended period of preparation, several years in duration with substantial performance improvements, and a period of full-time commitment with additional performance gains. Seamster et al. identified further characteristics of experts that were not linked to specific skills or knowledge: the ability to perceive meaningful patterns and a superior memory for domain-relevant facts; a structured knowledge base composed of general-domain and specific-domain knowledge, and a hierarchy of skills starting with automated basic domain skills and higher level skills co-ordinated by a set of high level strategies or self-monitoring skills. These general characteristics were overarched by efficiency of performance and minimal errors.

In contrast to the skilled performance development approach, Seamster et al. (1997) also referred to a popular notion of expertise based on talent and other immutable personality factors, the right stuff. These 'expert' attributes, are still prevalent in the aviation environment and may severely limit the effectiveness of training within an organisation when the assessment process is limited to determining whether the individual or crew had the 'right stuff' (Seamster et al. 1997). Table 1.4 shows some general characteristics of expert performance

Table 1.4 *Characteristics of Expert Performance*

General Characteristics	Knowledge Characteristics	Skill Characteristics
Ability to perceive meaningful patterns	Focused on a primary knowledge domain	Automated
		domain skills
Directed and constrained searches	A structured knowledge base	Skilled procedures
Fast and efficient with little error	A general-domain and specific-domain knowledge base	Skilled domain representation
Superior short and long-term memory		Skilled strategies and self-monitoring skills

From: Seamster, T.L., Redding, R.E., & Kaempf, G.L. (1997). *Applied cognitive task analysis in aviation.* Aldershot: Ashgate Publishing.

5.7 Implications

The AQP and the associated Crew resource Management Programmes define and develop the skills necessary for a pilot to function effectively in the airline environment. These skills are largely non-technical in nature and centre on the cultivation of human factors skills. The task orientated skills resulting from the AQP represent the major point of difference between traditional pilot training, as prescribed by the NZ CAA, and the skill and knowledge requirements of the air transport sector of the New Zealand Aviation Industry. Since the last quarter of the 20th century the gap between general aviation pilot training and airline training has increased. Beginning with a single pilot, technical competency centred training environment, where the expectation was that proficiency would automatically develop with increasing flight experience, airline flight training has evolved through programmes such as the AQP, to crew-focused, proficiency-based, flight training. While pilot training in the airlines was undergoing major changes, general aviation training remained largely unchanged since the time that Hunt and Crook (1985) completed their report for the CAA. This was confirmed by the observations of Helmreich and Foushee (2003) who noted that prior to the 1980s, airline training was largely centred on individualism and technical proficiency. With the introduction of the AQP in the 1990s the focus shifted to crew based competencies as defined by the University of Texas and NOTECHS models (Van Avermaete, 1998). These models, while having a high degree of commonality, differ in that the former is based on aircrew behaviour while the latter focuses on the behaviour of the individual within the crew environment. The worldwide pilot shortage of the 21st Century provides some confirmation of the observations of Karp (1996), who predicted that in times of pilot shortages, the traditional supply of high flight time general aviation pilots as recruits for the airline industry dries up and the traditional flight hour based selection criteria are no longer effective. Karp advocates proficiency based flight training as a more effective way of supplying well trained pilots for the airlines.

Section 6. Identification of Competencies

New Zealand flight training providers are required to operate under NZCAA Rule Part 141 which prescribes rules governing the certification and operation of organisations conducting training and assessments. The Rule lays down stringent requirements for quality assurance, management, and oversight of training operations (NZCAA Rule Part 141, 2007). Pilot training curriculum content is similarly prescribed by CAA Rule Part 61. Table 1.2 shows that while NZCAA Part 61 pilot licensing requirements involve both technical and non-technical skills, the emphasis has been on the teaching and assessment of technical skills. The argument has been made that basic flight training in New Zealand is geared towards training for a licence rather than training for the role of professional pilot. This section examines the competencies associated with pilot licensing and the additional skills that are required by the professional aviator employed on air transport operations. Specifically, it reviews two areas of pilot competency; the skills and knowledge taught and examined for CAA professional pilot licensing and the non-technical skills associated with the role of an air transport pilot.

To identify as broadly as possible the skills and knowledge that might contribute to professional pilot competency, three main avenues are explored. These include a major New Zealand study that identified the proficiencies of the professional pilot and the application of the findings of that study to the curriculum of a flight training school, a review of the models used for assessing pilot skill in major

European airlines and finally, reflecting a view that is gaining currency, the skills needed by an airline captain to be a business manager are explored.

6.1 The Development of Expertise during Pilot Training

As described in section one, the HURDA programme was scheduled to for introduction in the early 1990s (Crook & Hunt, 1988). Although the programme was initiated it was terminated prematurely although some of its goals, including competency and test specification, managed to survive through institutions such as Massey University School of Aviation (Crook, 1999). Central to the HURDA Programme was the Needs Based Education and Training model (NEBEAT) proposed by Hunt, (1984, 1986). The model defined competency as being the synthesis of ability and application. Based on information-processing models of psychology, the NEBEAT model focused on the accomplishments and performances that are pre-requisite or co-requisite to effective job performance. For example, the accomplishment of Aircraft Systems Management has numerous associated performances such as: managing the fuel system; managing the electrical system; monitoring the instruments as well as other similar activities (Crook & Hunt, 1988). By conducting a survey of New Zealand pilots, Crook & Hunt were able to identify six accomplishments and numerous associated performances associated with competent aircraft operation. This contrasted with the more traditional approach of defining competency as described by Lockett-Kay (1992). The traditional method of defining competency focuses on the tasks required to carry out a particular job. According to Lockett-Kay this is done by: describing the persons work or task; identifying each of its components and sorting them into sub-tasks, then developing descriptions of mastery performance.

The traditional method does not analyse tasks and subtasks in any depth and there is a lack of information on what skills and knowledge underpin the competency and how the competency can be developed (Lockett-Kay, 1992).

Following on from work done by Gagne (1970) and Glasser (1986) who developed frameworks for competency analysis and explored the relationship between knowledge and processing ability, Hunt (1986) developed a knowledge-processing hierarchy described as the NEBEAT Instructional Prescription Model. In describing the knowledge-processing hierarchy, Hunt & Kinross (1998) made the following observation.

> *This knowledge-process hierarchy defines the nature of competency in information processing terms as a synthesis of types of knowledge and levels of process abilities. Each level of the hierarchy, from accomplishments through performances to process abilities represents increasingly generic capacities of procedural knowledge.*
>
> (Hunt & Kinross, 1988 pp.6-7)

The knowledge-process hierarchy proposed by Hunt (1986) is often depicted as a pyramid as shown in Figure 1.5

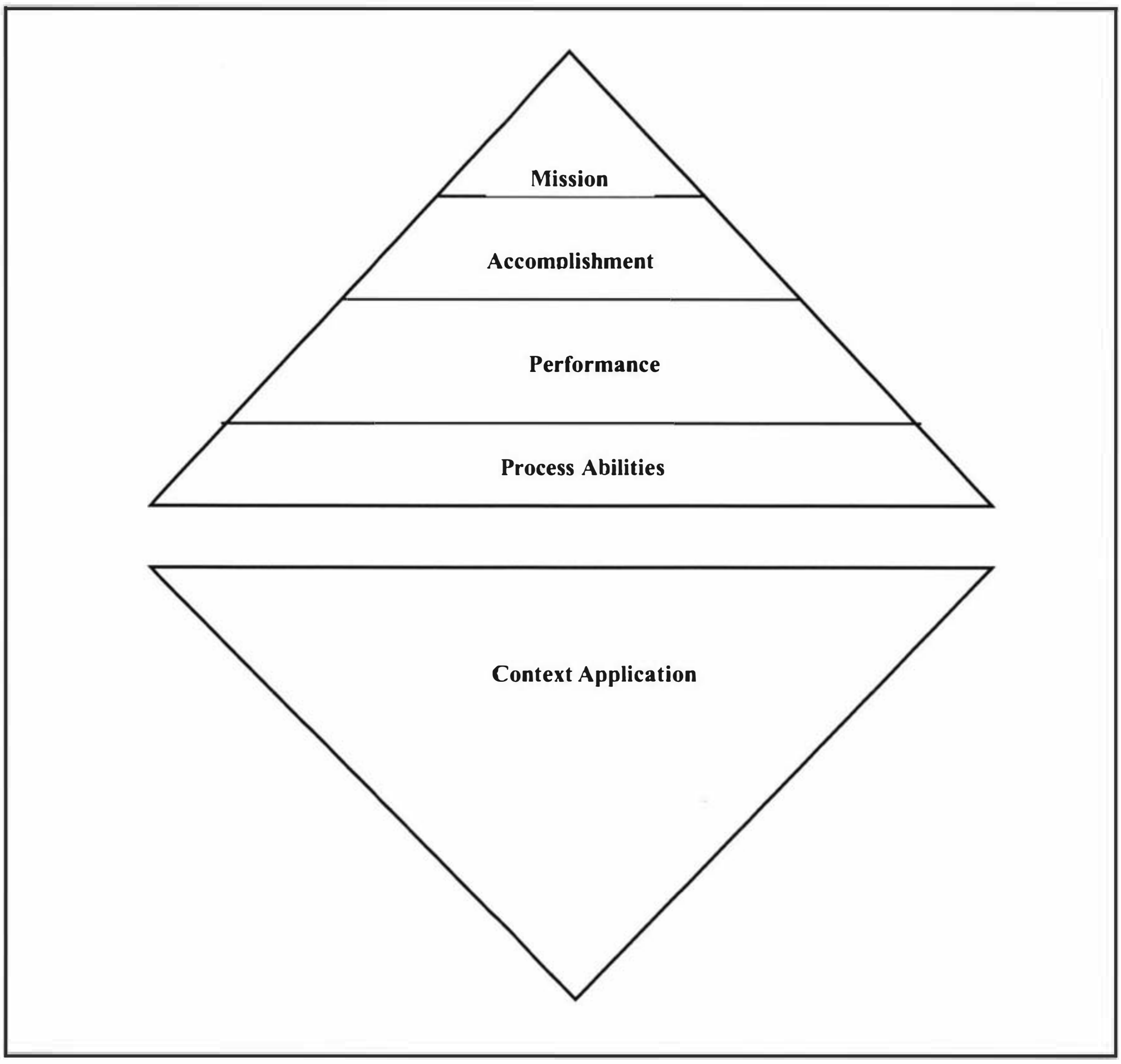

Figure 1.5 Knowledge-Processes Hierarchy
From: Crook, C. & Hunt, J.F.G. (1988) Competent flight crew licensing II, Palmerston North, Massey University.

According to Lockett-Kay (1992) organising knowledge structures using the knowledge-process hierarchy is useful in a number of contexts particularly when there is a need for goal-orientated generic knowledge-based capabilities. Considering the application of the knowledge-process hierarchy in the forensic psychiatric service, Lockett-Kay demonstrated how knowledge structures, using the knowledge-process hierarchy, could apply across agency and departmental boundaries with applications for hospital, prison, court and community settings. The changes in context merely requiring changes in the mix of competencies appropriate to the setting. The elements of the hierarchy described in Lockett-Kay (1992) are summarised below:

> Mission: The overriding goal of the job category. This is the goal-directed purpose to which all the accumulating activities are directed.
>
> Accomplishment: An accomplishment is a statement of the functional capacity required by an individual or group to accomplish with acceptable expertise. Each accomplishment is a derivative of a particular generic knowledge base.
>
> Performance: Performances identify the underlying capabilities of the accomplishment.
>
> Process abilities: Process abilities (sometimes called criterion abilities) are the final magnification of the knowledge-process hierarchy
>
> (Lockett-Kay, 1992 p12).

While Hunt's (1986) Knowledge-Process Hierarchy model (KPH) was first used for curriculum development in adult education, it was further refined, and used as the basis for the development of an undergraduate Diploma in Aviation and later a Bachelor of Aviation degree at Massey University (Lockett-Kay, 1992). The NEBEAT model became the cornerstone of the Massey University School of Aviation flight assessment process with candidates being assessed and graded in the four key accomplishments: aircraft command; flight navigation management; aircraft systems management, and aircraft performance management (Massey University Flight Testing Guide, 2007). Six key accomplishments proposed by Crook and Hunt (1988) are shown in Figure 1.6. Two of these, ground operations and the management and administration of flight operations are not directly relevant to basic flight training; however, they are essential to the air transport pilot's broader working environment.

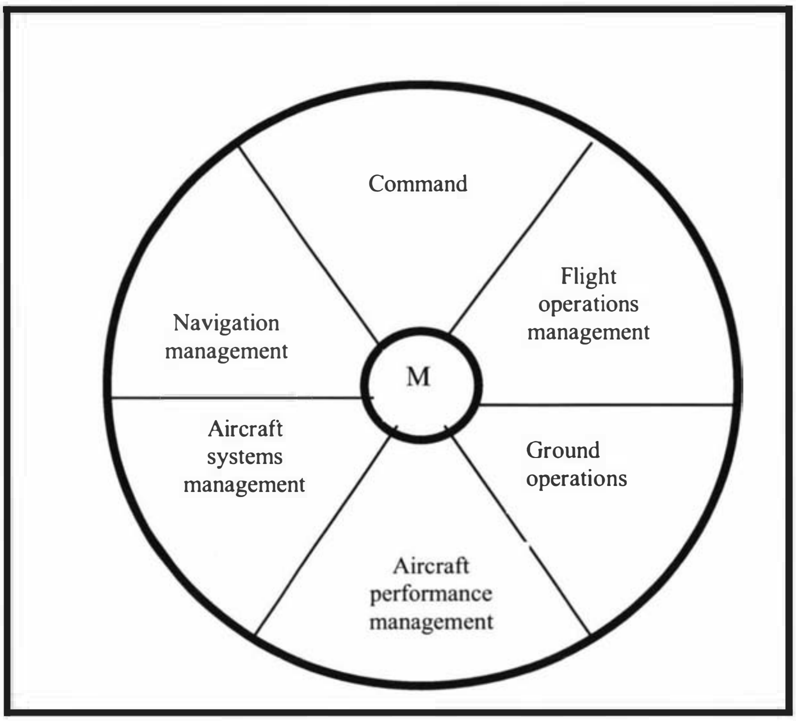

Figure 1.6 The key accomplishments

From: Crook, C. & Hunt, J.F.G. (1988). *Competent Flight Crew Licensing II.* Palmerston North: Massey University.

For pilot training, Crook & Hunt (1988) proposed a top down, three-level knowledge structure hierarchy of increasingly specific capabilities to process knowledge resulting in a procedure for mapping abilities in a manner in which interactive specifications of human competency could be prescribed for instructional and evaluation purposes Figures 1.7 and 1.8 show templates for a knowledge-process hierarchy illustrating how the mission or goal translates into a series of accomplishments prescribing the functions that need to be executed by the individual or group to achieve the mission. Each accomplishment expands further into performances and abilities, providing the final magnification for the overall task performance (Hunt, 1997).

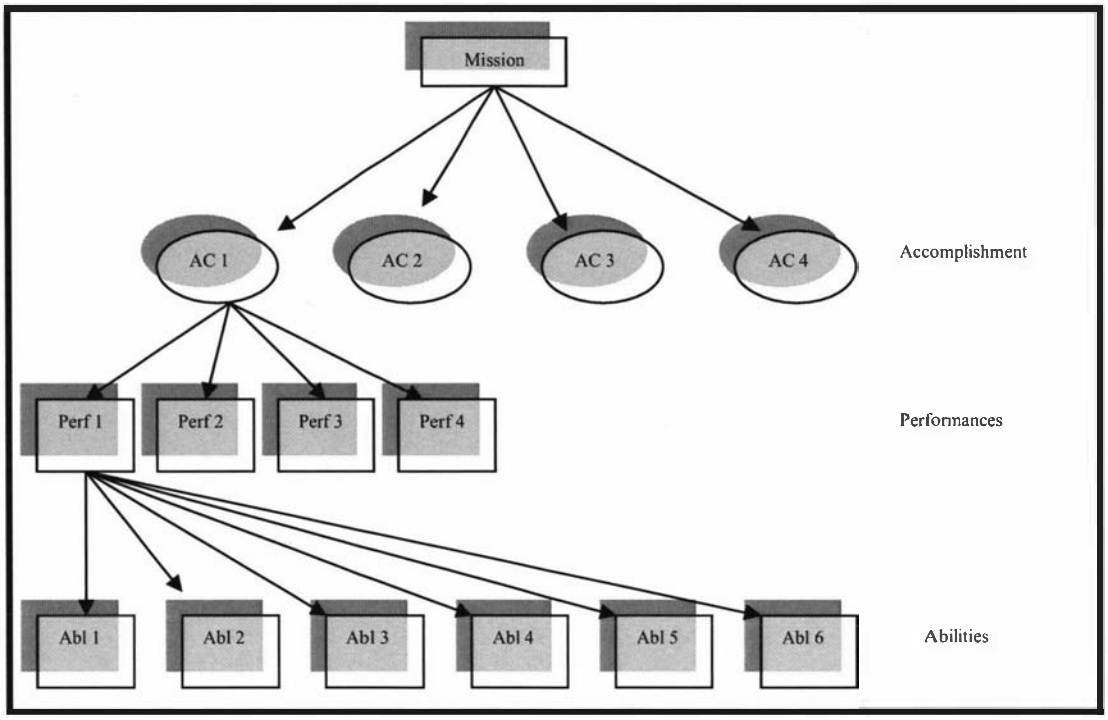

Figure 1.7 A Knowledge-Process Hierarchy Template

From: Hunt, G.J.F. (1997) Designing instruction for human factors training in aviation. Aldershot: Ashgate Publishing

The Massey University School of Aviation adopted this model for the Air Transport Pilot programme and it is in current use for training and evaluation using four of the main accomplishments described in Figure 1.6

Aircraft Command	(Non-technical skills)
Flight Navigation Management	(Technical skills)
Aircraft Systems Management	(Technical skills)
Aircraft performance management	(Technical Skills)

The ground operations accomplishment proposed in the original model was incorporated within the four main accomplishments and the management and administration of flight operations was not included in the ATP programme. Figure 6.4 uses Hunt's (1997) template to illustrate part of the Bachelor of Aviation Air Transport Pilot (BAv ATP) model for the aircraft command accomplishment. The figure shows how the aircraft command accomplishment breaks down into four performances each with their own process abilities. For clarity some of the abilities have been omitted.

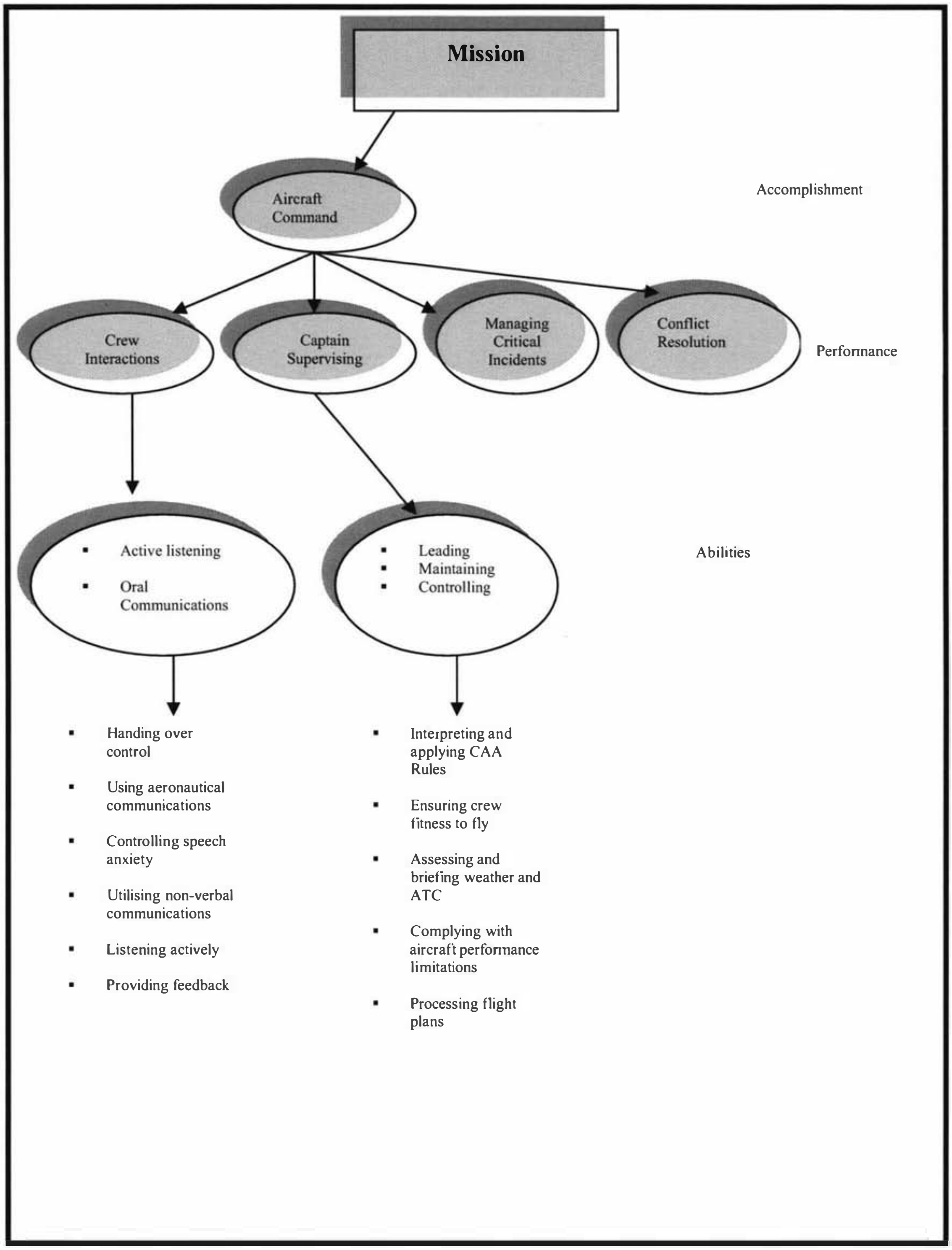

Figure 1.8 Abbreviated Knowledge-Process Hierarchy (KPH) adopted for the Massey School of Aviation

The Massey University BAv ATP programme used the Hunt (1987) KPH model for over twelve years and produced graduate pilots with single-pilot, multi-engine instrument ratings, commercial pilot licences, and with ground training to airline transport pilot licence standard. The graduates were examined and flights tested to NZ CAA Part 61 standards, and were assessed as competent in accordance with the CAA's own prescription. The KPH model used by Massey University School of Aviation focused on the technical skills required by the NZCAA licensing prescriptions but also had a higher level of aviation human factors than is prescribed by the CAA Part 61 licensing requirements. The technical skills comprised around 75% of the accomplishments defined by the model with aircraft performance management, aircraft systems management, and flight navigation management being technical skills and aircraft command being in the non-technical skills category.

6.2 The NOTECHS Model used by European Airlines

During 1997 and 1998, a European Joint Aviation Authority (JAA) project advisory group on human factors, consisting of representatives of the German, Dutch, and French Civil Aviation Authorities (DLR, NLR, and IMASSA) and the University of Aberdeen, conducted a study to determine ways of evaluating the non-technical skills of individual pilots in multi-pilot environments (van Avermaete, 1998). The requirement for non-technical skill evaluation in air transport pilots arose from changes to the JAA rules mandating the training and assessment of the non-technical skills associated with CRM. The project was named NOTECHS, an acronym for 'non-technical skills'. Van Avermaete (1998) observed that while the evaluation of non-technical skills may be new in the examination of commercial airline pilots as mandated by the Joint Aviation Requirements Flight Crew Licensing (JAR-FCL) requirements, the topic itself had been recognised and trained for in varying degrees for two decades usually under the name of Crew Resource Management (CRM). The NOTECHS study group defined non-technical skills as:

> *"Those skills referring to all of the pilot's attitudes and behaviours in the cockpit not directly related to aircraft control, systems management, and standard operating procedures".*
>
> (Van Avermaete, 1998 p.4)

6.3 The Components of the NOTECHS Model

The NOTECHS study group reviewed existing airline training systems and collected non-technical skills (NTS) descriptors. From this study a comprehensive inventory was created consisting of a large number of different NTS labels and descriptors covering the whole range of NTS (van Avermaete, 1998). A descriptive framework was created covering the whole NTS range. The framework consisted of three levels; categories, elements, and behaviours. Figure 1.9 shows the categories, elements, and behaviours that provided the framework for the non-technical skills associated with proficient pilot performance.

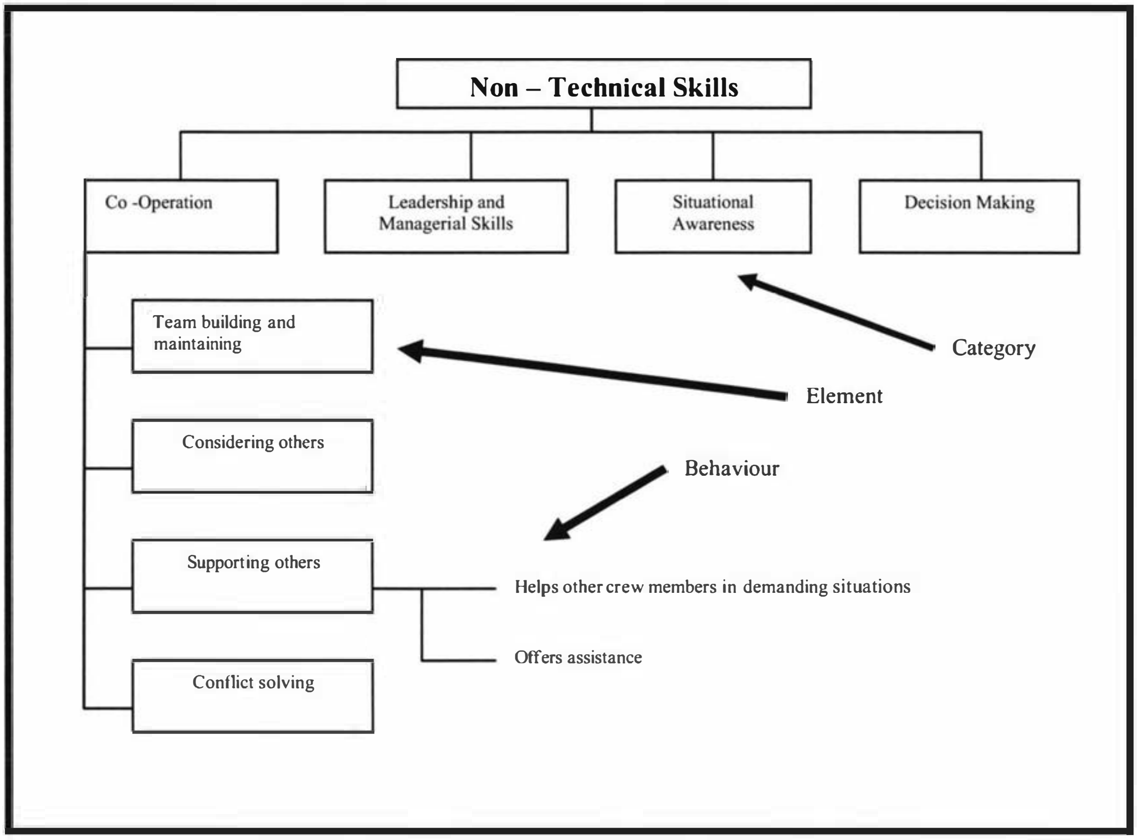

Figure 1.9 The NOTECHS descriptive framework consisting of categories, elements, and behaviours.

From: van Avermaete, J.A.G. (1998) *NOTECHS: Non-technical skill evaluation in JAR-FCL*, Hoofddorp: National Aerospace Laboratory

The four primary NOTECHS categories contained two social skill categories (co-operation; leadership & managerial skills) and two cognitive skills categories (situational awareness and decision making). From the four categories, the study group identified fifteen elements. These elements were comparable to the performances in the KPH model (Hunt, 1997). For each element a number of positive and negative exemplar behaviours were identified to assist trainers and examiners. According to van Avermaete (1998) observers often comment on the fact that 'communication' has not been included as a category. This was considered by the study group who concluded that communication was not so much a separate skill category but rather a means to be able to perform in each of the other categories. Examining the NOTECHS framework in greater detail it is possible to expand each category into its elements and give samples of supporting behaviours. Figures 1.10 to 1.13 show how each non-technical skill category sub-divides into elements and behaviours. While the categories and elements remain static the behaviours may vary depending on the nature of the operation being undertaken.

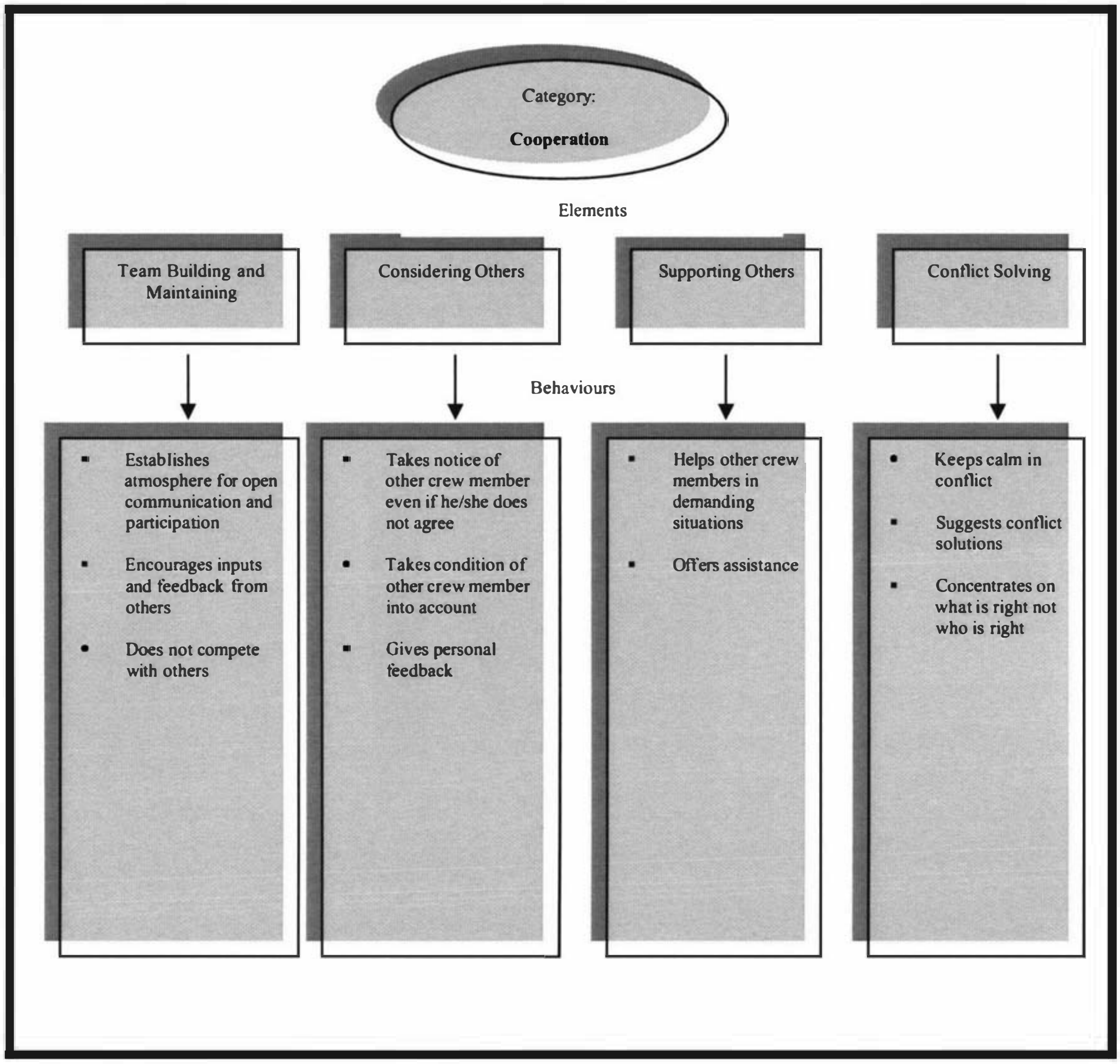

Figure 1.10 Elements and sample behaviours from category Cooperation

From: van Avermaete, J.A.G. (1998) *NOTECHS: Non-technical skill evaluation in JAR-FCL*, Hoofddorp: National Aerospace Laboratory

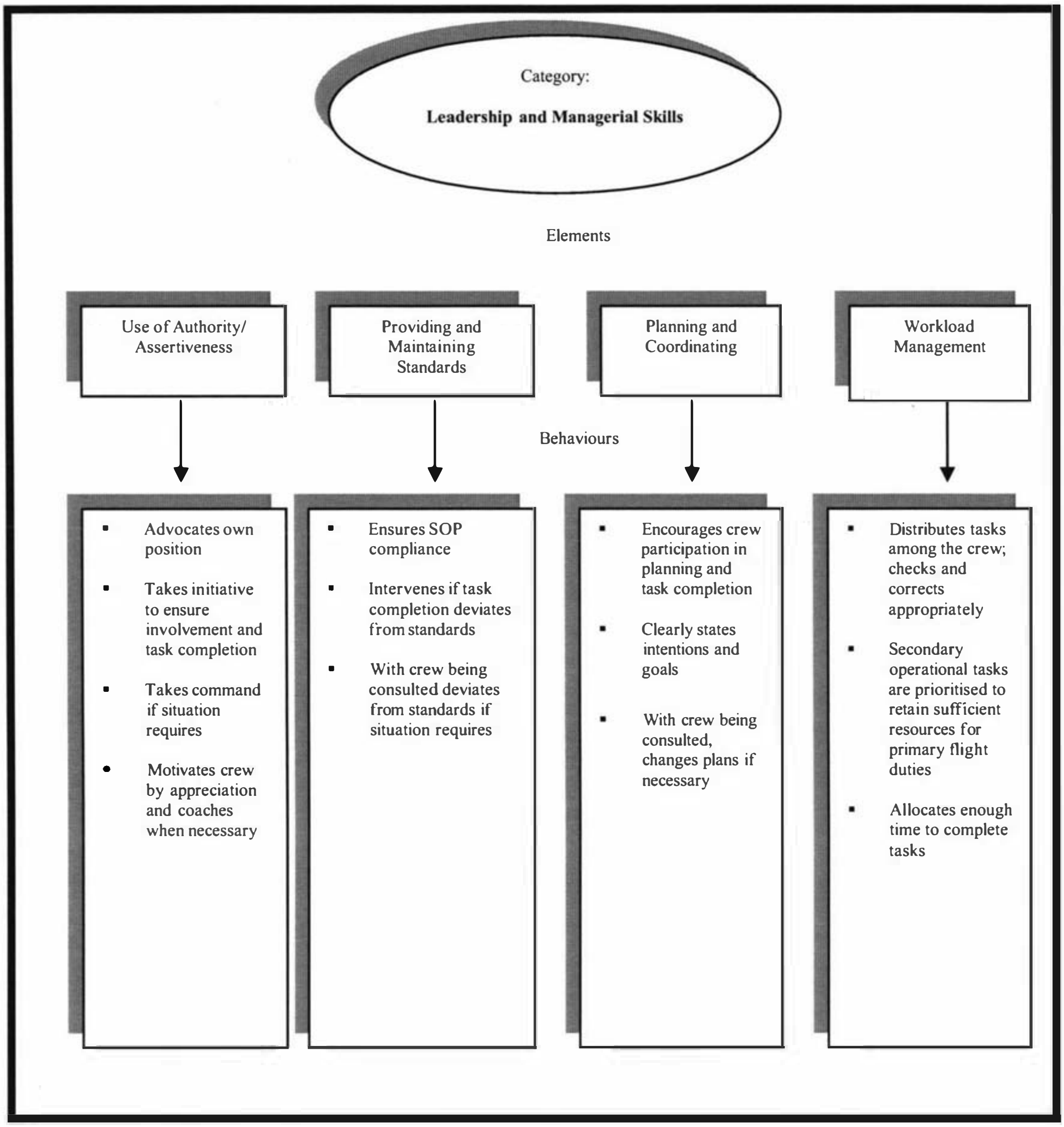

Figure 1.11 Elements and sample behaviours from category Leadership and Managerial Skills

From: van Avermaete, J.A.G. (1998) *NOTECHS: Non-technical skill evaluation in JAR-FCL*, Hoofddorp: National Aerospace Laboratory

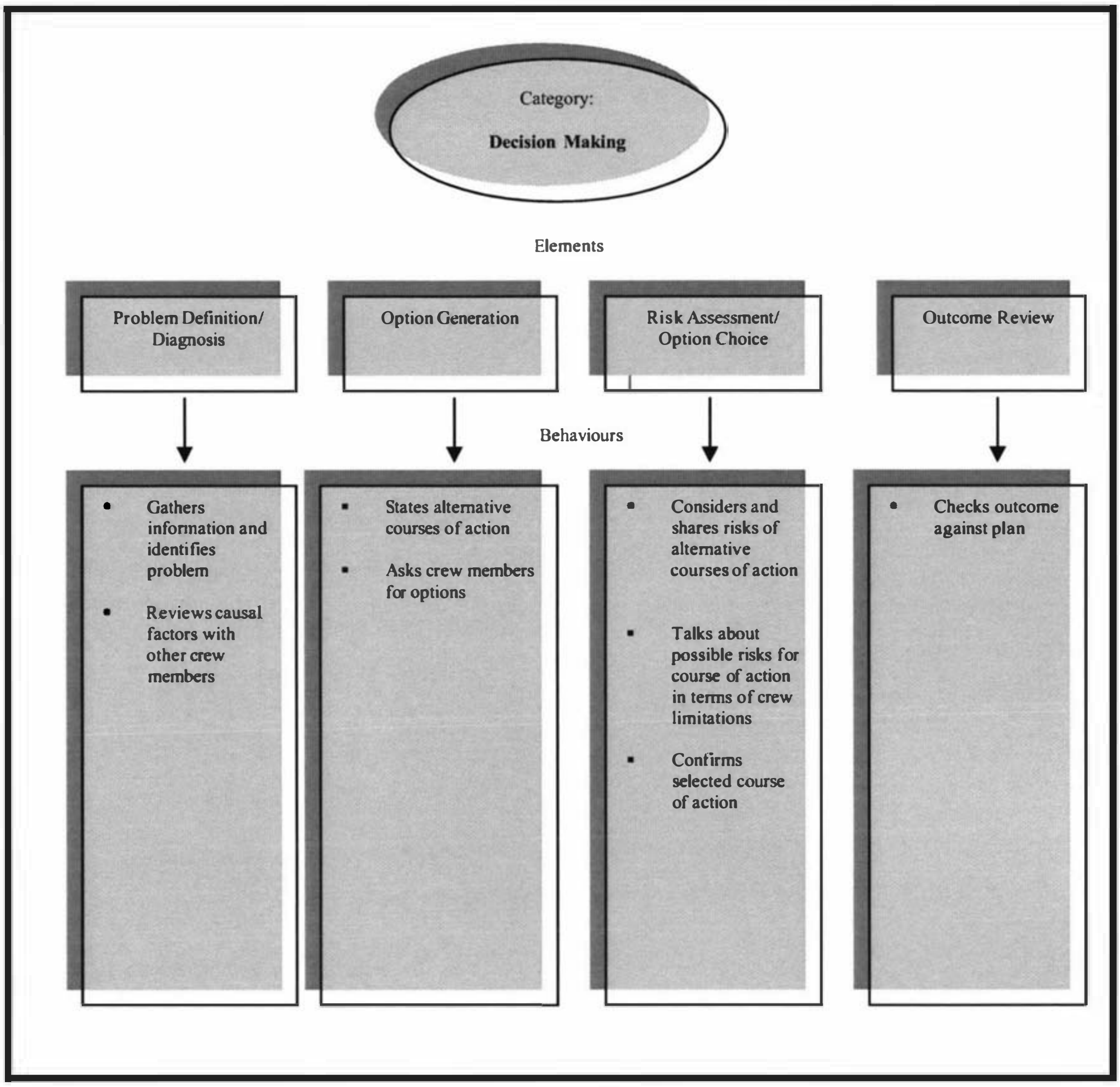

Figure 1.12 Elements and sample behaviours for category Decision Making

From: van Avermaete, J.A.G. (1998) *NOTECHS: Non-technical skill evaluation in JAR-FCL*, Hoofddorp: National Aerospace Laboratory

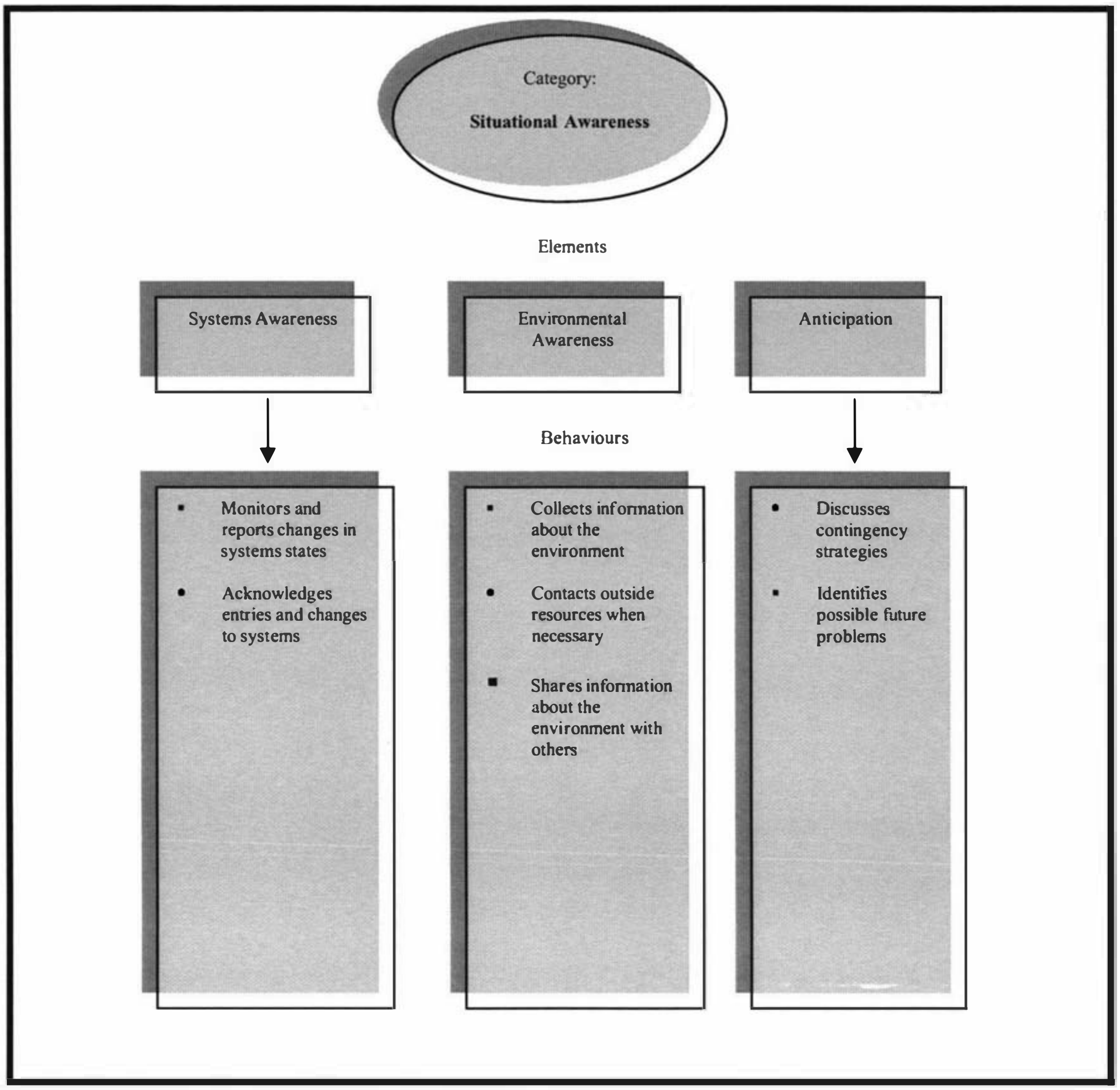

Figure 1.13 Elements and sample behaviours for category Situational Awareness

From: van Avermaete, J.A.G. (1998) *NOTECHS: Non-technical skill evaluation in JAR-FCL*, Hoofddorp: National Aerospace Laboratory

The Leadership and Managerial skills category described by Van Avermaete (1998) in figure 1.11 can be further expanded to include additional managerial skills associated with the role of captain. Other observers, Fallucco (2002) and Webb (2007) described the business management function of the modern aircraft captain. Fallucco (2002) distinguished between the leadership functions of the captain and the responsibilities associated with the management of resources. Much of the variable cost involved in operating an aircraft such as fuel costs and payload control can be directly influenced by the captain (Fallucco, 2002). The role of the air transport pilot as a manager has been accepted for at least two decades and underpins the Crew Resource Management concepts, not only for the Captain but for other Flight Deck Officers (Blain, 1972, Fallucco, 2002).

Spencer & Spencer (1993) proposed generic competency models for managers engaged in various occupations. Two of the models focused on technical professionals and human service professionals. Spencer & Spencer defined technical professionals as individuals whose work involved the use of technical knowledge and who deal primarily with problems concerning machines, numbers, or physical processes rather than interpersonal processes. Spencer & Spencer observed that high achieving technical professionals used interpersonal skills and team work to accomplish their technical jobs. Individuals involved in managing human services need to possess or develop strong competencies in achievement orientation, team leadership, organisational awareness, and relationship building.

The role of an air transport pilot encompasses both of these generic models with the pilot as a technical professional who has responsibility for the well being of a number of people including other crew members as well as passengers and other airline staff, resources, and property. Table 1.5 derived from Spencer & Spencer shows in more detail the competencies associated with both these groups.

Table 1.5 *Competencies for technical and service professionals*

Technical Professionals	**Human Service Professionals**
Achievement Orientation	Impact and Influence
Impact and Influence	Developing Others
Conceptual Thinking	Interpersonal Understanding
Analytical Thinking	Self-Confidence
Initiative	Self Control
Self-Confidence	Other Personal Effectiveness Competencies
Interpersonal Understanding	Professional Expertise
Concern for Order	Customer Service Orientation
Information-Seeking	Teamwork and Cooperation
Teamwork and Cooperation	Analytical Thinking
Expertise	Concept
Customer Service Orientation	Initiative
	Flexibility
	Directiveness/Assertiveness

From: Spencer & Spencer (1993), *Competence at work*, New York: John Wiley & Sons, Inc

Each competency associated with the technical professional and human service professional groups has associated behaviours. Sample behaviours are illustrated in Table 1.6

Table 1.6 *Technical and Service Professionals – Generic Competencies*

Competency	Sample behaviours
Achievement Orientation	Measures performance Improves outcomes Sets challenging goals Innovates
Impact and Influence	Uses direct persuasion, facts, figures Gives presentations tailored to audience Shows concern for professional reputation
Developing Others	Innovative teaching methods Flexible response to individual needs Belief in students' potential
Conceptual Thinking	Recognises patterns, uses concepts to diagnose situations Makes connections, theories Simplifies, clarifies difficult materials
Analytical Thinking	Sees causal relationships, inferences Systematically breaks apart complex problems
Interpersonal Understanding	Understands attitudes, interests, needs of others
Self-Confidence	Confidence in ones own abilities and judgement Takes responsibility for problems, failings Questions, gives suggestions to their superiors
Self-Control	Keeps own emotions from interfering with work Avoids inappropriate involvement with clients etc. Stress-resistant, has stamina, humour
Professional Expertise	Expands and uses professional knowledge
Concern for Order	Seeks clarity of roles and information Checks quality of work or information Keeps records
Customer Service Orientation	Discovers and meets underlying needs
Information-Seeking	Contacts many different sources Reads journals, etc.
Teamwork and Cooperation	Brainstorms, solicits input Credits others
Initiative	Persists in problem solving Anticipates problems
Flexibility	Adapts style, tactics to fit circumstances
Directiveness/Assertiveness	Sets limits, says no when necessary Confronts problem behaviour

From: Spencer & Spencer (1993), *Competence at work*, New York: John Wiley & Sons, Inc

The non-technical skills framework of the NOTECHS model (Van Avermaete, 1998), shows similarities with Spencer and Spencer (1993)'s generic management model. Table 1.7 shows that there is a high level of commonality between the models in the Cooperation and Leadership and Managerial Skills categories. Situational Awareness skills are not evident in the generic model.

Table 1.7 *The NOTECHS and Generic Management Models*

Category	NOTECH Model	Spencer & Spencer Management Model
Cooperation	Team Building and Maintaining	Teamwork and Cooperation
	Considering others	Interpersonal Understanding
	Supporting others	Developing Others
	Conflict solving	
Leadership and Managerial Skills	Use of Authority/Assertiveness	Directiveness/Assertiveness
		Concern for order
	Providing and Maintaining Standards	
		Self-Confidence
		Self-Control
		Professional Expertise
		Customer Service orientation
		Initiative
		Flexibility
		Impact and Influence
		Achievement Orientation
Decision making	Problem Definition and Diagnosis	Conceptual Thinking
	Risk Assessment and Option Choice	Analytical Thinking
	Outcome review	Information seeking
Situational Awareness	Systems Awareness	
	Environmental awareness	
	Anticipation	

6.4 The Knowledge-Process Hierarchy and NOTECHS: A Comparison

To a large extent the KPH model proposed by Hunt (1997) and the later NOTECHS model proposed by the NOTECHS group (van Avermaete, 1998) are complimentary. While the KPH model was originally developed as a generic model applicable to any occupational group it was successfully adapted to meets the needs of the pilot training community and was equally applicable to the teaching and assessment of both technical and non-technical skills. To the extent that graduates from the Massey University School of Aviation BAv ATP programme have successfully attained professional pilot licences and subsequently have been employed in a range of international and national airlines, the KPH model has proved to be a suitable basis for curriculum development and evaluation and can satisfy the competency prescriptions of the NZCAA pilot licencing requirements. The NOTECHS model represented the other end of the scale. Developed from research which evaluated the performance of experienced airline pilots under air transport operational conditions it concentrated on the non-technical skills associated with the profession of air transport pilot although it recognised that there was a degree of overlap between technical and non-technical skills.

6.5 Summary

While the KPH model produced competent pilots for licensing purposes it is suggested that there is a need for an even greater emphasis on the non-technical skills identified by the NOTECHS model. It is the NOTECHS components that are less emphasised in basic flight training and it is these components that are expected to develop with additional flight experience gained after licence issue. These represent the skill area that distinguishes a proficient pilot from a competent pilot. If the non-technical skills could be identified and progressively incorporated in basic flight training at an early stage the aspiring air transport pilot would be better prepared to benefit from additional flight experience accumulated during the journey from a graduate licensed pilot to entry into an air transport training system. Expanding basic training to include non-technical skill training may effectively shorten the time needed to obtain meaningful general aviation experience by giving the aspiring air transport pilot a focus on the skills needed in preparation for more advanced operations. The KPH model prepares the student pilot to meet the licensing requirements prescribed by the civil aviation authorities and the NTS model prepares the pilot for the profession of air transport flying. To this extent the two models are complimentary.

6.6 Summary of the Literature Review

Examination of the literature raises two important questions about New Zealand flight training which will become the primary focus of this study.

(1) Is there an overemphasis on training for technical skills versus non-technical skills in New Zealand pilot training?

(2) Are candidates for airline pilot employment appropriately skilled for entry into that profession?

In this chapter it was argued that professional pilot training in New Zealand concentrated largely on the development of competence in aircraft handling skills or technical-skills with less emphasis on the non-technical skills such as human factors and airmanship. The focus on technical skills resulted from the need for training organisations to comply with the NZ CAA licensing requirements which in turn demanded competency in a range of technical skills.

The need for training providers to offer training in the wider field of non-technical skills appeared to be constrained by resources and the limited demand for this training by the CAA and the wider general aviation industry. On the other hand, the expectation that additional flight experience gained after obtaining the basic professional licences and ratings would automatically lead to increasing levels of proficiency seemed to be widely accepted in the aviation community.

This has been discussed, together with the traditional airline entry requirement for general aviation flight experience prior to being accepted for airline training.

The development of expertise was examined in a generic sense with research indicating that that the process of acquiring and developing a skill in any domain progressed through different stages or levels. The generic view of expertise development also provides a contrary view to the aviation industry's notion that experience alone will result in skill development. There was general agreement that the development of expertise was a long term process. While experience and the duration of involvement in a particular domain was important, research identified three important factors in the development of expertise; the need to have focused goals, the need for feedback so that actual performance can be compared with desired performance, and the opportunity for repetition. Without these factors the mediocre practitioner remained a mediocre practitioner even though many years may have been devoted to the activity. This is at variance with the popularly held belief in aviation circles that flight experience alone leads to increased proficiency. In the present aviation environment of airline growth and on-going demand for air transport pilots, the traditional apprenticeship model of pilot training, where the newly licensed pilot's career development involves gaining flight experience through several years of flight instructing or other general aviation activities, may not be the most efficient or effective way to progress along a career path leading to airline employment.

Chapter Two

Methodology

2.1 The Research Problem

In the literature review a case was made for the need to establish whether the reported skill and knowledge gap between the flight school graduates and the industry's requirements for airline pilots could be identified and reduced. To achieve this a range of methods were used to collect data from those sectors of the aviation industry concerned with pilot training and competency, including flight training schools, general aviation, and airline operations. Use was made of diverse methods and sources to allow for triangulation, thereby increasing confidence in the results.

The questions that the research addressed were:

1. Is there a skill and knowledge gap between the flight school graduate standard and the airline industry requirements?
    a. What is the nature of this gap?
    b. Does the practice of building hours in General Aviation bridge this gap and prepare pilots for their role as airline pilots?

2. If this gap exists, is it because skills perceived as less important are less effectively trained for?
    a. Does the aviation industry perceive some flying skills to be more important than others?
    b. Is training equally effective for all types of flying skills?
    c. Is there a relationship between the perceived importance of skills and their training effectiveness?
    d. Are accidents caused by a lack of training effectiveness in some skills?

2.2 Overview of the Study

During the design of this study it was initially intended to obtain data by directly observing and assessing pilots under actual and simulated flight conditions. The observations would have included the Line Operational Evaluation (LOE), Line Operational Safety Audit (LOSA) and Non-Technical Skills (NOTECHS) assessments described earlier. It was anticipated that this would have identified the nature of the skill and knowledge gap reported by Spruston and O'Day (2001) and by other researchers (Hunt & Crook, 1985; Hunt, 1994; 2000; GAPAN/EPST, 2003). However the cost of collecting data available by direct observation greatly exceeded the resources of the study so another strategy was devised.

The new strategy involved a four part approach which included a case study that measured the skills of flight school graduates, a broad survey of the New Zealand aviation community to determine their perceptions of the importance and training effectiveness of flying skills, an analysis of air accident data to identify the relationship between skills and accident causes and finally, a qualitative study that examined airline pilots' evaluation of the quality of candidates presenting for airline positions and the essential skills needed to be an airline pilot. The four part approach had the advantage of combining several research methods, which strengthened the design and provided robustness and confidence in the results. Care was taken to ensure that there was no overlap of respondents between the four studies.

The research used three separate groups of pilots at different levels of expertise and training. The first or low experience group included student pilots who were undergoing training for the commercial pilot licence and instrument rating. The second group represented pilots in the process of gaining experience and building their flight hours and included general aviation pilots who were intending to become airline pilots. At the time of the study they were employed as flight instructors or in Part 135 air transport operations. The third group were qualified airline pilots who were employed in the airline industry. This group comprised experienced pilots who had attained a level of proficiency in the industry.

The case study was used to evaluate how well flight training schools prepared their students for employment as an airline pilots. It involved students enrolled in a university air transport pilot (ATP) programme who were undergoing training for the issue of a CPL and Instrument Rating. The University flight school was chosen because, unlike most other New Zealand training providers, the programme was designed explicitly to prepare graduates for eventual employment in the airlines. Because of this there was an emphasis on aviation human factors throughout the course including a basic introduction to Crew Resource Management (CRM). Another feature unique to the programme was the Final Route Check which replicated some of the features of a Line Operational Evaluation (LOE), although conducted in a light twin engine aircraft rather than a flight simulator. Associated with the FRC were comprehensive records of the student's performance and final assessment. This university programme represented a 'best case' scenario for preparing student pilots for airline operations.

The research involved the analysis of flight test results obtained from flight test records. Immediately prior to graduation, the students underwent a flight test involving a simulated two pilot, non-scheduled air transport operation. The data obtained from the test was analysed to evaluate their performance on the non-technical elements and to assess how the students performed in these elements. In the course of the flight test students were assessed in the role of pilot in command as well as that of support pilot. The University programme contained all the basic features of a typical New Zealand professional flight training school but differed in that there was a greater emphasis on aviation human factors throughout the training.

The second stage of the study consisted of a questionnaire distributed to New Zealand pilot training providers, general aviation air transport operators, and airlines. This section sought to identify the industry's perception of the skill deficiencies as reported by Hunt & Crook (1985), Hunt (1994), and Spruston & O'Day (2001) and to identify some of the reasons for these deficiencies. This was done by asking New Zealand pilots to rate the importance of technical and non-technical skills associated with the role of professional pilot and their perception of the quality of the training they had received as student pilots. From the questionnaire responses it was expected to determine the relative importance of both technical and non-technical skills, how well these had been trained for, whether the perception of importance changed with time and experience, and whether the pilots' perception of the training adequacy of those skills changed with time and experience. Respondents included, trainee pilots undergoing basic flight training, general aviation pilots employed as flight instructors or engaged in general aviation air transport such as CAA Part 135 operations and airline pilots included first and second officers, check and training captains, management pilots, and line captains.

The third stage involved the analysis of accident data. Part 121 airline accident data obtained from FAA sources was analysed and causes and contributing causes were categorised as technical or non-technical skill deficiencies. This data was supported by data from part of the stage two survey which considered the association of particular skill deficiencies with incidents that did not result in a negative outcome and so were unreported. The airline pilot group was asked to indicate whether they had observed behaviours associated with the nominated technical and non-technical skills endangering flight safety. While all pilot groups may encounter situations which potentially endanger flight safety, student pilots and general aviation pilots are normally engaged in single pilot operations. For the purpose of this study the extra dimension of multi-crew operations was considered more relevant and therefore only Part 121 heavy aircraft, multi-crew, airline operations were considered.

The fourth stage consisted of a survey of airline pilots employed by five New Zealand airlines. This cross section of pilots included management pilots, check and training pilots, captains, and first and second officers. The survey was conducted by telephone and the participants were asked a set of prepared questions. The survey was designed to determine the prerequisite skills and qualities considered important for prospective airline pilots and an evaluation of the quality of general aviation pilots.

The data from each of the four stages provided a different type of insight into the skill and knowledge deficiencies identified by the Government Review (Spruston & O'Day, 2001). The detailed methodology of each stage follows.

Stage One: A Case Study

2.3 Sample

The case study involved an analysis of flight test results from student pilots enrolled in a University Air Transport Pilot programme (n = 101). No specific biographical data was included in the Final Route Check (FRC) documentation but the candidates shared the following demographics:

- All candidates had completed the ATP practicum syllabus up to the point of the final route check which marked the completion of the flight-training programme.
- The candidates had completed between 220 and 230 hours of flight training including 40 hours on multi-engine aircraft.
- The candidates were holders of private pilot licences with multi-engine, single-pilot instrument ratings and were type rated on the PA34 aircraft that was used for the FRC.
- Each candidate received a comprehensive verbal and written briefing prior to the flight check detailing the task and flight examiners expectations for the flight.

- Each candidate had successfully completed papers on aviation human factors, aviation psychology and basic CRM.

2.4 Procedure

Prior to graduation the students on the ATP programme were required to undergo a Final Route Check (FRC). The FRC was similar in all respects to the Line Operational Evaluation (LOE) used in the airline Advanced Qualification Programme (see Chapter One). An archival analysis was made of the FRC assessments conducted between the years 2001 and 2004. During that period no substantial changes were made to the theory or practicum curriculum of the ATP programme apart from minor changes to the syllabus to reflect changes to CAA Rule Part 61 requirements. The candidate's role during the route check was that of pilot in command for two of the flight sectors and support pilot for two further sectors. The examiner's role was that of observer and fare paying passenger. The examiner sat in the cabin of the aircraft and had no direct role in the conduct of the flight.

2.5 Instrument Development

The FRC assessment was recorded on a comprehensive proforma and each individual test item was graded on a 10 point scale with 8 being the standard performance, less than 8 indicating a substandard performance, and over 8, a superior performance (see Appendix A). As well as a list of rated items there was provision on the proforma for a written summary of the candidate's performance. While the FRC was designed to simulate an air transport style route check there was no attempt to specifically model it on the NOTECHS framework or any other specific CRM assessment format. A post hoc content analysis of the FRC proforma (Appendix A) indicated that the data could be arranged into the categories, elements, and behaviours according to the NOTECHS framework (Appendix B).

Stage Two: The Industry Survey

2.6 Sample

In Stage Two, participants (n = 228) consisted of New Zealand trained pilots who were, or who had been employed as pilots in the air transport industry, or who were under training for professional pilot licences and were seeking a career as a pilot in the air transport industry. Agricultural aviation and helicopter aerial work, being non-air transport occupations, were not included. The participants formed three groups. Group 1 (n = 72), were the holders of Commercial Pilot licences who also held an additional professional qualification such as an instrument rating and/or a flight instructor rating. Participants in this group were either employed as general aviation pilots (i.e. non-airline) or indicated that they were seeking employment in this field. Pilots in this group were in the transitory experience gathering category, seeking employment as an airline pilot when the minimum entry experience requirements were met. A large proportion of this group were employed as flying instructors (72%).

Group 2 (n = 69), were student pilots enrolled at New Zealand flight training organisations. The flight training providers who gave access for the study to their students included a University flight training school, private flight training organisations and aero clubs who had Polytechnic affiliations. All of these organisations specialised in professional pilot training and were certified under New Zealand CAA Rule Part 141[1]. The student pilots were in all cases under

[1] A description of the NZCAA Rules referred to in this thesis is included in appendix C.

going training programmes leading to the attainment of a Commercial Pilot Licence with instrument rating and/or flight instructor rating issued under NZCAA Rule Part 61. The questionnaires were administered to student pilots who were at the stage of their training where they had just qualified for the Private Pilot Licence and typically had logged some 60–80 hours of flying experience.

Group 3 (n = 87), were airline pilots employed by NZCAA Rule Part 121 or 125 airlines or retired pilots who had previously been employed by airlines.
The airline pilots employed by Part 121 organisations represented the highest level of the pilot profession. As all pilots in this group are required to hold an airline transport pilot licence (the top pilot qualification prescribed by the Civil Aviation licensing requirements) they may be considered proficient or expert practitioners both in terms of qualifications and experience.

2.7 Selection

The ATP programme students were invited to participate in the survey after permission had been obtained from the Head of School. These PPL level students were briefed by the researcher at a convenient time during classes. The purpose and objectives of the research were described and the voluntary and confidential nature of the survey was explained. Stratified sampling of New Zealand flight training providers was conducted using organisations involved in professional pilot training identified in the comprehensive address lists contained in the NZ Wings Directory (McPherson, 1996). An initial approach was made by telephone with the Managers or Chief Flying Instructors seeking their verbal agreement to allow their students to participate. This was followed by a sample questionnaire and a letter fully explaining the project. After an appropriate interval the organisations were re-contacted by phone and on agreeing to participate, arrangements were made to supply questionnaires and instruction sheets. Provision was made for the return of the documents in a manner which preserved the confidentiality and anonymity of the participants and the organisation, and without expense to the participating organisation. All organisations approached agreed to participate.

General Aviation Organisations and New Zealand Airlines were identified and approached in a similar manner with initial contact being made through Chief Pilots or Operations Managers. Again, all organisations approached agreed to participate. An organisation representing New Zealand pilots including present and retired professional pilots, the New Zealand Guild of Air Pilots and Air Navigators, was approached and agreed to assist in the research by distributing the questionnaires among Guild members.

2.8 Characteristics of Sample

2.8.1 Gender

The survey results showed a predominance of males in all groups as shown in Table 2.1.

Table 2.1 *Participants Gender by Pilot Group*

Pilot Group	Males	Females
General Aviation	59	13
Students	56	13
Airline Pilots	84	2

2.8.2 Age

In the General Aviation Pilot group 7 (9.7%) were aged less than 20, 43 (59.7%) were in the 21 – 30 age group, 17 (23.6%) were in the 30 – 40 age group and 5 (6.9%) were over 40.

With the Student Pilots the majority of the respondents were in the younger age groups with 33 (47.8%) being in the less than 20 age group, 29 (42%) being in the 21 to 30 age group, 5 (7.2%) in the 31 to 40 age group and 2 (2.8%) over 40.

The Airline Pilot group contrasted with the previous two groups by having a majority of more mature pilots. In this group no pilots were aged below 20 years, 11 (12.8% were in the 21 – 30 age group, 28 (32.5%) were in the 31 – 40 age group, and 47 (54.6%) were over the age of 40. Table 2.2 shows the distribution of age with pilot groups.

Table 2.2 *Pilot group by age*

Age	< 20	21-30	31-40	>40
General aviation	7	43	17	5
Students	33	29	5	2
Airline pilots	0	11	28	48

2.8.3 Employment

Of the General Aviation group, 12 respondents (16.6%) indicated that they were not yet employed but were seeking employment as a professional pilot. A further 17 pilots (23.6%) indicated that they had been employed for less than 12 months, 29 (40.2%) had been employed from 1 – 5 years, while 14 (19.4%) had been employed as a professional pilot for more than 5 years. The distribution of length of employment in the general aviation group is shown in Table 2.3

Table 2.3 *Length of Employment – General Aviation Pilots*

< 12 months	1 – 5 years	> 5 years	Not yet employed
17	29	14	12

A total of 4 (4.6%) Airline Pilots indicated that they had been employed in the role for less than 12 months while 27 (31.3%) indicated that they had been an Airline Pilot for 1 - 5 years. There were 13 (15.1%) in the 5 – 10 year group, 25 (29.1%) in the 10 – 20 year group while another 17 (19.7%) indicated that they had been employed as an Airline Pilot for more than 20 years. Table 2.4 shows the distribution of airline pilots by length of employment.

Table 2.4 *Length of Employment in Years - Airline Pilots*

<12 months	1-5 years	5-10 years	10-20 years	>20 years
4	27	13	25	17

2.8.4 Flying Experience

In the general aviation group, 4 (5.5%) pilots indicated that they had between 200 and 250 hour flying experience, 24 (33.3%) had between 250 and 500 hours experience, 13 (18.1%) had between 500 and 1000 hours, 22 (30.5%) had between 1000 and 2500 hours and 9 (12.5%) had in excess of 2500 hours. Table 2.5 shows the distribution of flying experience in hours for the general aviation pilot group.

Table 2.5 *Flying Experience in Hours – General Aviation Pilots*

200-250	251-500	501-1000	1001-2500	>2500
4	24	13	22	9

The Airline Pilot responses indicated that 9 (10.4%) had between 1000 – 2500 hours flying experience (this represents the typical minimum entry experience for employment in this role). A further 23 (26.7%) had between 2500 and 5000 hours of experience. In the 5000 to 10000 hour range there were 20 (23.2%) respondents, 17 (19.7%) in the 10000 to 15000 hour range, 10 (11.6%) in the

15000 to 20000 hour range and 7 (8.1%) with more than 20000 hours experience. Table 2.6 shows the distribution of flight experience for the airline pilots

Table 2.6 *Flying Experience in Hours-Airline Pilots*

1000-2500	2500-5000	5000-10,000	10,000-15,000	15,000-20,000	>20,000
9	23	20	17	10	7

Student pilots provided details of their flying experience. As the student pilot group had only limited flying experience, and because there is a considerable variation of experience within the group the research deliberately targeted students who had achieved the Private Pilot Licence and were therefore entitled to act as Pilot in Command of an aircraft carrying passengers. The student pilots flying experience is shown in table 2.7. In the student pilot group the largest number of respondents were in the 50–100 hours experience group (n = 28).

Table 2.7 *Flying Experience in Hours-Student Pilots*

<50	50-100	100-150	150-200	200-250	250-500	>500
1	28	13	14	6	5	1

2.8.5 Military or Civilian Training

In the past an important source of professional pilots has been the military forces, particularly air forces. At the present time in New Zealand the growth of civilian flying schools and a down-sizing of the RNZAF have resulted in fewer ex military pilots entering the aviation industry. As table 2.8 shows only two of the respondents employed as general aviation pilots were military trained while a larger proportion of airline pilots came from a military background.

Table 2.8 *Military vs. Civilian Training*

Pilot group	Military Trained	Civil Trained
General Aviation	2	70
Student	0	69
Airline	28	59

2.8.6 Gaining Experience

The airline and general aviation pilots were asked to indicate how they gained flying experience to meet the airline entry requirements or in the case of the general aviation pilots, how they planned to gain the experience. Table 2.9 shows the distribution of responses.

Table 2.9 *Previous Experience - Airline and General Aviation Pilots*

Experience	Airline	General Aviation
Flight instructing	38	54
G.A.-non air transport	7	2
G.A.-air transport	22	6
Other (specify)	16	0
Not applicable	3	7

2.8.7 Airline Pilot Appointments

Airline pilot respondents were requested to indicate their present or most recent appointment. Table 2.10 shows distribution according to rank.

Table 2.10 *Airline Appointment*

Captain	First Officer	Second Officer
49	37	1

2.8.8 Present Employment

The airline and general aviation pilots were asked to describe their present employment. There were more choices with the general aviation group because of the wider scope of employment opportunities for general aviation pilots. Table 2.11 shows distribution by employment category.

Table 2.11 *Airline and General Aviation Pilots - Present Employment*

Employment	Airline	General Aviation
Part 121	66	2
Part 125	11	0
Part 135	0	18
Corporate	2	1
Instructing	0	41
Unemployed	0	7
Retired	6	0

2.8.9 Pilot Qualifications

The three pilot groups were asked to indicate what pilot qualifications they now hold or have held. Table 2.12 shows distribution by pilot qualification type.

Table 2.12 *Pilot Qualifications*

Qualification	Airline	General	Student
PPL	0	0	55
PPL/IR	0	0	3
CPL/IR	4	13	8*
CPL/IR/Instructor	13	40	0
CPL/Instructor	0	13	0
ATPL	19	0	0
ATPL/Instructor	51	0	0
Other	0	3	0

* Students training to be flight instructors

2.8.10 Educational Qualifications

The respondents were asked to indicate their highest formal education qualifications. Table 2.13 shows distribution by educational qualification.

Table 2.13 *Formal Educational Qualifications*

Qualification	Airline	General Aviation	Student
No Formal Qualifications	4	3	2
School Certificate	17	8	2
University Entrance	27	20	25
NCEA	2	3	20
Polytechnic Certificate/Diploma	8	10	3
Undergraduate University Diploma	3	3	1
University Bachelor Degree	23	18	11
University Masters Degree	3	0	0
Doctorate Degree	0	1	0
Other Academic Qualification(s)	0	2	5

2.9 Procedure

Stratified random sampling of three groups from the New Zealand professional pilot population was conducted with group one consisting of general aviation pilots, group two student pilots, and group three airline pilots. Stratified random sampling is an appropriate method for examining occupational groups as it allows the inclusion of parameters of special interest and controls for internal validity through control variables (Tuckman, 1999). Small differences in the questionnaire formats were made for each group. These differences were in the demographic section of the questionnaire and involved excluding questions that were not relevant to the particular pilot group such as aviation employment history for the student pilot group. Additionally only the general aviation and airline pilot groups were asked to indicate observed behaviours associated with flight safety.

2.10 Instrument Development

In order to determine the skills and competencies associated with the professional pilots' role, the survey was focused on a wide cross section of the New Zealand Aviation Industry. A questionnaire was created which examined a large selection of the competencies associated with the role of professional pilot, and applied to a broad cross section of the industry including airline pilots, general aviation pilots, and student pilots training for professional licences. In determining the form of the questionnaire, advice was sought from New Zealand airline training and operations managers (n = 5) on their airlines requirements for pilot recruits. The managers were interviewed individually using a semi-structured interview technique. The semi-structured interview has several advantages when face to face interviews are conducted on an individual basis:

- With repeated contact rapport increases between interviewer and the informant
- The informant's perspective is provided rather than the perspective of the researcher being imposed
- The informant uses language natural to them rather than trying to understand and fit into the concepts of the study
- The informant has equal status to the researcher in the dialogue rather than being a guinea pig.

(Burns, 2000, p. 425)

The development of the questionnaire had four major influences. These included the JAA NOTECHS model (Van Avermaete, 1998), a range of management competencies derived from Spencer and Spencer's (1998) management models, Hunt's (1985) KPH model, and several non-technical skill categories identified by New Zealand airline managers as being relevant to airline operations in this country.

The JAA NOTECHS system had already been adopted by many major European airlines and Civil Aviation Authorities as representing the non-technical skills identified as important for airline pilots. The New Zealand airline managers influenced the inclusion of technical skills as well as a broader scope of generic management competencies derived from Spencer and Spencer. The technical skills together with human factors competencies identified by Hunt in his KPH model formed the basis of the university programme described in this study and had proved to be a successful model for nearly two decades.

The development of the questionnaire is described together with the definitions of the variables and how a generic management model is closely allied to the accepted and validated NOTECHS framework for the development of expertise in air transport pilot non-technical skills. The questionnaire was designed to determine the responses of New Zealand trained pilots to the importance of technical and non-technical skills and the adequacy of their training in these skills. The questionnaire consisted of two sections. In the first section the participants were given a list of 29 different competencies or elements each with a selection of sample behaviours. The respondents were asked to answer three questions pertaining to each of the 29 competencies listed in the questionnaire. The responses were recorded by means of a Likert scale.

The three questions were:

- How important are these competencies for a professional pilot?
- How effective was your training in these competencies to CPL/IR level?
- Have you ever observed behaviour associated with these competencies that have directly endangered flight safety? (This question did not appear on the students' questionnaire as it was considered that this was more relevant to operational flying rather than flight training).

Part two of the questionnaire consisted of biographical and general data. In this section demographic information was sought about the participant's age, type of employment, years of employment, flying experience and qualifications. In general aviation pilots' questionnaire, the participants were requested to indicate how well they thought their training to CPL level equipped them for employment as a professional pilot. In the case of airline pilots a similar set of questions determined the respondent's opinion of how well their CPL training prepared them for an airline pilot job and how well it prepared them for multi-crew operations. The information from part two of the questionnaire was used to provide an indication of longitudinal changes in the respondents' attitudes with age and experience.

2.10.1 The Questionnaire Format

The questionnaire consisted of two parts. Part 1 was constructed using the 15 elements and descriptive behaviours which formed the NOTECHS framework as the basis of the Questionnaire. Additionally, there were nine generic management competencies with sample behaviours that were identified from the Spencer and Spencer model. Finally three technical skill accomplishments with sample behaviours were included. The reason for including these technical skills was to determine the respondent's views of the importance and training effectiveness of these skills which have been the traditional basis of pilot training and assessment for pilot licensing.

Table's 2.14 - 2.16 show the individual items that the respondents were asked to assess. The question numbers indicate where the items can be found in the questionnaires. The actual questionnaires for the three groups have been included in Appendix D - F

Table 2.14 *NOTECHS Questions*

Questionnaire	Category	Competencies (15)
	Leadership and Management	
Q1		Using authority and assertiveness
Q2		Maintaining standards
Q3		Planning and coordinating
Q4		Workload management
	Situational Awareness	
Q12		Systems awareness
Q13		Environmental awareness
Q14		Time keeping
	Cooperation	
Q17		Team building and maintaining
Q18		Considering others
Q19		Supporting others
Q20		Conflict resolution
	Decision making	
Q23		Defining and diagnosing problems
Q24		Generating options
Q25		Risk assessment and option choosing
Q26		Reviewing Outcomes

Table 2.15 *Generic Management Competency Questions*

Questionnaire	Competencies (9)
Q5	Organisational Awareness
Q6	Customer Awareness
Q7	Leadership
Q8	Organisational Commitment
Q9	Self Control
Q10	Self Confidence
Q11	Flexibility
Q21	Developing others
Q22	Relationship Building

Table 2.16 *Technical Questions*

Questionnaire	Competencies (3)
Q27	Aircraft Handling Skills
Q28	Aircraft Systems Management
Q28	Aircraft Navigation Management

For each competency the General Aviation and Airline Pilots were asked to respond to the three questions:

- How important are these competencies for a professional pilot?
- How effective was your training in these competencies to CPL/IR level?
- Have you ever observed behaviours associated with these competencies that have endangered flight safety?

A five point Likert type scale was provided for the response to the question about endangering flight safety. This question was not included in the Student Pilot questionnaire as it was considered that the students were not likely to have been exposed to these types of situation.

Part Two of the Questionnaire gathered biographical and general data from the three pilot groups. Due to the differing nature of the pilot groups, Part Two was tailored to each specific group. The airline pilot participants were requested to indicate their age by marking one of four age categories: Under 20, 21 – 30, 31 – 40, over 40. The second question required them to indicate their current employment: Part 121 airline, Part 125 airline, Corporate (private) air transport, or retired. The respondents were also asked to indicate their present or most recent airline rank, length or service, previous military service, gender, total flying experience, type of training organisation attended to CPL/IR level, present pilot qualifications and highest educational qualifications.

The respondents were questioned on their flying backgrounds. As most New Zealand airlines do not recruit directly from the flight schools, new pilot applicants are expected to gain additional flying experience as a pre-requisite. The respondents were asked to indicate if this experience was gained by flight instruction, general aviation – non-air transport, general aviation – air transport, other (specify), or not applicable.

Two further questions were designed to determine the effectiveness of the respondents' basic training. Respondents were asked to indicate how well they considered their flight training to CPL/IR prepared them for employment as an airline pilot and how well they considered the same training prepared them for multi-crew operations. The remaining questions were designed to determine the respondents' secondary duties and responsibilities both within their organisation and outside of their organisation.

Alexander (2003) suggested that experts were able to bring new knowledge into a domain by employing deep-processing strategies which involved researching, investigating, and maintaining a high level of engagement over extended periods of time. It is suggested that in the case of airline pilots, involvement with secondary duties within the airline or the wider aviation community may be an indication of having developed some level of expertise. As seniority and experience grows pilots may become involved in activities such as such as management, flight safety, check and training, ALPA representation, and technical instruction within their airlines, and externally, with involvement in activities such as general aviation flight/ground instruction, flight safety, and aviation consultancy, managing /owning an aviation enterprise and membership of professional bodies such as the RAeS and GAPAN. Such activities may be evidence of expertise according to Alexander's proposition that experts engage at a high level over extended periods of time. This was included as a question in the Airline Pilot Questionnaire (Appendix E).

The general aviation pilots' part two questions were similar to the Airline Pilots. The differences reflected the broader employment environment of a GA pilot. Age, length of employment, military experience, gender, total flying experience, type of training organisation, pilot qualifications, and educational qualifications questions were the same for all pilot groups. The GA respondents were asked how well they considered that their flight training had prepared them for employment as a professional pilot and how well the CPL/IR theory curriculum prepared them for employment as a professional pilot. (General Aviation Pilot Questionnaire, Appendix F)

There were further differences with the student pilot group. A general lack of aviation experience necessitated that the students' questionnaire be restricted in scope, but concentrating on the same basic biographical data that applied to the other groups. A question unique to the student group was to determine what sort of professional pilot employment they would be seeking on graduation (Student Pilot Questionnaire, Appendix D).

2.10.2 Electronic Questionnaire

In response to suggestions made by a New Zealand Airline Pilot Association official (C. Oliver, personal communication, September, 2006) an alternative electronic questionnaire was prepared using a proprietary software programme produced by "Survey monkey"™. The format of the questionnaire was identical to the hard copy questionnaires. A good response was obtained from student pilots. A third level airline operating in New Zealand indicated that they would prefer to participate in the survey by using the electronic questionnaire. In the event no responses were obtained from that airline although both hard copy and electronic questionnaires were offered.

Stage Three: Air Accident Analysis

2.11 Sample

FAA Part 121 aircraft accident data covering a period of 40 years was obtained from FAA and American National Transportation Safety Board (NTSB) sources (n = 229). Accidents attributable to crew error on fixed wing, scheduled air transport operations were selected with cases attributable solely to mechanical defects or weather phenomena excluded.

2.12 Procedure

The aircraft accident data was examined to determine if any of the technical skills proposed by Hunt (1986), and the non-technical skill categories obtained from the Principal Component Analysis in the second study was identifiable as causal factors. The presence of these technical and non-technical skill categories as primary or secondary causes of aircraft accidents is one possible indicator of deficiencies in the training of these skills or areas where these skills should become the focus of further training.

The accidents were analysed for evidence of technical and non-technical skill deficiencies as causal factors (NTSB, 2007). The analysis was made by examining the 'probable cause' text assigned to each report. This was a section that summarised the events surrounding the accident and focused very clearly on the exact cause(s) of the accident and the roles crew members played in the event.

The technical or non-technical skill categories responsible for the direct cause of the accident and those which were contributing or secondary causes were readily identified from the 'probable cause' section. For example an accident attributable to the co-pilots decision to continue approach below minimums may be due to "decision making" deficiencies but if the report indicated that the Captain failed to monitor the co-pilot's actions during the approach, "team working" would be assigned as a contributing factor.

The American data bases were chosen for two reasons. Firstly they were comprehensive, featuring several hundred accidents and incidents of all kinds. Secondly, and importantly, the reports attributed 'probable causes' to the accidents and incidents. Accident and incident reports from New Zealand, Australian and United Kingdom authorities reported a lower volume of accidents and did not provide 'probable cause' information. In these reports the investigations resulted in a series of findings which stopped short of suggesting a probable cause.

Stage Four: The Airline Pilot Interviews

In this part of the study New Zealand airline pilots were interviewed to obtain their views on the adequacy of the General Aviation pilots presenting for employment in the airlines and qualities that distinguish a successful airline pilot.

2.13 Sample

A broad sample of the New Zealand airline pilot population including pilots in managerial and training positions, captains, and first and second officers of five New Zealand airlines were interviewed (n = 22). Twelve of the pilots interviewed were Captains, nine were First Officers, and one was a Second Officer. Of the Captains, six had training responsibilities and three had management duties. The airlines represented were Mt Cook, Air Nelson, Air New Zealand and Eagle Airways.

2.14 Procedure

Senior managers of New Zealand based airlines were contacted by phone and their cooperation sought for the participation of their pilots in a telephone interview. All the managers contacted agreed to participate in the interviews themselves and provided contact numbers of other company pilots who they considered would be suitable. Contact was made during daytime working hours and in some cases pilots were contacted at home when off duty. The telephone interviews took between 20 to 30 minutes.

2.15 Instrument Development

This part of the study was intended to support the data obtained from the stage one and two by asking airline pilots to elaborate in more depth on the quality and effectiveness of general aviation training. In addition, it provided a measure of the effectiveness of the 'experience' the GA pilots had gained in preparing them for employment as an airline pilot The subjects were requested to respond to the following ten questions:

- What skills/qualities are needed to be a successful airline pilot?
- How do new pilots entering the airlines rate in these qualities?
- Are there any particularly good skills/qualities that new pilots bring to the airline?
- Are there any particularly bad skills/qualities that new pilots bring to the airline?
- Has training effectiveness improved over the years?
- What are the reasons for any changes?
- What areas of basic training could be improved for new pilots joining the airline?
- What changes would you like to see to the basic training programme?
- What is the best way to gather flying experience in preparation for joining an airline? Instructing, PT 135, Other.
- Is previous multi-crew training or experience beneficial?

In contrast to the questionnaire used in the second stage, which employed mainly closed, fixed response questions, the technique employed for this stage was that of open-ended questions. Both techniques have their own advantages and disadvantages and it was reasoned that by employing both techniques the accuracy of the data collected would be improved. Patton (1990) described closed, fixed response questions as being categories of questions and responses that have been determined in advance where the respondent chooses from a selection of fixed responses. The advantage of this method according to Patton is that the data analysis is simple; responses can be directly compared and aggregated, and many questions can be asked in a short time frame. The disadvantages are that respondents have to fit their experiences and feelings into the researcher's categories and this may distort what the respondent really means by limited response choices. Also the researcher's categories may be perceived as impersonal, irrelevant, and mechanistic (Patton, 1990).

The advantages of open-ended interview questions are that they do not stifle responses and the respondents get the chance to raise new issues. It can be a more rewarding process for respondents as they feel that they have been given the opportunity to speak their mind. Disadvantages of this type of interview are possible coding difficulties particularly if multiple answers are given and the interviews can be time consuming (Patton, 1990). The interview was based around a series of key ideas designed to obtain the views of experienced pilots on the perceived quality of flight school graduates entering the airline industry and to obtain opinions of how improvements could be made to basic flight training to ensure a better quality of graduate entering the airline industry.

2.16 Summary

This chapter defined the research questions and gave an overview of the methodology used during the four stages of the study. The next chapter presents the results of each stage of the survey.

Chapter 3

Results

3.1 Introduction

In the previous chapter the methodology used in the study was explained. The main part of the survey consisted of a questionnaire targeting the wider aviation community in New Zealand and was supported by a case study, an analysis of air accident reports, and interviews with New Zealand airline pilots. Stage 1 of the study was a case study and involved the analysis of flight test results from a flight training programme to determine the extent and effectiveness of non-technical skill training in such a programme. Stage 2 explored the perception of the importance of technical and non-technical skills in a cross section of student pilots and two industry pilot groups, stage 3 analysed Part 121 air transport accidents for evidence of technical and non-technical skill deficiencies as direct and contributing causes, and stage 4 sought the views of New Zealand airline pilots on the quality of basic flight training and the standard of new recruits into the airline industry. In this chapter the results of each stage will be presented separately and in the following discussion chapter the results will be considered conjointly.

Stage 1: Case Study of Non-technical Skills in A Structured Pilot Training Programme

This section presents the analysis of flight test results from a highly structured university flight training programme with the objective of determining the student's performance in non-technical skill areas under simulated two-pilot air transport operations. The university flight training programme was chosen for three reasons. Firstly the programme was unique in that flight training continued after the issue of the multi-engine instrument rating with the students receiving additional training in two-pilot operations with the objective of familiarising the students with the basic principles of two-pilot, air transport operations. This training is not required under the New Zealand Civil Aviation Rules and is not normally available in this country. The second reason was that the strong emphasis on aviation human factors, including an introduction to the principles of crew resource management was an unusual feature of this programme. CRM and its associated human factors training is normally only conducted by airlines as part of their recurrent pilot training programmes and is not part of the Part 61 licensing requirements. The final reason for choosing the university flight programme was the availability of comprehensive flight test records covering a number of years. From these records it was hoped that detailed data on the performance of advanced students in the non-technical skill area could be obtained.

The university aviation school was founded in 1990 and its Flight Crew Development Programme (now called the Air Transport Pilot Programme) has been described as:

"A stand alone aviation degree in which the aviation licences are integrated with academic knowledge, technical theory and skilled single and two-crew flight practice"

(Hunt, 1994 p. 2)

An analysis of the programme showed that about 40 percent of it was focused on the development of technical skills, 30 percent was devoted to science respondents and the remaining 30 percent focused on human factors and management topics (Hunt, 1994). While the School's programme had a greater focus on human factor based non-technical skills, in many other respects it was similar to the normal New Zealand general aviation pilot training school where training was geared to satisfy CAA Part 61 licensing requirements.

This stage of the study focused on non-technical skill training for the issue of the basic professional pilot qualifications of commercial pilot licence and instrument rating. The University programme was designed specifically for students wishing to eventually pursue an airline pilot career. While the programme emphasised the theoretical aspects of crew resource management and aviation human factors, its scope was limited by the requirements of CAA Rule Part 61 which required a narrow focus on single pilot operations. Additional multi-crew training would have involved considerable expense. Unlike the U.K, multi-crew training was not mandated in New Zealand at the time of the study (UK CAA LASORS, 2007). In the university programme, an additional 20 hours of multi-engine training post instrument rating issue, was devoted to two pilot operations (Massey University

BAv ATP Handbook. 2007). This flight training was supplemented by simulator training exercises. The programme's final flight exam consisted of a multi-crew, multi-leg, simulated CAA Rule part 135 Air Transport Operation. Two licensed and instrument rated students operated the flight with the flight examiner acting in the role of passenger. The final flight examination results of the university programme were analysed with the following objectives:

- To determine if non-technical skills can be effectively assessed in the context of a simulated two-pilot air transport operation.

- To determine if early formal training in non-technical skills translates to improved practical performance in a two-pilot simulated CAA Part 135 air transport operation.

3.2 Flight Test Performance

3.2.1 Technical Skills

There was no requirement to assess handling skills in the flight test but space was available on the flight test proforma for examiners to record general comments. The Final Route Check (FRC) was developed specifically to assess the candidate's ability to conduct a multi-sector non-scheduled light aircraft air transport operation such as would be encountered by a commercial pilot employed by an air charter company operating under CAA Rule Part 135. The candidate had the assistance of a support pilot acting as a crew member. As the candidates had recently qualified for instrument ratings and were in current flying practice, their technical skills were not specifically evaluated. It was presumed that they were competent to Rule Part 61 standards. Although there was no specific provision made on the test proforma for assessing technical skills, the examiners frequently made reference to the candidates' handling skills in the post flight summary. In the assessments analysed (n = 101) it was recorded on 35 occasions that the candidates' aircraft handling skills were "satisfactory". On 29 occasions the candidates' handling skills were judged as "above average", "good" or "superior". On 7 occasions deficient handling skills were noted and on 30 occasions no mention was made of the candidates' aircraft handling skills.

3.2.2 Non-Technical Skills

While the FRC proforma had little provision for the assessment of technical skills a wide range of non-technical skill behaviours were observed and assessed. Based on the NOTECHS descriptive framework model proposed by van Avermaete (1998), the 130[1] items assessed in the FRC were organised into appropriate categories elements and behaviours (see Appendix B). Although the FRC proforma was based on the NOTECHS descriptive framework, the former was more limited in scope. Some of the NOTECHS behaviours would not be observed on routine air transport flights but would occur only under special conditions such as simulator based emergency scenarios. The FRC was designed to be a flight examination and as such no emergency events were planned or expected so these behaviours were excluded.

In reviewing the individual items that were assessed during the FRC it was found that they mainly referred to the elements *Planning and Coordinating* in the *Leadership and Management* category, *Supporting Others* in the *Cooperation* category and *Generating Options* in the *Decision Making* category. Due to the structure of the FRC, the other NOTECHS elements: *Considering Others, Conflict Solving*, and *Reviewing Outcomes* were not independently assessed, however as suggested by Flin, Goeters, Hormann & Martin (1998), there is a certain interdependence of the various non-technical skills observable in flight deck operations. These behaviours possibly fall into one of the first three categories or

[1] The FRC proforma has been subject to revision and the actual number of test items may vary slightly

simply the opportunity to observe them did not arise during an actual flight such as in the case of *Conflict Solving*.

3.3 Reliability and Validity

Internal consistency of the behavioural items was assessed using the Cronbach's α coefficient (see tables 3.1 to 3.4). Five of the elements produced an α coefficient of .7 or higher and may be considered as acceptable while four elements produced α coefficients in the .4 to .5 range and must be treated with caution (Burns, 2000). According to Pallant (2001) small α coefficients may arise when there are less than 10 items in the scale which was the case in this analysis.

Content validity is the representativeness or sampling adequacy of the measuring instrument (Burns, 2000). A test such as the FRC may be considered valid if it represents the objectives of a given instructional sequence – in this case the objective was to assess how well the BAv-ATP programme prepared graduates for employment as air transport pilots. The FRC was developed by an experienced airline check and training pilot with qualifications in instructional design and it was concluded with some confidence that the FRC had appropriate content validity.

3.4 Inter-Rater Reliability

For the FRC to provide consistent and meaningful results, the examiners observing and evaluating crew behaviours must be trained appropriately and given guidance and standardised grading systems. The FRC examiners receive a comprehensive five page written briefing on the test and accompany an experienced examiner on a FRC to observe the conduct and grading of the test before conducting a flight test themselves. Baker and Dismukes (2003) proposed a 'gold standard' approach to crew performance evaluation. The 'gold standards' are based on the judgements of expert flight instructors who define the performance standards. School policy for the FRC was to establish a 'gold standard' by employing external examiners who were highly experienced airline check and training pilots. The number of such examiners was restricted for ease of standardisation. The underlying philosophy was for the aviation industry to define the graduate standard rather than the School to impose its own on the industry. The elements and number of behavioural items tested in the FRC are shown in Tables 3.1 to 3.4.

The first NOTECH category (Leadership and Management) shown in Table 3.1 contains the elements; *authority and assertiveness, providing and maintaining standards, planning and coordinating* and *workload management.* In the FRC a total of 32 behaviours associated with these elements were assessed. All elements except *authority and assertiveness* were rated as slightly exceeding the standard performance (rated at 8 on the test proforma) with *authority and assertiveness* being marginally below.

Table 3.1 *NOTECHS Elements and Behavioural Items for Leadership & Management.*

Leadership and Management				
Element	Authority and Assertiveness	Providing and Maintaining Standards	Planning and Coordinating	Workload Management
Items tested	7	8	15	3
Internal consistency reliability	r = .791	r = .706	r = .885	r = .785*
Mean score	7.60	8.12	8.07	8.13
Max	9.00	9.00	10.00	10.00
Min	6.00	6.00	6.00	6.00
SD	(.61)	(.58)	(.61)	(.76)

- one item eliminated to improve reliability

In Table 3.2 the NOTECHS cooperation category contains the elements; *team building and maintaining, considering others, supporting others,* and *conflict* *resolution.* In the FRC most of the assessed behaviours were associated with the *supporting others* category. No behaviours associated with the *considering others* and *conflict solving* categories were assessed. These categories did not fit within an in-flight assessment but may have been appropriate to a simulator scenario.

Table 3.2 *NOTECHS Elements and Behavioural Items for Cooperation*

Cooperation				
Element	Team Building and Maintenance	Considering Others	Supporting Others	Conflict Solving
Items tested	3	Nil	45	Nil
Internal consistency reliability	r = .546		r = .929	
Mean score	7.52		7.86	
Max	10.00		10.00	
Min	6.00		6.00	
SD	(.64)		(.47)	

In the NOTECHS *situational awareness* category, with the three associated elements; *systems awareness, environmental awareness*, and *time keeping*, a smaller number of behaviours were assessed in the FRC. In Table 3.3 only *time keeping* was assessed as achieving the standard with *systems* and *environmental awareness* being below standard.

Table 3.3 *NOTECHS Elements and Behavioural Items for Situational Awareness*

Situational Awareness			
Element	Systems Awareness	Environmental Awareness	Time Keeping
Items tested	5	4	3
Internal consistency reliability	r = .514*	r = .489*	r = .419*
Mean score	7.23	7.50	8.10
Max	9.00	9.00	10.00
Min	6.00	6.00	6.00
SD	(.47)	(.48)	(.67)

*one item eliminated to improve reliability

The final NOTECHS category, *decision making* is shown in Table 3.4. Associated with *decision making* are the 4 elements; *problem definition and diagnosis*, *generating options, risk assessment and option choosing*, and *reviewing outcomes.* No behaviours were observed or assesses for the later item. All assessments in the *decision making* category were slightly below the standard.

Table 3.4 *NOTECHS Elements and Behavioural Items for Decision Making*

Decision Making

Element	Problem Definition and Diagnosis	Generating Options	Risk Assessment and Option Choosing	Reviewing Outcomes
Items Tested	5	10	1	Nil
Internal consistency reliability	r = .964	r = .706*	n.a.	
Mean score	7.67	7.62	7.65	
Max	9.00	9.00	10.00	
Min	6.00	6.00	5.00	
SD	(.57)	(.43)	(.80)	

- one item eliminated to improve reliability

The FRC results indicated that in the NOTECHS Leading and Managing category, on the three elements; *providing and maintaining standards, planning and coordinating,* and *workload management,* students achieved mean scores of > 8 indicating that in general, most candidates reached or surpassed the standard performance. The only other NOTECH category to be assessed as meeting the standard was Situational Awareness, where the element of time keeping scored > 8. In the other NOTECH categories, the elements mean scores were < 8 but were in the 7.2 – 7.8 range suggesting slightly below standard performance. There was a lack of reportable data for the elements, *considering others, conflict solving,* and *reviewing outcomes.*

3.5 Stage 1 Summary

The results of this survey showed that it was possible to identify the key non-technical skills elements within a simulated two-pilot air transport operation. Although the student's training to this point had been concentrated on single-pilot operations and there had been only limited attention paid to formally training for the non-technical skills, there was an indication that students performed satisfactorily in the NOTECHS leadership and management category. They performed less well in the cooperation, situational awareness, and decision making categories.

Stage 2: A Survey of the Importance, Training Effectiveness and Flight Safety Implications of Technical and Non-Technical Skills.

3.6 Introduction

This stage analyses the responses of three pilot groups to a two part questionnaire designed to determine the extent to which New Zealand pilots valued nominated technical and non-technical skills associated with the role of a professional pilot and their perception of the quality of the training they had received as student pilots. The airline pilot group was also asked to indicate the frequency with which these skills endangered flight safety. The analysis of the questionnaire responses is presented. A Principal Component Analysis (PCA) was conducted on the non-technical skills to produce a smaller number of categories and ANOVA was used to examine differences between the three pilot groups on these components. Content analysis was used to examine qualitative data.

3.7 Importance and Training Effectiveness of Technical and Non-Technical Skills

3.7.1 Principal Component Analysis

A principal component analysis (PCA) was conducted with the objective of examining the non-technical skills to determine if they clustered into identifiable groups. The principal component analysis is an appropriate method of identifying subsets of variables within a larger mass of variables so that a manageable set of closely related factors can be identified (Burns, 2000; Tabachnick & Fidell, 2007). The twenty five items of the competency importance scale were subject to principal component analysis. Prior to performing the PCA the suitability of the data for factor analysis was assessed. Inspection of the correlation matrix revealed that there were many coefficients of .30 or greater. A correlation coefficient of .30 is considered to be the minimum value for a PCA (Tabachnick & Fidell, 2007). The Kaiser- Meyer – Oklin (KMO) value was .853 which exceeds the minimum recommended value of .60 and the Bartlett's test of sphericity (1616.52; $p \leq .0001$), supported the factorability of the correlation matrix. Principal components were then extracted. A Kaisers' criterion test revealed the presence of seven components with Eigenvalues exceeding 1.0, explaining 24.4%, 6.03%, 5.9%, 5.6%, 5.1%, 4.8%, and 4.3% of the variance respectively.

An inspection of the scree plot revealed a break between the six and seventh component. It was decided to retain 6 components for further investigation. To aid the interpretation of the six components, varimax rotation was performed. The rotated solution revealed the presence of an underlying structure with the six components showing a number of moderately strong loadings with loadings below 0.4 being rejected.

Generally each item correlated highly with each component however three of the items had loadings on a second component. The variable "organisational commitment importance" loaded both on component 1 (.41) and component 2 (.46), while "conflict resolution importance" loaded on component 1 (.47) and component 3 (.47). The variable "self control importance" loaded on component 1(.40) and component 4 (.54). The six factor solution explained a total of 51.88% of the variance. The "organisational commitment" item slightly favoured component 2 and the item "self-control" favoured component 4. The item "conflict resolution" loaded equally on components 1 and 3. In this case the decision was made to include "conflict resolution" in component 4 (decision making). In the aviation context this attribute would be more critical under situations of decision making under stress than in the general team working environment. The six factor solution explained a total of 51.88% of the variance. Table 3.5 shows a PCA of the importance of nominated non-technical skills.

Table 3.5 *Principal Components Analysis of Competency Importance*

Component 1 Team Working	**1**	**2**	**3**	**4**	**5**	**6**
Considering others	**.78**	.03	.05	.20	.01	.16
Supporting others	**.68**	.18	.27	.08	.06	.10
Team building and maintaining	**.58**	.21	.22	.08	.15	.03
Component 2 Organisational focus	**1**	**2**	**3**	**4**	**5**	**6**
Relationship building	.24	**.67**	.17	.10	.07	.14
Organisational awareness	.10	**.60**	.16	.11	.10	-.04
Time keeping	-.03	**.58**	.15	.002	.09	.50
Self-confidence	.12	**.52**	.11	.39	.002	.18
Organisational commitment	.41	**.46**	-.11	.20	.16	-.07
Developing others	.35	**.42**	.20	.20	.08	.10
Leadership and management	.31	**.40**	-.003	.06	.13	-.10
Component 3 Decision making	**1**	**2**	**3**	**4**	**5**	**6**
Risk assessment and option choosing	.24	-.10	**.65**	.06	.15	.07
Reviewing outcomes	.04	.21	**.65**	-.05	.01	.176
Generating options	.14	.11	**.63**	.22	.10	.02
Defining and diagnosing problems	-.09	.41	**.51**	.21	.06	-.03
Conflict resolution	.47	.22	**.47**	.02	-.02	.09
Component 4 Cognitive functioning	**1**	**2**	**3**	**4**	**5**	**6**
Conceptual thinking	.09	.16	.08	**.81**	.09	.005
Analytical thinking	.07	.13	.14	**.78**	.09	.17
Self-control	.40	.10	.04	**.54**	.03	.32
Component 5 Task management	**1**	**2**	**3**	**4**	**5**	**6**
Flexibility	.30	.16	.04	.35	.14	-.09
Maintaining standards	-.06	.05	.01	.11	**.74**	.20
Authority and assertiveness	.18	.05	.05	.20	**.70**	-.01
Planning and coordinating	.18	.21	.32	-.02	**.53**	-.19
Workload management	.06	.12	.19	-.03	**.40**	.26
Customer awareness	.38	.32	-.25	-.14	.38	.17
Component 6 Situational awareness	**1**	**2**	**3**	**4**	**5**	**6**
Environmental awareness	.08	.08	.04	.10	-.02	**.78**
Systems awareness	.15	-.04	.13	.12	.21	**.70**
Eigenvalues	6.35	1.57	1.54	1.45	1.32	1.25
% of variance	24.44	6.03	5.92	5.59	5.08	4.81
Cronbach's α	.73	.72	.68	.73	.57	.55
Mean	11.55	26.49	18.96	11.74	16.55	9.32

Each component that emerged represented a group of related non-technical skills producing a total of six categories. The first category consisted of three NOTECHS elements which are directly related to individuals functioning in small teams or groups, such as an aircraft flight deck crew. For this reason Component 1 was called *Team Working.*

Component 2 was a broader more eclectic mixture of both NOTECHS elements and generic management skills derived from Spencer and Spencer's Technical/Professional and Service Management models (Spencer & Spencer, 1993). The skills and behaviours represented by this group appear to belong to the wider organisation rather than just to the smaller flight deck crew unit. It is suggested that these are the skills that an individual needs to function successfully in an airline environment. This group was assigned the name *Organisational Focus.*

The skills represented in Component 3 were again NOTECHS elements, were important at all levels of the organisation and applied to both leaders and followers. This group retained the NOTECHS *Decision Making* category label.

Component 4 represents the generic management skills relevant to the individual's intellect and how that functions in the context of the crew and wider organisation. These skills were labelled *Cognitive Functioning.*

Component 5 consists of the Leadership and Managerial skill category from the NOTECHS model. It was considered that these skills were desirable not only for leaders and managers but could equally apply to the individual working in a crew or organisation. New Zealand airline pilots have the same technical qualifications and licences irrespective of whether they function as a captain or co-pilot, although there may be a difference in the level of experience. Leadership and management qualities are important for all flight deck crew. For that reason Component 5 was re-labelled *Task Management*.

Finally, Component 6 consists of the NOTECHS category including the elements *situational awareness and environmental awareness.* Component 6 was labelled Situational Awareness. Eigenvalues, variance, α coefficients, means and standard deviations for each skill group are presented in Table 3.5 The coefficients for *team working, organisational focus*, and *cognitive functioning* skills were .73, .72, and .73 respectively while the α coefficient for *decision making* skills was .68, *task management* skills, .57, and *situational awareness*, .55.

The Cronbach's α coefficient should ideally be above .7 however with short scales with less than 10 items it is not unusual to find low Cronbach's α coefficients (Pallant, 2001). Under these conditions an alternative means of assessing internal consistency is by the mean inter-item correlation for the items (Briggs & Cheek, 1986). According to Briggs and Cheek, an inter-item correlation in the range of .2 to .4 is acceptable. The mean inter-item correlations for decision making, task management, and situational awareness were .44, .35, and .38 respectively. Using the Briggs and Cheek criteria the items were retained. The research question results will now be examined.

3.7.2 The Relationship between Importance and training Effectiveness

The survey results indicated that a high level of importance was attached to the technical skills with all three being graded > 4 suggesting that the competency was considered very important. Of equal value to the three technical skills were *situational awareness* and *task management.* These were the highest ranking non-technical skills and were rated equal to the technical skills in the very important category. The remaining non-technical skills, *cognitive functioning, team working, decision making* and *organisational focus* fell in the "moderate importance" category (rated between 3 and 4) although tending to the upper end of this category. The respondents' perception of training effectiveness was measured and it was found that overall the respondents rated training effectiveness for technical skills as > 4, indicating that they considered they had received effective training.

In the case of the non-technical skills the respondents reported only moderately effective training for *situational awareness* and *task management* and in the cases of *cognitive functioning, team working, decision making* and *organisational focus*, minimal training effectiveness (see Table 3.6).

Table 3.6 *Ranking of Means of Importance and Training Effectiveness*

Skill	Importance	Effectiveness	Pearson's ρ
Aircraft handling skills	4.66	4.28	.203**
Situational awareness	4.66	3.93	.335**
Aircraft navigational management	4.61	4.09	.212**
Aircraft systems management	4.57	4.03	.355**
Task management	4.13	3.12	.321**
Cognitive functioning	3.91	2.75	.514**
Team working	3.88	2.45	.374**
Decision making	3.78	2.60	.333**
Organisational focus	3.72	2.58	.417**

** correlation is significant at $p<.01$

3.7.3 Relative Importance of Technical and Non-Technical Skills.

The knowledge-process hierarchy proposed by Hunt (1986) identified flight navigation management, aircraft systems management, and aircraft handling skills as the three main accomplishments for professional pilots. These skills are technical skills. The importance rating of these technical skills as assessed by the three pilot groups is shown in table 3.7

Table 3.7 *Technical Skills Importance Assessment by Pilot Group.*

Skill	Student pilots		G.A. pilots		Airline pilots	
Aircraft handling	4.81	(.42)	4.66	(.63)	4.51	(.64)
Systems management	4.62	(.51)	4.57	(.74)	4.52	(.58)
Navigation management	4.62	(.53)	4.60	(.49)	4.53	(.60)

Measured on a 5 point Likert type scale ranging from 5 = of utmost importance and 1 = of no importance, the three technical skills were rated as very important by all pilot groups. Comparing these mean scores with those of the non-technical skills it was found that with the exception of situational awareness, the non-technical scores were lower in all cases.

An ANOVA was conducted to explore differences in importance of the three technical skill categories, aircraft handling, aircraft systems management and flight navigation management between student pilots, general aviation pilots and airline pilots.

There was a statistically significant difference at the $p<.05$ level in the aircraft handling skill scores between student pilots and airline pilots [$F(2, 238) = 5.6$, p =.<.05]. The effect size, calculated by using eta squared, was .046, a small effect. Post-hoc comparisons using the Tamhane test indicated that the mean score for student pilots (M=4.81, SD=.42) was significantly different from the airline pilots (M=4.51, SD=.64). The general aviation pilots (M=4.66, SD=.63) did not differ significantly from the student pilots or airline pilots.

Table 3.8 *Non – Technical Skills Importance Assessment by Pilot Group*

Skill	All pilots		Student pilots		General aviation pilots		Airline pilots	
Situational awareness	4.65	(.45)	4.71	(.41)	4.68	(.42)	4.60	(.49)
Task management	4.11	(.52)	4.02	(.49)	4.17	(.42)	4.20	(.60)
Team working	3.93	(.64)	3.91	(.61)	3.81	(.78)	3.92	(.55)
Cognitive functioning	3.93	(.77)	4.07	(.61)	4.05	(.67)	3.65	(.93)
Decision making	3.88	(.62)	3.84	(.55)	3.70	(.73)	3.80	(.58)
Organisational focus	3.60	(.56)	3.77	(.60)	3.80	(.60)	3.62	(.48)

Examination of tables 3.7 and 3.8 shows that all pilots rated the technical skills, and the non-technical skills of situational awareness and task management, as being most important (>4). The general aviation and student pilots also rated cognitive functioning as very important. The remaining non-technical skills were rated by all pilots as less important (<4). The ANOVA revealed a statistically significant difference at the $p<.05$ level in the perception of importance of cognitive functioning between the airline pilot group and the student and general aviation groups [$F(2, 238) = 7.8$, $p<.05$]. The effect size, using eta squared, was .06, a medium effect. Post-hoc comparisons using the Tamhane test indicated that the mean scores for the airline pilot group (M=3.62, SD=.93) was significantly different from the student pilots (M=4.06, SD=.61) and the general aviation pilots (M=4.05, SD=.67). The student pilots and the general aviation pilots did not differ significantly.

3.7.4 Training Effectiveness of Technical and Non-Technical skills

The technical and non-technical skills were ranked in order of perceived training effectiveness. Overall, pilots ranked the three technical skill categories to have had the most effective training and the non-technical skills less effective training. The perceived training effectiveness in the technical and non-technical skills is presented in the following tables. Table 3.9 shows the combined pilot groups and Tables 3.10 to 3.12 show student pilots, general aviation pilots and airline pilots respectively.

Table 3.9 *Perceived Training Effectiveness – All Pilots*

					95% Confidence level	
Skill	*n*	Mean	SD	SE	Lower	Upper
Aircraft handling	241	4.2	.73	.04	4.1892	4.3751
Aircraft navigation management	241	4.0	.79	.05	3.9786	4.1797
Aircraft systems management	241	4.0	.87	.05	3.9222	4.1442
Situational awareness	241	3.9	.78	.05	3.8381	4.0374
Task management	241	3.1	.84	.05	3.0166	3.2303
Cognitive functioning	241	2.7	.93	.06	2.6407	2.8780
Organisational focus	241	2.5	.86	.05	2.4481	2.6675
Decision making	241	2.5	1.0	.06	2.3941	2.6549
Team working	241	2.2	1.2	.07	2.1417	2.4475

Table 3.10 *Perceived Training Effectiveness – Student Pilots*

					95% Confidence Level	
Skill	*n*	Mean	SD	SE	Lower	Upper
Aircraft handling	85	4.4	.77	.08	4.2444	4.5792
Situational awareness	85	4.3	.63	.06	4.1806	4.4547
Aircraft systems management	85	4.1	.89	.09	3.9740	4.3555
Aircraft navigation management	85	4.2	.86	.09	4.0731	4.4446
Task management	85	3.2	.87	.09	3.0604	3.4396
Cognitive functioning	85	3.1	.80	.08	2.9805	3.3254
Organisational focus	85	2.8	.87	.09	2.5996	2.9769
Decision making	85	2.8	1.1	.12	2.5333	3.0243
Team working	85	2.4	1.4	.15	2.1056	2.7179

Table 3.11 *Perceived Training Effectiveness – General Aviation Pilots*

Skill	η	Mean	SD	SE	95% Confidence level Lower	Upper
Aircraft handling	69	4.4	.55	.06	4.3014	4.5681
Aircraft systems management	69	4.1	.74	.08	3.9945	4.3533
Aircraft navigation management	69	4.1	.60	.07	3.9279	4.2171
Situational awareness	69	3.9	.59	.07	3.8000	4.0841
Task management	69	3.2	.58	.07	3.1244	3.4045
Cognitive functioning	69	2.8	.87	.10	2.6263	3.0452
Organisational focus	69	2.6	.75	.09	2.4507	2.8122
Decision making	69	2.5	.85	.10	2.3241	2.7367
Team working	69	2.3	1.0	.12	2.1210	2.6036

Table 3.12 *Perceived Training Effectiveness – Airline Pilots*

					95% Confidence level	
Skill	*n*	Mean	SD	SE	Lower	Upper
Aircraft handling	87	4.0	.75	.08	3.8738	4.1952
Aircraft navigation management	87	3.9	.82	.08	3.7310	4.0829
Aircraft systems management	87	3.7	.91	.09	3.5977	3.9885
Situational awareness	87	3.5	.87	.09	3.3766	3.7498
Task management	87	2.8	.93	.09	2.6894	3.0864
Cognitive functioning	87	2.7	.93	.06	2.6407	2.8780
Organisational focus	87	2.2	.86	.09	2.0895	2.4589
Decision making	87	2.2	.98	.10	2.0614	2.4811
Team working	87	2.1	1.1	.11	1.8890	2.3639

3.7.5 Training Effectiveness: Differences Between Pilot Groups

ANOVA revealed statistically significant differences at the $p<.05$ level in the perception of the training effectiveness of aircraft handling skills, aircraft systems management, and aircraft navigation management between the three pilot groups. Aircraft handling skills produced the following results: [$F(2, 238) = 8.2$, $p<.05$]. The effect size, calculated using eta squared, was .06, a medium effect. Post-hoc comparisons using the Tamhane test indicated that the airline pilots perception of training effectiveness for aircraft handling skills ($M=4.03$, $SD=.75$) was significantly different from the student pilot group ($M=4.4$, $SD=.77$) and the general aviation pilot group ($M= 4.4$, $SD=.55$). There was no significant difference between the student pilots and the general aviation pilots.

There was evidence of differences between the perception of aircraft systems management training effectiveness for the three pilot groups [F (2, 238) = 5.3, p<.05]. The effect size, calculated using eta squared, was .04, a small effect. Post-hoc comparisons using the Tamhane test indicated that the airline pilots perception of the training effectiveness in this skill (M=3.79, SD=.910 was significantly different from the student pilot group (M=4.1, SD=.88) and the general aviation pilots (M=4.1, SD=.74). There was no significant difference between the student pilot and general aviation pilot group.

A difference in the perception of training effectiveness in aircraft navigation management was found, [F (2, 237) = 4.35, p<.05]. The effect size, calculated using eta squared, was .03, a small effect. Post-hoc comparisons using the Tamhane test indicated that there was a significant difference in the perception of training effectiveness between the student pilot group (M=4.24, SD=.86) and the airline pilot group (M=3.9, SD=.82). There were no significant differences between general aviation pilots and the airline pilot and student pilot groups.

3.7.6 Importance and Training Effectiveness by Pilot Group

Tables 3.13 to 3.15 summarise the perception of importance and training effectiveness for the three pilot groups.

Table 3.13 *Perception of Importance and Training Effectiveness – Student Pilots*

	Importance		Training effectiveness		
Skills	Very important	Moderately important	Effective	Moderately effective	Minimal
Aircraft handling	√		√		
Aircraft systems	√		√		
Aircraft navigation	√		√		
Sit. Awareness	√		√		
Task management	√			√	
Cogn. Functioning	√			√	
Decision making		√			√
Organisational focus		√			√
Team working		√			√

Table 3.14 *Perception of Importance and Training Effectiveness - GA Pilots*

	Importance		Training effectiveness		
Skills	Very important	Moderately important	Effective	Moderately effective	Minimal
Aircraft handling	√		√		
Aircraft systems	√		√		
Aircraft navigation	√		√		
Sit. Awareness	√			√	
Task management	√			√	
Cogn. Functioning	√				√
Decision making		√			√
Organisational focus		√			√
Team working		√			√

Table 3.15 *Perception of Importance and Training Effectiveness – Airline Pilots*

	Importance		Training effectiveness		
Skills	Very important	Moderately important	Effective	Moderately effective	Minimal
Aircraft handling	√		√		
Aircraft systems	√			√	
Aircraft navigation	√			√	
Sit. Awareness	√			√	
Task management	√			√	
Cogn. functioning		√			√
Decision making		√			√
Organisational focus		√			√
Team working		√			√

The results shown in tables 3.13 – 3.15 suggest that the three pilot groups were very similar in how they assessed the importance of both technical and non-technical skills. There were differences in the assessment of training effectiveness between the groups with the perception of high training effectiveness reducing as the pilots gained experience in the industry. With increasing expertise there is a reduction in the perception of training effectiveness in both technical and non-technical skills, with the airline pilot group reporting lower effectiveness for all non-technical skills training.

3.7.7 Effectiveness of Pilot Training to CPL - Instrument Rating

In the stage 2 questionnaire all three pilot groups were required to indicate their perception of the effectiveness of their training in the technical and non-technical skills. Additionally the general aviation and airline pilot groups were asked to indicate overall how well did their training to CPL – Instrument Rating standard prepared them for the role of professional pilot. The question did not apply to the student pilots who at this point in their training are not qualified. From a total of 152 questionnaire responses 49% of the respondents perceived that their training to CPL – Instrument Rating standard was largely satisfactory in preparing them for employment as a professional pilot. A further 24% perceived the training to have prepared them very well, while 25% perceived the training to be barely adequate or inadequate (see table 3.16).

Table 3.16 *Flight Training Quality: General Aviation and Airline Pilots*

Rating	Frequency	Percent
Very well	37	24
Largely satisfactory	76	49
Barely adequate	31	20
Inadequate	8	5

3.7.8 Effectiveness of Training for Multi-Crew Airline Operations

The airline pilots' were asked to indicate how well their training to CPL – Instrument Rating standard had prepared them for multi-crew operations. The most frequent response was barely adequately. Of a total of 84 responses 40% indicated barely adequately, 30% indicated that the training was inadequate while 11% chose "very well", and 19%, largely satisfactory (see table 3.17).

Table 3.17 *Multi – Crew Training Effectiveness*

Rating	Frequency	Percentage
Very well	9	11
Largely satisfactory	16	19
Barely adequately	34	40
Inadequately	25	30

3.7.9 Changes in Perception of Effectiveness of Basic Pilot Training as Experience Increases

A one-way analysis of variance was conducted to explore the differences between the three pilot groups of flight experience on the perceived effectiveness of training. The ANOVA is an appropriate method for testing for differences in means when there are more than two groups (Burns, 2000). A conservative post-hoc test, Tamhane, was used to determine which group differed from which. Tamhane's T2 is appropriate for unequal variances (Hochberg & Tamhane (1989). While the respondents were asked to indicate both their total flying experience and the number of years of employment in their various flying roles, it was considered that experience in terms of flight hours logged was a better indicator of total experience than years of service as many pilots change jobs and may not always be employed on a full time basis. The respondents were divided into three groups according to their flight experience.

The first group was labelled NYQ (not yet qualified) indicating that they were student pilots and therefore not employed as pilots. For the remaining two groups, the GA pilots and the airline pilots, a cut-off point of 2500 hours was nominated to distinguish the low experience group (<2500 hours) from the high experience group (>2500 hours). The 2500 hour cut–off represented the minimum flight experience acceptable for entry into Air New Zealand and while being somewhat arbitrary, is representative of the minimum entry experience requirements for a number of airlines. No significant differences were found between the groups for team working. The means for the three pilot groups are shown in Table 3.18

Table 3.18 *Means for the Three Pilot Groups. SD in Brackets*

TRAINING EFFECTIVENESS	MEANS		
	NYQ	General Aviation (GA)	Airline Pilots (AP)
Task management [F (2, 238) = 5.5, p<.05]. Effect size, calculated using eta squared, was .04. Post-hoc comparison indicated that the mean score for airline pilots (M = 2.88, SD = .93) was significantly different from NYQ (M = 3.25, SD = .87) and GA (M = 3.26, SD = .58)	3.25 (.87)	3.26 (.58)	2.88 (.93)
Decision making [F (2, 238) = 5.4, p<.05]. Effect size, calculated using eta squared, was .04. Post-hoc comparison indicated that the mean score for airline pilots (M = 2.27, SD = .98) was significantly different from the NYQ (M = 2.77, SD = 1.1).	2.77 (1.1)	2.53 (.85)	2.27 (.98)
Cognitive functioning [F (2, 238) = 20.48, p<.05]. Effect size, calculated using eta squared, was .01. Post-hoc comparison indicated that the mean score for airline pilots (M = 2.31, SD = .92) was significantly different from the NYQ (M = 3.1, SD = .79).	3.14 (.79)	2.83 (.87)	2.31 (.92)
Organisational focus [F (2, 238) = 8.45, p<.05]. Effect size, calculated using eta squared, was .06. post-hoc comparison indicated that the airline pilot score(M = 2.27, SD = .86) was significantly different from NYQ (M = 2.78, SD = .87) and GA (M = 2.63, SD = .75).	2.70 (.87)	2.63 (.75)	2.27 (.86)
Situational awareness [F (2, 238) = 23.56, p<.05] Effect size using eta squared, was .02. post-hoc comparison indicated that the airline pilot score (M = 3.56, SD = .87 was significantly different from NYQ (M = 4.31, SD = .63) and GA (M = 3.9, SD = .59). There was also a significant difference between NYQ (M = 4.31, SD = .63) and GA (M = 3.9, SD = .59).	4.31 (.63)	3.94 (.59)	3.56 (.87)

Table 3.18 shows that with the exception of team working and task management, the airline pilots consistently rate the training they received to CPL/IR to be less effective than did the pilots currently undergoing basic training. No significant differences between the pilots under training and the general aviation pilots were found. Airline pilots also claimed that the training for the non-technical skills, situational awareness and task management, was only moderately effective while the training for the remaining non-technical skills was of minimal effectiveness. With the exception of aircraft handling skills, which was rated as effective, the airline pilots rated the technical skills training for aircraft systems and aircraft navigation as only moderately effective- In contrast, the student pilot group rated training in all the technical skills and situational awareness to be effective with the remaining non-technical skills being rated as less than effective. The general aviation pilot group followed a similar pattern to student pilots with the exception of situational awareness training which was rated as less than effective.

3.8 Technical and Non-Technical Skills as Perceived Safety Risks

The questionnaire asked the airline pilot group if they had ever observed behaviour associated with the technical and non-technical skills that had directly endangered flight safety. The responses were in accordance with a 5 point scale with 0 = not sure, 1 = no, 2 = very rarely, 3 = occasionally, and 5 = frequently. The responses in descending order of frequency are shown in Table 3.19.

Table 3.19 *Perceived Safety Risk -Frequencies*

Skill	Perceived Risk
Aircraft handling skills	2.3
Situational awareness	2.2
Aircraft systems management	2.1
Aircraft navigation management	2.1
Task management	2.1
Cognitive functioning	1.8
Decision making	1.5
Team working	1.5
Organisational focus	1.5

With the exception of *task management* and *situational awareness* the non-technical skills were reported as appearing less than "very rarely" as a factor endangering flight safety

Stage Three: Aircraft Accident Analysis

3.9 Technical and Non-Technical Skills as Causes of Aircraft Accidents

According to Harle (1994), aircraft accidents often arise from a variety of human factors aligning to defeat the inbuilt defences of the system. The analysis of the airline accidents therefore considered the role of technical and non-technical skills as both primary and contributing factors. The full tables including a brief description of the accidents are included in Appendix (G) and a summary of the primary and contributing factors are included in tables 3.20 to 3.22 below. Of the 238 FAA and NTSB cases analysed 9 were found to have had inconclusive or non-human error causes and were disregarded. Table 3.20 shows the abbreviations used in the tables and throughout this chapter.

Table 3.20 *List of abbreviations*

Skill	Abbreviation	Skill	Abbreviation
Aircraft handling	AHS	Decision making	DM
Aircraft systems management	ASM	Cognitive functioning	CF
Aircraft navigation management	ANM	Task management	TM
Team working	TW	Situational awareness	SA
Organisational focus	OF		

An examination of the 229 accidents from the FAA and NTSB databases revealed a predominance of non-technical skill failures as the primary cause of accidents (see table 3.21). The table also compares the frequency of cases with the perceived importance rating of the skill category as indicated in table 3.8.

Table 3.21 *Skills as Primary Causes of Aircraft Accidents*

Category	TM	AHS	DM	SA	ASM
Number of cases	113 (49.3%)	53 (23%)	23 (10.04%)	15 (6.5%)	9 (3.9%)
Perceived importance	4.2	4.5	3.8	4.6	4.5

Analysis of the data revealed that task management (TM) was the primary cause for the majority of the accidents under review. TM was the primary cause in 113 cases or 49% of the total causes. TM consists of the elements; *maintaining standards, use of authority and assertiveness, planning and coordinating*, and *workload management*. The next highest contributor was aircraft handling skills (AHS) with 53 cases or 23% being attributable to that cause. Of note was the fact that TM, rated at an importance level of 4.2, was perceived by the airline pilot group as having less importance than AHS at 4.5.

Table 3.22 *Skills as Contributing Causes of Aircraft Accidents*

Category	TM	AHS	DM	SA	ASM	TW
Number of cases	20 (8.7%)	4 (1.7%)	24 (10.4%)	15(6.5%)	4 (1.7%)	37 (16.1%)
Perceived importance	4.2	4.6	3.8	4.6	4.5	3.9

As a contributing cause of accidents, team working (TW) skills featured the highest at 37 cases or 16.1% followed by decision making skills at 24 cases or 10%. Pilots rated TW as only 3.9 in importance with decision making (DM) at

3.8. Again non-technical skills were perceived by pilots to be of less importance than technical skills although they accounted for more primary and secondary accident causes.

3.9.1 Accident Causes and Perceived Accident Risk

In comparing the reported FAA and NTSB air transport accident causes with the New Zealand Airline Pilot's experience of technical and non-technical skills as factors endangering flight safety, the NZ pilots indicated that they had never or very rarely observed behaviours that endangered flight safety (see table 3.23).

Table 3.23 Comparison of *US Accident Causes with NZ Pilot Observations*

Category	TM	AHS	DM	SA	ASM
% cases	49.3%	23%	10.04%	6.5%	3.9%
NZ Pilots Rating	2.1	2.3	1.5	2.2	2.1
Frequency of observed flight safety endangering behaviour	Very rarely	Very rarely	Never	Very rarely	Very rarely

Stage 4: Interviews with Airline Pilots.

3.10 Introduction

Stage 2 of the study surveyed a broad spectrum of New Zealand pilots ranging from students under training to general aviation and airline pilots. This group included pilots who were employed in the industry or were seeking employment and also some highly experienced but retired pilots. Stage 4 focused on New Zealand airline pilots who were in current employment at the time of the survey. The aim of this stage of the survey was to obtain the views of experienced pilots on quality of new airline entrants and to attempt to identify areas where improvements could be made. The respondents were interviewed by phone and the responses to the ten research questions were recorded. The data from the interviews was subjected to a content analysis. This technique was chosen as a suitable method of analysing a semi-structured telephone interview (Stemler, 2001). By asking the respondents to comment on a standardised set of questions it was possible to identify common themes in the answers provided (Stemler, 2001).

3.11 Qualities of Airline Pilots

Airline pilots identified 92 skills and qualities they regarded as important to the competent airline pilot. These were readily categorised into the six NOTECH categories (van Avermaete, 1998), and the technical skill category, aircraft handling skills (see table 3.24).

Table 3.24 *The Skills and Qualities of Successful Airline Pilots*

Skill or quality	Frequencies
Situational awareness	7
Team working	14
People skills	25
Organisational focus	3
Technical skills	20
Task management	9
Personal attributes	14

The second question was designed to determine if the general aviation industry was providing these skills either through the flight training organisations or wider industry experience. The pilots' responses are shown in Table 3.25.

Table 3.25 *Adequacy of Training for Airline Pilot Competency*

Response	Frequencies
GA pilot quality was adequate	11
New pilots had satisfactory aircraft handling skills but were deficient in non-technical skills	8
New pilots lacked all round skills	2
Variable quality	1

Exactly 50% of the respondents reported that the quality of new pilots entering the airlines was adequate. This was qualified by several respondents who attributed this adequacy to the success of their filtering and selection processes. One of the airline management pilots participating in the survey whose duties included pilot selection for his company, reported that between 70% and 90% of the applicants interviewed for airline entry had the right qualities and were accepted. A number of the respondents (36%) indicated that the new pilots had satisfactory "stick and rudder" skills but were lacking in other skills. These were of a non-technical nature and included lack of people skills and lack of situational awareness. Two respondents reported a general lack of skill among general aviation pilot recruits while one reported a widely variable range of skills and qualities with some new entrants being very good and others poor. The third and fourth questions were designed to determine if there were any outstandingly good or bad skills or qualities that GA pilots brought to the airlines (see tables 3.26 and 3.27).

Table 3.26 *Positive Skills and Qualities which New Pilots bring to the Airline*

Qualities	Frequencies
None observed	2
Instructing experience	2
People skills	5
IFR/Aircraft handling skills	5
Decision making	1
Military background	1
Self discipline and motivation	7
Multi-crew experience	1
Academic and trade qualifications	1

Table 3.27 *Poor Skills or Qualities which New Pilots bring to the Airline*

Qualities	Frequencies
Nothing in particular	4
Lack of self discipline	5
Poor personal attributes *	14
Lack of IFR knowledge/capability **	4
Poor aircraft handling skills	1

* Poor personal attributes included a variety of items including failure to listen, boredom, stepping stone mentality, overconfidence, inability to be self critical and others.

** Two respondents reported that expatriate pilots returning to NZ after working overseas, whilst having good handling skills, often lacked IFR knowledge and bad weather operational experience.

The respondents were asked to indicate whether they considered that basic pilot training effectiveness had improved over the years. This question was designed to explore the effect of the human factors syllabus which has been introduced into the NZCAA licensing curriculum at all levels in recent years. No other major changes have been made to the curriculum content or experience requirements over the last 20 to 40 years (see table 3.28).

Table 3.28 *Training Effectiveness Improvements*

Technical skills	Frequencies	Non-technical skills	Frequencies
Yes	10	Yes	9
No	7	No	4
Not sure	5	Not sure	9

For the technical skills a majority of the respondents (10) considered that training effectiveness has improved although seven of the respondents disagreed. Five of the respondents were unsure. For non-technical skills the majority of the respondents (9) considered that the standard had improved with only four indicating that it had not improved. A further nine respondents indicated that they were unsure. The respondents were then asked to indicate why they thought that the training effectiveness had changed. The responses are indicated in Table 3.29

Table 3.29 *Reasons for Perceived Changes to Training Effectiveness*

Change	Frequencies
Not known	7
Improvements to Licensing syllabus	1
Better training and education in non-technical skills	5
The introduction of Simulators, CBT, audio visual devices	8
Feedback to training schools from airlines	1
Better selection of students at training schools	1

Respondents were asked to indicate which areas of basic flight training needed the most improvement. A wide variety of responses resulted with a majority (54%) indicating that they did not know or could not think of anything specific (see table 3.30).

Table 3.30 *Areas of Improvement for New Pilots Joining the Airline*

Improvement	Frequencies
Not sure	12
CRM	2
IFR procedures	2
GPS	1
Situational awareness	1
People skills	1
All pilot training needs improvement	1

Respondents were asked to identify the changes they would like to see in basic pilot training. Their responses are summarised in Table 3.31.

Table 3.31 *Changes Needed to the Basic Training Programme*

Training changes	Frequencies
Not sure or none	4
Enhanced commercial awareness	1
Airline role training	14
Better recruitment and selection for pilot training	2
Better interaction between airlines and training schools	1
More emphasis on CRM during basic training	2

Respondents were asked to indicate what they considered to be the best flying experience a pilot could obtain in preparation for joining an airline. They were asked to choose between flight instructing, PT 135 air transport operations or " other".These choices represented the usual ways new pilots gained further flying experience with "other" representing a variety of activities such as agricultural aviation, military flying, and aerial work such as photography and survey flying (see table 3.32).

Table 3.32 *The Best Flying Experience in Preparation for Airline Flying*

Type of flying experience	Frequencies
Don't know	2
Instructing	2
PT 135	6
Combination of instructing and PT 135	12

The final question required the respondents to indicate if they thought multi-crew training or experience was important for pilots prior to joining an airline. A majority (77%) considered that it would be beneficial. Four respondents considered that it was not necessary as the airlines could provide good multi-crew training and one long-haul pilot gave a qualified response indicating that it was highly desirable for second officers joining the crews of long haul aircraft with more than two pilots, but that it was not necessary for two pilot domestic operations as adequate training would be given by the airline (see table 3.33).

Table 3.33 *Desirability of Prior Multi-Crew Training or Experience*

Importance	Frequencies
Yes	17
No	4
Yes for long haul, no for domestic	1

The interviews revealed that while a majority of the airline pilots interviewed considered the basic training received by airline entrants in the technical skills was satisfactory, there was a need for improvement in non-technical skill training. The airline respondents considered that training effectiveness in general had improved over the years. There was support for some airline specific training to be included in the basic flight training programme as well as support for pre-airline multi-crew training. A majority of airline pilots indicated that people skills were the most desirable quality for aspiring airline pilots. Although many general aviation pilots build up their experience by working as flying instructors the airline pilots did not rate this experience highly as preparation for an airline career. A greater number considered that Part 135 experience was a better option although a majority preferred a combination of both. Of the negative qualities observed in new pilots joining the airlines the airline pilots interviewed cited poor personal attributes and lack of self discipline as the leading cause of problems. Deficiencies in IFR skills and aircraft handling skills were considered less of a problem.

3.12 Summary

The results of stages 1 and 4 of the survey supported the data obtained from the industry-wide survey conducted in stage 2. In the case study evidence was found that the inclusion of non-technical skill training early in basic pilot training was reflected in the performance of student pilots undergoing a simulated Rule Part 135 air transport competency check. The responses of the three pilot groups to the perceived importance and training effectiveness of technical and non-technical skills indicated an overall appreciation of the importance of these skills. There was also general agreement that the training effectiveness of non-technical skills was deficient. The stage 4 results supported these findings. The results of the four stages of the study are discussed in the following chapter.

Chapter Four

Discussion

4.1 Introduction

The research problem centred on identifying the nature of the skill disparity between flight school graduate standards and airline entry requirements. The study has shown that the shortfall between the skills and knowledge demonstrated by flight school graduates and the skill and knowledge needed by the New Zealand aviation industry may be due to a lack of awareness of the importance of non-technical skills and a lack of training in those skills during basic flight training. An examination of how flight school graduate pilots progress to airline entry level training suggests that the traditional apprenticeship model where the flight school graduate spends a number of years in general aviation accumulating flight experience may not be the most effective or efficient way to develop the proficiency needed to begin airline pilot training.

This chapter starts by discussing how a typical New Zealand pilot's career develops in terms of Birkett's Career Progression and Hierarchy Schema (Birkett, 1993). The schema, described in Chapter 1, figure 1.3, shows how career development in any occupation proceeds through stages with the overall level of expertise progressively increasing as it builds on a foundation of formal education and is supplemented by work experience and continuing education.

Three distinct stages in the career progression of New Zealand pilots were identified. An initial basic training phase during which various licences and ratings were earned was usually followed by a period of employment as a general aviation pilot where the pilot gained experience to meet the entry requirements for an airline. On gaining sufficient experience and passing selection criteria, the general aviation pilot was able to enter the airline training system for training and subsequent employment as a flight crew member. In Birkett's (1993) Schema, formal education would be represented by the pilot's initial basic training phase and the work experience and continuing education stage by the period of employment as a general aviation pilot. The goal of entry into airline employment would be the result of developing sufficient proficiency during general aviation employment.

The initial training phase concentrated primarily on the technical subjects prescribed by the licensing authority, the NZ CAA. The only formal non-technical subject required by Part 61 was aviation human factors, a broadly based subject with very little depth at this level. One part of the human factors programme was aircraft command which was also included in the examination requirements for the commercial pilot licence, instrument rating, and airline transport pilot licence (NZ CAA Advisory Circular AC61-5). Training providers concentrated on the knowledge and skill requirements prescribed by the CAA and in general there was little or no attempt at specific airline role training or education for later commercial or airline employment. The focus was on achieving the licencing requirements with the expectation that the newly qualified pilot would earn a living as a flight instructor or general aviation pilot on single pilot operations for a number of years before being selected for airline employment. Figure 4.1 shows a typical career path for the New Zealand trained pilots entering the airline industry.

While the basic pilot training hours are fixed by CAA licensing requirements, the experience levels required for airline entry vary considerably from airline to airline and in accordance with the demand for pilots. During periods of growth within the industry the demand for pilots may exceed the supply and a drop in the airline entry experience requirements will be the consequence (Marlantes, Kotzen & Sterns, 2008). Figure 4.1 shows typical flight experience from basic training to airline entry.

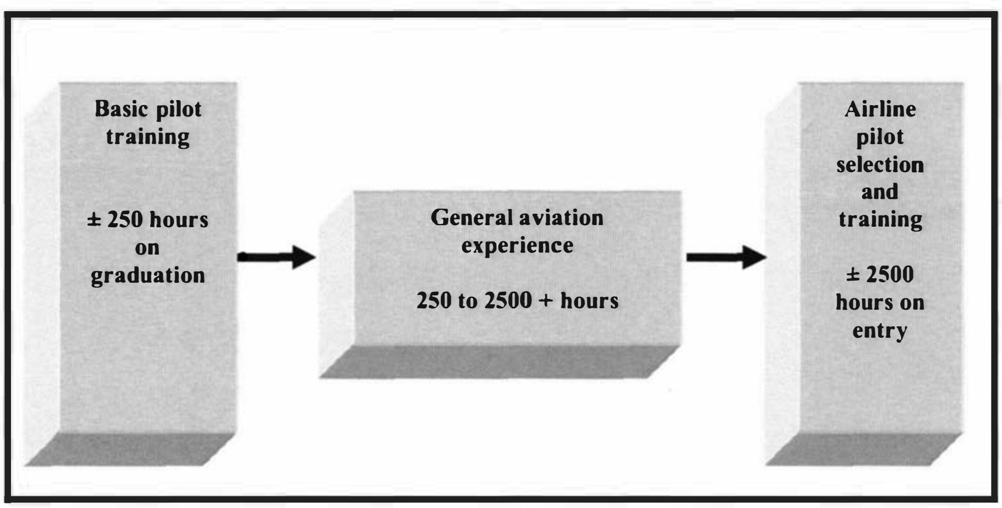

Figure 4.1 From basic training to airline entry-typical flight hours.

The basic pilot training phase in figure 4.1 is a highly structured and supervised training course. The flight experience requirements are prescribed by Civil Aviation Rule Part 61 AC51-5 and, given the expense of flight training and resource constraints, training providers aim to ensure that the licencing standards are achieved in the minimum specified flight hours. The highly supervised nature of the training and safety issues associated with low experience pilots means that there may be limited opportunities for students to be fully exposed to situations where aviation decision making becomes imperative. The student operates in a sheltered environment under the supervision of experienced instructors.

On gaining employment in the general aviation industry, the newly qualified pilot enters the work experience and continuing education career phase identified by Birkett (1993). While Birkett demonstrated that career progression was related to the soundness of formal education together with work experience and continuing education, the general aviation pilot is likely to encounter an environment that is less structured and probably less supervised because of the nature of the general aviation sector of the industry in New Zealand. The sector is characterised by small, often marginally viable organisations[1] run by owner/operators who may employ a small staff of pilots. The owner may fulfil multiple roles within the organisation such as operations manager, chief pilot and maintenance coordinator as well as general administration duties. The focus in these organisations is on achieving financial outcomes and the opportunity for continuing education for pilot employees is limited. A general aviation pilot can be employed in a wide variety of roles such as flight instruction, CAA Rule Part 135 air operations, scenic and tourist flying, skydiving or a variety of other aerial work. The varied nature of the general aviation pilot's role means there is a possibility of the pilot experiencing "skill fade" or a deterioration of flying ability due to lack of practice. Having built up to a peak of performance culminating with successfully passing a

[1] In 2003 there were 37 Rule Part 135 aviation companies each operating an average of 3.1 light aircraft (New Zealand Wings Directory, 2003).

flight test as a student pilot, there is a possibility of experiencing degradation of skill if the new pilot is not able to obtain regular flying practice. This may occur when the pilot can only obtain part time employment or is unable to undertake IFR operations (Clark, 2004). Unfortunately at this stage of his or her career the pilot has not developed a robust foundation of skills and knowledge and lack of practice may lead to a decline in skill even though the total amount of flight experience may be increasing (Hunter, 2007)

The new general aviation pilot will be exposed to a range of weather conditions in which he or she will be expected to operate and, as a single pilot operator, may also be exposed to situations requiring good decision making on a regular basis with minimal support. It is in this rather challenging environment the general aviation pilot is expected to develop the qualities that the airlines seek in their pilot recruits. The structure identified in Birkett's schema related to formal and on-going education in the appropriate skills to enable the graduate pilot to develop proficiency is often not in place or may not be effective enough in the general aviation environment to optimise career progression.

On the other hand, the environment in which the airline pilot operates shares some of the characteristics of the basic flight training organisation and may differ in several respects from the general aviation operating environment. In contrast to general aviation pilot, the airline pilot operates in a structured environment with constant supervision from captains, training captains, simulator instructors and other supervisors. Flight operations are conducted in accordance with clearly defined standard operating procedures and rules, and are likely to be conducted over a set network of routes without the variability of general aviation operations. In this respect there is a similarity to the basic flight school environment. The airline pilot does not have the same exposure to the customer as does the general aviation pilot and has a team of specialised people to deal with the passenger's requirements. Additionally the airline pilot may not experience the same close identification with their organisation as the general aviation pilot who is more likely to belong to a smaller company. Like the general aviation pilot, the airline pilot will operate in all weather conditions but will have the advantage of engaging in aeronautical decision making in the supportive environment of a crew, and backed with SOPs and simulator rehearsals of emergencies. During their working lives airline pilots will operate as crew members and be subject to regular training and assessments resulting in frequent feedback on professional performance. The training will cover the technical skills associated with the particular aircraft being operated as well as the non-technical skills that form the basis of crew resource management (Federal Aviation Administration, 2004). New entrants to an airline coming from a general aviation background will be introduced to multi-crew operations and indoctrinated into the role of an airline pilot. Unlike the general aviation pilot, the airline pilot will be free to concentrate on pilot duties without the additional burden of other tasks. Table 4.2 compares the operating environments of the three pilot groups.

Table 4.1 *A Comparison of Training Environments of Pilot Groups*

Basic Pilot Training	**General Aviation Environment**	**Airline Environment**
1. CAA Rule Part 61 focus 2. Technical Subjects • Aircraft technical knowledge • Navigation • Meteorology • Air Law • Radio Procedures 3 . Non-Technical Subject • Aviation Human Factors 4. Flight Training • Prescribed minimum flight experience requirements • Prescribed flight test handling limits 5. Structured training environment 6. Supervised training environment 7. Minimal exposure to bad weather 8. Limited opportunity for aeronautical decision making (sheltered environment) 9. Licensing focus not domain focus 10. Feedback on personal performance 11. Emphasis on aircraft handling 12. Single pilot orientation	• Possibly unstructured and unsupervised or minimal supervision • "Bottom line" driven • Exposure to a variety of weather conditions • Single pilot operations with requirement for good aviation decision making • High customer exposure • Company representative • Extra duties e.g. baggage handling, aircraft cleaning etc. • Variety of aircraft operations • Possibly older type aircraft with basic equipment and prone to serviceability problems • G.A. pilots may experience frequent job changes, periods of being out of work, or working on a part time basis. • Any further training restricted to technical training and self study • Limited opportunity for feed back on personal performance • Possibility of "skill fade" if insufficient opportunity for IFR operations or regular flying.	• Highly structured and supervised • Multi-crew • Operations governed by SOPs • All weather operations • Regular training, assessment and feedback • Technical training concentrated on aircraft and equipment • Non-technical training associated with CRM • Use of simulators and other training devices • Limited customer exposure • Additional duties on a voluntary basis only

From table 4.1 it can be seen that the basic pilot training school graduate is a licensed pilot who has been trained for single pilot operations in a structured and sheltered environment. The focus of the training is on the technical skills required to achieve the CAA licenses and ratings with a broad coverage of aviation human factors. On graduating to the general aviation environment, the newly qualified pilot will gain experience in the aeronautical decision making associated with single pilot operations and operating in a commercial environment in a variety of weather conditions. Provided that there is an opportunity for regular flying, the general aviation pilot's aircraft handling skills should also improve. There is an expectation that this experience that will prepare the pilot for entry into airline employment. As this study shows the process may be neither efficient nor effective. Airline training focuses on multi-crew training, technical training on a complex air transport aircraft and its equipment, and the various non-technical skills that are essential to crew resource management. Experience gained in the general aviation environment, being much less structured and having a single-pilot focus, appears to contribute to this in only a minor way. In the context of this environment, the next section discusses the skills needed to be an airline pilot, how well those skills are currently trained for and how the attitudes and beliefs about the importance and impact of the various skills is reflected in the quality of training.

4.2 Identification of Professional Pilots Skills

The second stage of the study identified nine sets of skills which New Zealand aviation industry participants rated as being important to the role of professional pilot. The skills consisted of the technical skills based on Crook and Hunt's key accomplishments (Crook & Hunt, 1988), and a further six groups of non-technical skills derived from the NOTECHS model (Van Avermaete, 1998), and the generic management model proposed by Spencer and Spencer (1993).

Finding 1

Three technical skill categories and six non-technical skill categories were identified as being the skills required for effective performance in the professional pilot role.

Whereas others had focused on the importance of technical, non-technical or management skills, this study was able to demonstrate that airline pilot competency is based on a combination of these three types of skill. The technical skills included: aircraft handling skills, system management skills and aircraft navigation management skills These skills have formed the basis of traditional pilot training methods for many years and they are well accepted as important in the industry. The non-technical skills consisted of six categories of skills; team working, organisational focus, decision making, cognitive functioning, task management and situational awareness. These skills were rated important, though overall not as important as technical skills, by all three pilot groups participating in the second stage study. Although the elements derived from existing models such as NOTECHS (Van Avermaete, 1998) and the Spencer and Spencer (1993) generic management model, the manner in which these elements combined in the analyses resulted in several new skill categories. These new non-technical skill categories included the input from New Zealand airline industry leaders in the preparation of the stage 2 questionnaire. Each of the non-technical skill categories will be discussed in greater detail in the following paragraphs.

The team working skill category consisted of three elements; *team building and maintaining, considering others,* and *supporting others.* The three team working elements had been previously defined by the NOTECHS model (Van Avermaete, 1998) and Spencer and Spencer (1983). However, the team context of air crews is different to most other team situations. Pilots employed on airline operations do not usually join permanent crews but fly on a roster basis. Unlike sporting, military, and industrial teams, where membership ensures a degree of permanency thus enabling on-going team practice and rehearsal, the air transport pilot must develop team working or crew skills which are portable and easily integrated into small, temporary teams (Flin & Maran, 2004). Flin and Maran compared the roles of airline pilots with those of anaesthetists and surgeons and observed that CRM skills were similar to those needed in operating theatre teams, intensive care units, and emergency rooms. Team working skills do not differentiate between team leadership, such as captaincy of an aircraft, and team membership. The skills are important to all crew members irrespective of rank and are thus a prerequisite for captaincy or leadership. Of importance is that team working skills are individual attributes rather than attributes of the team as a whole (Stone, 2004; Spencer & Spencer, 1993).

The organisational focus skill category consisted of *relationship building, organisational awareness, time keeping, self-confidence, organisational commitment, developing others, and leadership.* With the exception of *time keeping* which was reported as an element of the NOTECHS situational awareness category (Van Avermaete, 1998), the remaining items were derived from the generic management models proposed by Spencer and Spencer (1993). Organisational focus skills are concerned with the individual's place in the wider organisational environment rather than simply as a member of a crew or team, although there are some skills that are congruent with successful crew or team participation. These are the management skills defined by Spencer and Spencer and fit with the role of the air transport pilot as a manager of a system. A commonly held view of the airline managers interviewed for this research was the recognition of the airline captain as a business manager responsible for promoting the company's interests. In an address to the staff and students at a University flight school wings ceremony, Webb (2007) described the modern airline captain as being the "C.E.O. of a multi-million dollar business unit". This attribute would be associated with the *organisational commitment* element of the organisational focus group of skills.

The third non-technical skill category, decision making, consisted of five elements which closely follow the NOTECHS decision making categories. These included; *risk assessment and option choosing, reviewing outcomes, generating options, defining and diagnosing problems* and *conflict resolution.* Decision making involves cognitive processes in which communication is a key component (Flin et al, 1998). Decision making skills, with the exception of *conflict resolution,* are cognitive skills and therefore are not able to be observed directly but must be inferred by some other behaviour such as communication (Flin et al. 1998).

The cognitive functioning skill category comprised three generic management skills that represented desirable personal attributes for workers and managers employed in human service and technical professions (Spencer & Spencer, 1993). These skills were: *conceptual thinking, analytical thinking* and *self-control*. Spencer and Spencer define technical professionals as individuals engaged in occupations involving the use of technical knowledge and human service workers as workers who are in occupations that involve helping, serving, or caring for other people. Commercial pilots are clearly technical professionals who to some degree fall into the category of human service worker. The skills defined by Spencer & Spencer as important to human service and technical workers, also apply to airline pilots.

The task management skill category consisted of six elements including; *maintaining standards, authority and assertiveness, planning and coordinating*, *workload management*, *flexibility* and *customer awareness.* The category, consisting of a combination of NOTECHS and generic management elements (Van Avermaete, 1998; Spencer & Spencer, 1993), was named task management to reflect the roles of the captain and crew on the flight deck. The various elements making up the task management category are relevant to the management of a crew or small group as described by (Fallucco, 2002). Another observer, Orasanu (1993), offered a broader definition of the role of captain on the flight deck. The aircraft captain is responsible for the coordinating and directing of three conceptually distinct components that characterize effective crew performance, situational awareness, decision strategies, and task management. According to Orasanu these three components work together to comprise what she calls the crew's metacognitive competence. The role of the crew members in achieving a proficient performance requires not only effective leadership but a high degree of integration and standardisation. According to Kanki and Palmer (1993):

> *Effective team performance in complex tasks requires team members to integrate their activities in an ordered, timely fashion...........this type of coordination of tasks among crewmembers is facilitated by the fact that pilots share the same knowledge and skills. Standard Operating Procedures (SOPs) extend the shared knowledge base by setting up expectations about who is doing what and when.*
>
> (Kanki & Palmer, 1993 p118)

The situational awareness skill category involved two elements; *environmental awareness and systems awareness.* These elements are cognitive skills and are introduced in early pilot training and continue to develop throughout the pilot's career. Situational awareness is derived from the NOTECHS category of the same name and the two elements, environmental awareness and systems awareness represent awareness of both the external and internal environment in which the pilot is operating (Van Avermaete, 1998). Orasanu (1993) suggested that situational awareness is a key ingredient of effective decision making. Early awareness of events unfolding in the environment or within the aircraft may lead to better quality decision making than when the crew is suddenly faced with an unexpected problem.

4.3 Importance of Skills by Pilot Group

The research questions addressed in this study sought to discover the differences in perception between the three pilot groups regarding the importance of a range of technical and non-technical skills to the role of a professional pilot.

4.3.1 The Importance of Technical Skills

Finding 2

While all pilot groups rated the aircraft technical skills as very important, student pilots perceived aircraft handling skills to be more important than airline pilots.

In table 3.7 the results indicated that the three technical skills identified in the study were rated as very important by all pilot groups. The reason for the difference between the airline pilots and the student pilot's perception of aircraft handling skill importance may be due to the emphasis that the NZCAA Part 61 licensing requirements places on technical skills and from the strong aircraft handling focus that is central to the student's basic flight training. At the time the questionnaire was administered the students had passed their private pilot licence flight tests and at this point were about half way through their training. Their experience level was very low and their frame of reference restricted to the limits and boundaries imposed by their training providers. During their training student pilots are under the influence of their instructors and tutors and the general culture of their school. This finding may reflect the emphasis placed on technical skill training, particularly aircraft handling, during basic training in order to meet the NZCAA Part 61 licensing requirements.

Student pilots fall into the categories of novice or advanced beginner while under training and, on completion of training, graduates from the programme as a competent performer (Klien and Hoffman, 1993). Novices and advanced beginners operate in an environment bound by rules and general guidelines which result in limited and inflexible behaviour. They lack experience and skill and an appreciation of contextual relevance. The Part 61 flight tests emphasise aircraft handling accuracy, systems management and navigation and the application of the civil aviation rules as they apply to aircraft operations. The student's energies are directed towards flying within prescribed limits and staying legal. From the beginning the student will learn and practice controlling the aircraft smoothly and developing competencies such as climbing and descending at the correct speed, turning with a constant angle of bank, maintaining height, keeping straight on take-off and during the landing roll and rounding out at the correct height and developing numerous other competencies in preparation for the commercial pilot flight test. Throughout this experience the central figure will be the student as he or she operates the aircraft in a single pilot role. Even during dual lessons the flight instructor will not normally take an active part in controlling the aircraft, the emphasis being on the student acting as the sole crew member. By the end of the programme, the student, having completed all the flight tests and having satisfied all the CAA licensing requirements, may be regarded as a competent performer in the multitude of technical skills that are assessed in the various flight tests (see CH 1, Table 1.2). According to Klien and Hoffman, the competent performer has reached the level of a journeyman and will have developed a sense of mastery and the ability to cope with, and manage, a variety of types of situations although performance at this level will lack speed and flexibility. Of the three technical skills student pilots rated aircraft handling skills to be of the highest importance.

General aviation pilots also rated the three technical skills as very important although they rated aircraft handling skills and aircraft systems management as slightly less important than student pilots. General aviation pilots rated flight navigation management slightly higher in importance than the student pilots and airline pilots. These results suggest that by using an aircraft operationally rather than just for training there is more of an emphasis on managing the aircraft and its navigation rather than "hands on" flying. The general aviation pilot has learnt or is learning to operate the aircraft economically and safely with due regard to passenger comfort and on time performance.

As table 3.7 shows, the airline pilot group rated the technical skills as very important though slightly lower in importance than the student pilot and the general aviation group. The lower importance that airline pilots placed on technical skills was reinforced by the results of the airline interviews (stage 4). Airline pilots were asked to indicate what they considered to be the skills and qualities of a successful airline pilot. The subjects identified seven different skill groups, only one of which described technical skills. The non-technical skills described included situational awareness, team working, people skills, organisational focus, task management and personal attributes. Although technical skills were the second most frequently mentioned skill, airline pilots rated people skills as being the most important of the skills and qualities of successful airline pilots.

4.3.2 The Importance of Non-Technical Skills

Finding 3

There were differences in perception of the importance of non-technical skills between the three pilot groups. Organisational focus, decision making and team working were rated as moderately important by all pilot groups. Student pilots and general aviation pilots rated cognitive functioning as very important and all pilot groups rated task management and situational awareness as very important. Airline pilots rated cognitive functioning as less important than general aviation or student pilot.

All pilot groups rated non-technical skills as important or higher. There was agreement across all groups that the non technical skills of situational awareness and task management were very important. All groups also agreed that decision making, organisational focus and team working were moderately important. Student and general aviation pilots rated cognitive functioning as very important, while the airline pilots rated it as moderately important. There was an expectation that students, focusing on developing the technical skills which are the foundation of their basic pilot training, would rate technical skills to be of higher importance and non-technical skills to be of lower importance than other pilots. It was expected that students would perceive an increase in the importance of non-technical skills as the graduate pilot progressed through the general aviation phase and eventually into the airline environment. These expectations were based on the reasoning that the perceived increase of importance of non-technical skills as the pilot's career progressed would result from the new pilot's increasing exposure to the operational environment. The student pilot having no operational experience and relatively little need to call on non-technical skills in the highly structured and protected environment of flight training schools would be expected to have little or no understanding of non-technical skills while the airline pilot's considerable operational experience would result in a greater awareness of the importance of non-technical skills. However, the results showed that contrary to expectations, the student pilots had a good appreciation of the importance of non-technical skills and that this was maintained as the pilot's career progressed.

The student pilot's perception of non-technical skill importance may result from the increased emphasis on aviation human factors in the CAA Part 61 curriculum. In addition to this the university flight training graduates described in stage 1 of the study and a European airline training school which has established a base in New Zealand to supply airline pilots for the European and New Zealand market both offer programmes which include crew resource management, a non-technical skill subject which remains outside of the NZCAA licensing prescriptions. Students from both programmes participated in the research associated with this study. The perceived importance of non-technical skills must not be confused with proficiency in those skills. The perception of importance may be only due to an awareness of the importance of the skills. As this study will discuss later all pilot groups perceived the training in some of the non-technical skills to be only moderately effective or of minimal effectiveness.

Two non-technical skill categories rated as very important by all three groups were situational awareness and task management. Situational awareness consists of the elements; *systems awareness* and *environmental awareness*. Defined simply as knowing what is going on around you, Endsley and Garland (2000) offer a general definition that is applicable across a wide variety of domains as:

> *"the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future"*
>
> (Endsley and Garland, 2000 p5)

According to Endsley and Garland, situational awareness skills are cognitive skills and differ from the other non-technical skills in that they share some characteristics of technical skills. For example systems awareness may involve the detection and interpretation of information or warnings from an aircraft system such as fuel, fire, or other warning systems and annunciators. The perception of, and attention to, such information requires technical skill although further processing of the information will involve non-technical skills such as decision making.

As the student pilot's training progresses, situational awareness will develop as more advanced exercises such as navigation and instrument flying are introduced. Endsley and Garland (2000) proposed three levels of situational awareness: level 1 SA = perception, level 2 SA = comprehension, and level 3 SA = projection. Levels 1 SA and 2 SA were shown as *perception* and *attention* processes in Endsley and Garland's model and represent the parts of situational awareness that are taught and reinforced during basic training. Ranging from simple tasks such as monitoring engine temperatures and pressures and fuel pressures and quantities to more advanced procedures such as assessing drift and applying drift corrections on a navigational flight or maintaining the correct approach profile during an instrument approach, the student pilot's attention will be constantly drawn to the importance of situational awareness throughout the training. The other two processes, pattern matching and synthesis represent level 3 SA as described by Endsley and Garland. These processes will be evident in the competent performer but will be relatively undeveloped. These processes represent the skills that continue to develop with time and experience and differentiate between the beginner or novice and the proficient or expert practitioner. After analysing flight test results of 101 student pilots completing an Air Transport Pilot programme, de Montalk (2005) observed that of the non-technical skills tested in the final route check (FRC) situational awareness was among the skills that scored lowest. This would support the argument that situational awareness is not fully developed during basic flight training but continues to develop throughout the pilot's career. As the FRC was designed to simulate an air transport operation it was concluded that the students' lack of experience in this role and the very protective environment within the ATP programme led to the students' lower situational awareness scores (de Montalk, 2005). Level 3 SA is expected to develop with on-going experience during the pilot's general aviation and airline career (Endsley & Garland, 2000). Figure 4.2 shows the mechanisms and processes involved in situational awareness.

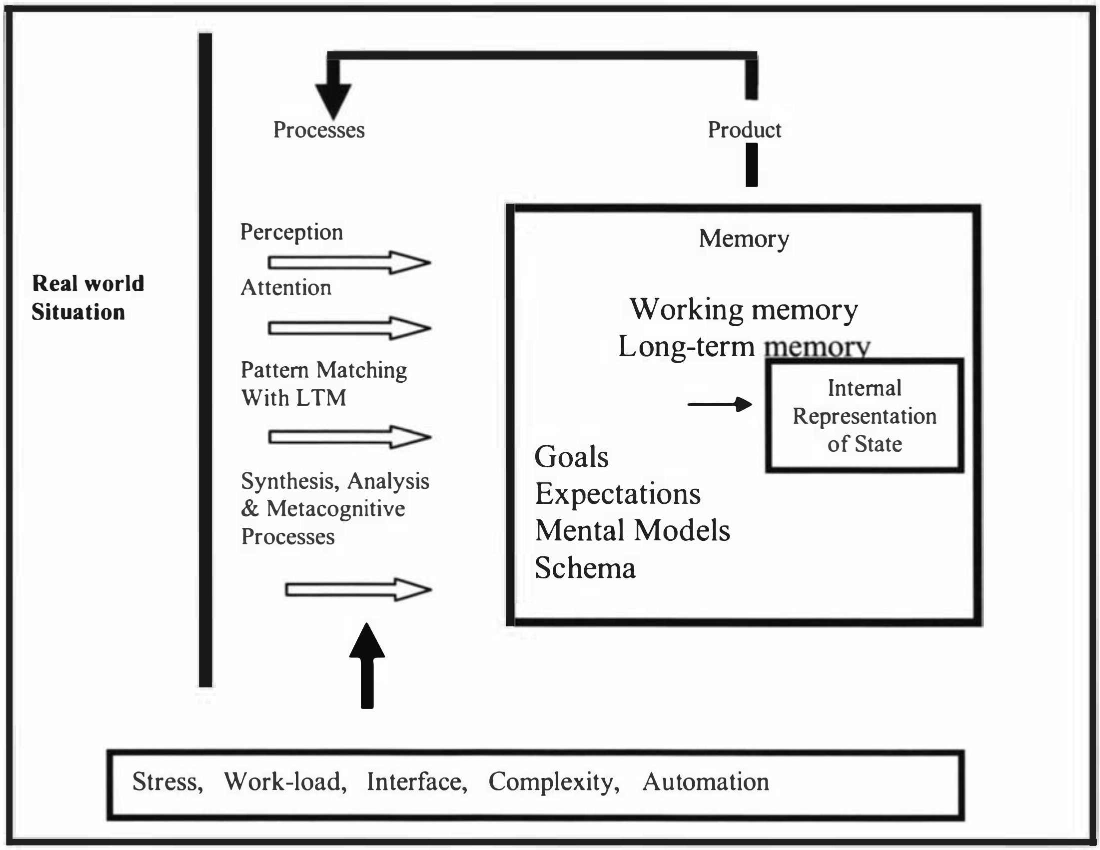

Figure 4.2 The development of Situational Awareness
From: Endsley, M.R., Garland, D.J. (2000) *Situational awareness analysis and measurement*, New Jersey: Lawrence Erlbaum Associates

The airline pilots rated situational awareness slightly lower in importance than the student pilots but equal to the general aviation pilots rating. Also rated as very important by all three pilot groups were task management skills. Although the practical application of task management skills is limited in the early stages of basic flight training, task management is associated with aircraft captaincy and the management of crews and small groups. In most flight training programmes the emphasis is on single pilot operations so that the student pilot's training will be orientated towards managing tasks as a single pilot. As their training progresses the student pilot is exposed to increasing task management demands as part of their navigation and instrument training. The effect of this may be to heighten the student pilot's awareness of the importance of task management skills.

The perception of task management as very important was also shared by the general aviation pilot group. Their perception of task management importance was slightly higher than that of the student pilot's. This may indicate an increasing importance in task management as experience is gained. The airline pilot group rated task management higher in importance than the other two pilot groups. This possibly results from the highly structured nature of scheduled airline operations where a culture of flight safety, passenger comfort, economy of operation, and on time performance prevails. The airline pilots who were interviewed in the airline pilot survey reported both situational awareness and task management as important skills and qualities for airline pilots although ranking them behind team working, people skills, technical skills and personal attributes.

The third non-technical skill category rated as important by all pilot groups was cognitive functioning. Although not taught as a specific subject during basic flight training, cognitive functioning skills were rated as very important by both the student pilot and general aviation pilot groups. A difference was found between the airline pilot group and the student pilot and general aviation pilot groups with the airline pilot's perception of cognitive functioning being only moderately important. The importance of cognitive functioning and flying is discussed in more depth in the following paragraphs.

The definition of cognitive competence proposed by Spencer and Spencer (1993) is:

> *"The individual's working to come to an understanding of a situation, task, problem, opportunity, or body of knowledge"*
>
> (Spencer & Spencer, 1993, p67).

The non-technical skills associated with cognitive functioning develop during basic flight training. In some cases cognitive functioning ability is tested as part of a selection process for entry into a training programme. The student pilot is faced with numerous examinations in a variety of technical subjects as well as having to cope with airborne situations that require a high level of mental arithmetic and problem solving. Flight training is a demanding experience and students will often have to function under high stress conditions and consequently be exposed to high pressure environments throughout their basic flight training. With the majority of the student respondents (47.8%) under the age of 20, enrolment in a professional flight training programme offers considerable challenges to young school leavers. Included in this is possibly the stress of living away from home for the first time, adjusting to a high discipline regime, learning to fly, and having to master numerous technical subjects and pass exams. In such an environment student pilots may have a heightened awareness of the importance of cognitive functioning. In many respects the general aviation pilot faces similar challenges and demands. As shown in Table 2.3, 63 per cent of the general aviation pilots who participated in the survey had been employed for less than 5 years with 23 percent having less than 1 years experience. This latter group particularly may have been experiencing similar challenges to the student pilots as newcomers to the aviation industry..

The difference between the airline pilot's perception of the importance of cognitive functioning and those of the student pilot and general aviation pilot groups may be due to the difference in work environments. The airline pilots work in a highly structured and disciplined regime which may be less demanding and challenging than the general aviation pilot's everyday work environment. With the benefit of greater overall experience, the airline pilot may not have to exercise the same level of cognitive functioning skill needed by the student pilot who is faced with new challenges and novel experiences on a daily basis. For this reason the airline pilot may not perceive cognitive functioning to be as important as the other groups. This is consistent with the observations of Hunt, L.M. (1995), that mental operations may become 'automatised' with experience and practice, reducing the cognitive load. The remaining non-technical skill categories; team working, decision making, and organisational focus were perceived as being moderately important by all three pilot groups. Each of these categories will be explored in turn.

Team working is not emphasised during basic flight training and is not included in the NZ CAA Human Factors syllabus. With the exception of the university aviation programme referred to in this study, where the principles of crew resource management are an integral part of the training, most training providers direct their training towards single pilot operations with the pilot in command operating the aircraft without the assistance of additional crew members. Even with the university programme, there is still an emphasis on single pilot operations rather than working in teams or crews.

The general aviation pilots' rating of team working as being of moderate importance rather than very important may be due to the single-pilot nature of the general aviation pilot's employment. While team working is not specifically taught during basic training, it is possible that an informal team environment develops within a training organisation as a group of students share the same goals and objectives and experience the same difficulties and achievements as their training progresses. The general aviation pilot usually works as a single pilot and may not have the same support structures in place particularly in small organisations. It is not unusual for the general aviation pilot to have other responsibilities, for example, aircraft loading and cleaning, looking after passengers and being responsible for organising maintenance. One observer described the role of the general aviation pilot as: "pilot, navigator, radio operator, systems manager, records keeper, oft-times flight attendant, and sometimes zoo keeper" (Lawhon, 2003 p2).

The decision making skill category, also rated as only moderately important, has been linked to situational awareness. According to Endsley and Garland (2000), operators make decisions based on their internal model of the environment. Stanners and French (2005) concluded that there was a significant relationship between situational awareness and decision making, in that people with a high degree of situational awareness made high quality decisions. During basic training the student is encouraged to make decisions concerning the conduct of a flight. Initially most of the aeronautical decision making will be done by the flight instructor but as the student's experience increases he or she will be required to play an increasing part in making operational decisions. Aeronautical decision making is prescribed in the NZCAA Part 61 curriculum for human factors.

The final non-technical skill category, rated by all pilot groups as being of moderate importance, was organisational focus. As in the case of team working skills, organisational focus skills are not part of the standard pilot training curriculum and are not taught or examined during basic pilot training. General aviation pilots were similar to the student pilots in that they were involved in single pilot operations in light aircraft. These operations included mainly flight instruction and Part 135 air transport operation, either VFR, or IFR in light aircraft. General aviation pilots often have their sights on advancement to an airline job and may not have a strong feeling of loyalty towards their employer, regarding their position as a stepping stone to a more permanent career. The "stepping stone mentality" was a phenomenon reported during the third stage airline pilot interviews. When asked to report examples of bad skills or attributes that new pilots bring to the airline, the highest frequency of responses was "poor personal attributes". An example of poor personal attributes, cited by several airline pilots, was new pilots openly admitting that they were only using their new position as a stepping stone to a bigger company. It was found that new pilots with this attitude were less willing to learn and accept instruction and guidance from more senior pilots. There were incentives however for the general aviation pilot to develop organisational focus. The general aviation pilot is likely to be actively involved with promoting the company to the customers and may be rewarded financially by flight pay or bonuses. The general aviation company is usually smaller than an airline company with management and staff known to each other on a first name basis.

Although organisational focus was nominated by the airline pilots in the stage three interviews as being one of the skills and qualities of successful airline pilots, extensive membership of the airline pilot's union, NZALPA, may see the pilot's interests being better served by this organisation rather than by any direct involvement with the airline company. Airline pilots may be more team and task focused and will usually have little contact with passengers.

4.3.3 The Effectiveness of Basic Pilot Training

In the preceding sections the identification of important technical and non technical skills was discussed together with the perceived importance of individual technical and non-technical skill categories. Findings 2 and 3 showed that all pilot groups considered the technical and non-technical skills identified in the study to be important although there were some variations in how the three groups rated the importance of individual skills. In this section the effectiveness of training in those skills is explored. Unlike the perception of skill importance there is less agreement between the pilot groups on training effectiveness.

4.3.4 Training Effectiveness of Technical Skills

Finding 4

All pilot groups rated the training for the technical skills of aircraft handling skills, aircraft systems management and aircraft navigation management to be effective or moderately effective. There were differences between the perceived effectiveness of aircraft handling skills and aircraft systems management skills reported by the airline pilot group and the student pilot and general aviation pilot groups. There was also a difference between perception of flight navigation management training effectiveness reported by airline pilot group and the student pilot group.

The student pilot group was surveyed at the private pilot licence level where most of their training would have been directed towards meeting the handling skills and systems and navigation management requirements for the private and commercial pilot flight test. As these skills are all technical skills it was not unexpected that the student pilots would rate the training as effective. The general aviation pilot group produced similar results. General aviation pilots often operate aircraft types and equipment not too dissimilar to that used in the training schools. General aviation pilots who are employed as flight instructors use the same type of training aircraft and for multi-engine air transport operations the light twin aircraft are similar to and equipped to the same standard as training aircraft. In the general aviation group surveyed, 23.6% indicated that they had been employed as general aviation pilots for a period of less than 12 months and provided that these pilots were employed soon after graduating from training school, so had not suffered from skill degradation, their previous technical skill based training had prepared them satisfactorily for the role of general aviation pilot. Flight school graduates seeking a position in general aviation as flight instructors require further training to obtain instructor qualifications. Often this training follows on immediately from the basic commercial pilot licence/instrument rating training re-enforcing the knowledge and technical skills gained during the basic training.

In contrast to the other two groups, the only technical skill the airline pilots rated as having effective training was aircraft handling. The other technical skills, aircraft systems management and aircraft navigation management, were rated as having only moderately effective training and contrasted with the higher ratings given by the student pilot and general aviation pilots group. While the reason for the difference between the groups was not obvious a possible explanation is suggested. The airline pilot group, due to their greater average age and longer involvement in the industry, may have experienced significant changes in technology as they moved into newer generations of air transport aircraft. The longer serving airline pilots may have operated piston engine, turboprop, and turbojet aircraft and have experienced the change from flight deck crews which included navigators and flight engineers, to modern two-pilot glass cockpits with Global Navigation Satellite Systems (GNSS). The automated systems associated with GNSS may provide advantages in terms of reliability and efficiency but experience has shown that automation may cause human performance problems. According to Galotti (1997) as many as sixty automation related concerns have been identified and include such factors as loss of systems awareness, poor human-machine interface, boredom and automation complacency, to name a few. Faced with the challenges that this equipment brings it the airline pilot group may perceive their basic training in navigational and systems management to have been less effective. The general aviation pilot on the other hand may be operating older, non-automated aircraft and navigational systems identical to or very similar to that with which they had operated during basic training.

4.3.5 Training Effectiveness of Non-Technical Skills

Finding 6

The three pilot groups were unanimous in their perception that the training effectiveness of the non-technical skills of decision making, organisational focus, and team working was minimal. Similarly all groups perceived the training of task management to be only moderately effective. The student pilots rated situational awareness training as effective while the general aviation and airline pilots rated it as moderately effective. The student pilots rated cognitive functioning training as moderately effective with the general aviation and airline pilots rating it as minimal.

With the exception of the student pilot group who rated situational awareness training as effective, the training for the remaining non-technical skill categories; decision making, organisational focus, task management, team working, and cognitive functioning was perceived to be only moderately effective or of minimal effectiveness. The student pilots' perception of situational awareness training as effective may be due to the emphasis placed on this skill in present day pilot training programmes. Aviation human factors (which includes situational awareness) was introduced into the commercial pilot training curriculum in the early 1990's when the HURDA programme was introduced prompting the NZCAA to introduce Human Factors training to PPL level. Subsequently the NZCAA introduced a human factors training requirement, based on the United Kingdom CAA training programme for the issue of the CPL (Transport Accident Investigation Commission, 1991). A driver for the introduction of aviation human factors was an air transport accident on May 16th 1989 involving a loss of situational awareness during a single-pilot IFR charter flight where the pilot became disoriented at night during an instrument approach with fatal results (Transport Accident Investigation Commission, 1991). This prompted the Transport Accident Investigation Commission (TAIC) to issue Safety Recommendation 037/91 which proposed the introduction of training on the limitations of human performance and methods of handling excess workload, as part of the flying training syllabus. Prior to 1990, the pilot training curriculum included the subject of airmanship which was a more narrowly focused and technically orientated subject. Airmanship was later absorbed into the wider aviation human factors curriculum with the scope shifting to more non-technical subjects. Although student pilots considered that they had received effective training in situational awareness skills, the analysis of flight test results from stage 1 of this study, found that students participating in a university ATP programme achieved slightly lower scores in situational awareness than they did in some other technical and non-technical skills. This was attributed to a possible over-protective environment within the particular flight training programme. (de Montalk, 2005). Both the general aviation group and the airline pilot group rated situational awareness training to be moderately effective.

Another area of difference between the student pilot group and the general aviation and airline groups was the perception of training effectiveness of cognitive functioning. While all three groups rated cognitive functioning to be important (student and general aviation pilots perceived it to be very important, airline pilots rating it as moderately important), the student pilots rated cognitive functioning training to be only moderately effective while the other two groups rated it as being of minimal effectiveness. Cognitive functioning skills develop during basic flight training and are not taught as specific topics. In some cases cognitive functioning ability would be tested as part of a selection process for entry into a training programme.

An area of agreement between the student pilots and general aviation pilot groups was the perception that there was moderately effective training for the non-technical skill category, task management. The task management skills category is associated with captaincy and aircraft command. The student pilot's training emphasises the role of the pilot in command of a light aircraft flying solo or carrying passengers on private operations and the task management skill elements are focused on during the training. The graduate student pilot will likely be employed in a single pilot role on light aircraft and consequently the emphasis on task management during basic flight training programme is likely to have a considerable influence on the subsequent general aviation role. The difference in the perception of the training effectiveness of this skill by the airline pilots and the two other groups may be evidence that there has been more emphasis on non-technical skills with the introduction of aviation human factors as part of the CAA Rule Part 61 curriculum in recent years. Many of the airline pilots would have received their training in the early or pre- human factors era where the scope of human factors training was restricted to airmanship.

The remaining non-technical skill categories, decision making, organisational focus and team working were rated as having minimal training effectiveness by the three pilot groups. The basic pilot training syllabus does not include organisational focus or team working as specific subjects. The theory of aeronautical decision making forms part of the human factors syllabus for the CPL, ATPL, and instrument rating and has a practical application in almost every aspect of flight training. The fact that the student pilots rated decision making training as having minimal effectiveness appears unusual given that the student's rated training for situational awareness as effective. A possible reason for the low rating is that the student pilots operate in a highly structured and supervised environment where many of the major decisions concerning their training flights were made by their instructors. Authorisation for a solo navigational flight, for example, is obtained by the student in consultation with a flying instructor, with the final decision for the flight to proceed being made by the instructor. For safety reasons flight training providers impose strict weather criteria and limitations on their operations. In most cases the student will be encouraged to participate in the decision making process but may not be aware that they are being formally instructed in decision making. An effective training method for aviation decision making is scenario based training utilising flight simulators (Federal Aviation Administration, 2004). The use of flight simulators and similar training devices by New Zealand training providers is not widespread and scenario based training is not common practice. During an analysis of the final route check results of students enrolled in a university BAv air transport pilot programme, de Montalk (2005) observed that students received lower scores in team working, and decision making and situational awareness than they did in the other technical and non-technical skills. It was concluded that this was due to a lack of training in a multi-crew environment and a lack of experience in air transport operations.

The general aviation pilots rated organisational focus training to be of minimal effectiveness indicating that their experience in the general aviation role revealed that a perceived need for training in organisational focus was not being met by the training providers. According to Spencer and Spencer (1993), organisation awareness, a key ingredient of organisational focus, refers to the individual's perception of the power relationships within his or her own organisation and in other organisations with which they are involved. It involves an appreciation of the organisation's place in the wider world, and political astuteness and the ability to use chains of command. As organisational focus is associated with a specific employment situation it is not required as part of basic pilot training, however it is suggested that there may be a place for the awareness of the broad principles of organisational focus to be introduced at an early stage of training.

The general aviation perception of decision making and team working training being of minimal effectiveness reflects that of the student pilot group and confirmed that while both skills were considered important by general aviation pilots there was little training provided during basic training. These skills were left to develop by themselves through experience.

Prior to 1991 the NZCAA pilot training syllabus included a subject called airmanship (M.J.Tucker, NZCAA, personal communication, September 2007). Airmanship was a wide ranging topic based on the long standing construct of seamanship and embracing the skills, knowledge and attitudes that defined the "art" of being a successful aviator. A lot of these skills were of a practical and technical nature: how to secure an aircraft in the open after a flight, how to avoid inconvenience and danger to other aircraft, people and buildings when running up an engine; others were of a non-technical nature such as maintaining a good lookout for collision avoidance in the air, how to assess wind direction by direct observation for example.

During the early 1990s the subject of aviation human factors was introduced into the NZCAA curriculum for all licences from the private pilot licence through to the airline transport pilot licence. This subject included the topic of airmanship as well as a broad range of topics including physiology and a number of non-technical skills (A.J.Wackrow, NZCAA, personal communication, September, 2007). With 49% of the airline pilots indicating that they had been employed as airline pilots for greater than 10 years and given that this would have been preceded by several years in basic training and in general aviation, it is probable that these pilots began their training before the introduction of aviation human factors as a required subject. The earlier airmanship subject was narrowly focused and directed towards aircraft handling and would not adequately prepare pilots for the much wider range of non-technical skills recognised as important by present day airline pilots. It is suggested that this is the most probable reason for the low rating for training effectiveness.

A comparison of the three pilot groups showed that in the past basic pilot training had concentrated on the technical skills although CAA licensing requirements had changed in recent years to include some non-technical skill training in aviation human factors (Table 4.2). As graduates from the basic flight training programmes gained employment in the general aviation industry, any additional formal training was generally limited to technical training such as the gaining of additional aircraft type ratings and new equipment such as GPS, flight directors and weather radar. Upgrading of licences to the airline transport pilot licence, when required, was normally achieved by home study with the assistance of correspondence courses. General aviation pilots on-going training was again focused on the development of technical skills. The airline pilots on the other hand were subject to an on-going regime of both technical and non-technical training throughout their careers with an airline.

4.3.6 Skill Deficiencies in Multi-Crew Aircraft Accidents.

Finding 7

Non-technical skills are more likely to be the primary cause of accidents in multi-crew air transport operations than technical skills.

In the sample of accidents reviewed (n = 229), non-technical skill deficiencies accounted for 66% of the primary accident causes (Appendix G). As contributing causes of accidents, non-technical skills also exceeded technical skill deficiencies. This finding is consistent with the analysis of Murphy (1980) cited in Weiner, Kanki, and Helmreich (1993) who concluded that "pilot error" was more likely to be the cause of deficiencies in workload and task management, as well as situational awareness and resource management than deficient “stick and rudder” skills.

The results presented in Chapter 3 suggest that the major cause of accidents was attributed to task management. This non-technical skill group accounted for 49% of the accidents and was rated by the airline pilot group as very important. The technical skill category, aircraft handling skills, was given a higher rating of importance although accounting for only 23% of the accidents. The airline pilots rated the technical skills together with situational awareness and task management as very important and the remaining non-technical skills as moderately important. The difference in the perception of importance that the airline pilots’ attached to task management and aircraft handling skills warrants some further consideration. Although task management has been identified as the primary cause of a majority of multi-crew aircraft accidents, airline pilots continue to rate aircraft handling skills as more important than task management skills. A possible reason for this may be that there is a difference in perception of an accident cause depending on who is considering it. Take a hypothetical example where an aircraft has run off the side of the runway when attempting to land in a strong crosswind. From the pilots perceptive the accident may be attributable to aircraft mishandling, lack of recent practice in cross wind landings, or inexperience, all of which would be classified as deficiencies in technical skills. An accident investigator may have a very different perspective. Taking a wider view the investigator might attribute the accident to poor planning and coordinating on the part of the crew in selecting a runway with a crosswind component close to the aircraft limits when a more favourable alternative runway may be available, or to poor workload management when the non-flying pilot fails to monitor the flying pilot during the crucial landing phase because of attending to paperwork. These are examples of deficiencies in task management and illustrate a difference in the perception of pilots and investigators of technical and non-technical skills as a primary accident cause. An example of this difference in perception is described in the following paragraph.

On 9 June 1995 a de Havilland DHC-8 aircraft was involved in a controlled flight into terrain accident near Palmerston North. The accident resulted in some casualties and one cabin crew member and three passengers lost their lives. The official accident report published by the New Zealand transport Accident Investigation Commission (TAIC, 1995) attributed the cause to six factors which included technical skill and non-technical skill deficiencies. All factors were attributed to failures by the pilots. In a review of the accident, Zotov (2006) identified numerous other systemic failures attributable to poor management decisions that had existed in the airline for some time prior to the accident. According to Zotov the different view of causality minimised the pilots' role in causing the accident and highlighted several areas of good CRM performance displayed by the crew.

The airline pilots group rated task management skills training as only moderately effective. This group also rated cognitive functioning, decision making, organisational focus and team working training as minimally effective. Decision making and team work also feature as contributing causes of aircraft accidents.

With the non-technical skills being the primary cause of aircraft accidents in this category the results suggest that the less than effective training reported by the airline pilots may indicate that basic pilot training does not in itself adequately prepare pilots for employment as airline pilots

4.3.7 Accident Risk in Multi-Crew Air Transport Operations.

Finding 9

New Zealand airline pilots rarely observe technical or non-technical skill behaviours that endanger flight safety.

The review of NTSB/FAA Part 121 accidents revealed that non-technical skill failures were the primary cause of multi-crew accidents in a majority of cases. While these accidents mainly involved American aircraft and pilots there was no reason to expect that primary accident causes would be any different in New Zealand. The infrequence of air accidents amongst the small aviation population of New Zealand makes it difficult to obtain statistically valid results regarding accident causes. Table 4.2 constructed from information obtained from NZCAA Aviation Industry Safety Updates Revisions 15 to 18 shows the reported accidents over a 12 year period.

Table 4.2 *Part 121 Multi-Crew Air Transport Accidents/Incidents*

Year	1994	95	96	97	98	99	00	01	02	03	04	05	06
Accidents	0	3	0	1	0	0	2	0	1	1	0	2	0

Ten accidents were reported to the CAA from 1994 to 2006 and were investigated by the Transport Accident Investigation Commission (TAIC). The TAIC records show that 3 accidents were causes by extreme and unexpected weather phenomena including an unexpected crosswind gust that exceeded the aircraft's crosswind limit, severe airframe icing leading to a loss of control, and clear air turbulence leading to a passenger injury. A further three occurrences involved engine failures due to mechanical failures and an additional double engine failure due to a bird strike. The remaining three accidents (all involving fatalities) were primarily caused by technical and none technical skill deficiencies including aircraft systems management and aircraft navigation management. One accident involved non-technical skill failure as the primary cause and included task management and team working skill deficiencies. Table 4.3 shows the ten accidents reported for the period 1994-2006 and illustrates the low number of accidents attributable to technical or non-technical skill deficiencies compared to other factors such as weather and mechanical problems. The number of airline accidents reported in New Zealand is so low that a statistical analysis is impossible.

Table 4.3 *Reported Part 121 Accidents/Incidents and Probable Causes*

TAIC Reference	Description	Probable Cause		
		Technical	Non-technical	Other
05-001	Aircraft left runway, unexpected wind gust			√
05-006	Loss of control. Auto pilot disconnect after non-standard fuel balancing procedure	√		
03-006	Loss of control after encountering severe airframe icing			√
02-014	Engine failure			√
01-002	Engine failure x 2			√
00-001	Engine failure			√
97-003	Controlled flight into terrain	√		
95-019	Engine failure			√
95-011	Controlled flight into terrain		√	
95-006	Clear air turbulence. Passenger injured			√

When asked to indicate whether behaviour involving technical or non-technical skills had ever been observed to directly endanger flight safety the responses were invariably at the low end of the scale. The three technical skills together with *situational awareness* and *task management* were rated in the 'very rarely' to 'occasionally' range (2~3) The remaining non-technical skills: *cognitive functioning, decision making*, *team working* and *organisational focus,* were found to be extremely rare and were reported as never having been observed to endanger flight safety to 'very rarely' (1~2). Although the NSTB/FAA safety reports indicate that non-technical skill deficiencies are the primary cause of Part 121 multi-crew accidents this has not been the experience of New Zealand airline pilots. A possible explanation for this may be that the pilots' first reaction to an accident is to suspect a mishandling of the aircraft or its systems rather than any underlying non-technical cause

4.3.8 Effectiveness of Basic Training to CPL/Instrument Rating

Finding 10

New Zealand trained professional pilots' rate pilot training to commercial pilot licence/instrument rating standard as satisfactory.

Table 8.19 shows that a majority of professional pilots (73%) considered their training to CPL-Instrument Rating standard prepared them well for a role as a professional pilot. The majority of the group (49%) rated their flight training quality as largely satisfactory and 24% indicated that it prepared them very well. A smaller number of respondents (25%) indicated that their training was not satisfactory.

The professional pilot group included both the general aviation pilots and the airline pilots. The student pilots, having not yet qualified, were not included in this part of the survey. The largely favourable response to the quality of basic pilot training may indicate that the NZCAA pilot training curriculum and standards and the general standard of delivery by flight training providers is satisfactory for most sectors of the industry. On the other hand, the substantial number of respondents indicating that their training was less than satisfactory is of some concern. As has been demonstrated in earlier sections, the airline pilot group found the training in both technical and non-technical skills to be less than effective with the exception of aircraft handling skills. While basic flight training is adequate for the general aviation industry it falls short of the airline industry requirements. As indicated in Table 3.25 the majority of the responses of the airline pilots participating in the telephone interview indicated that the quality of GA pilots entering the airlines was adequate or that handling skills were adequate but non-technical skills were deficient.

4.3.9 Preparation for Multi-Crew Air Transport Operations.

Finding 11

New Zealand trained airline pilots' rate flight training to commercial pilot licence/instrument rating standard to be barely adequate for preparing pilots for multi-crew airline operations.

A majority of the airline pilots (70%) did not consider that flight training to CPL – Instrument Rating standard to be adequate for preparing pilots for multi-crew airline operations. This result is not surprising as the present CPL – IR curriculum is focused on single pilot operations and students are not normally introduced to the basic concepts of operating in a crew (Turney, 2003). There are some exceptions with Massey University School of Aviation offering a CRM paper in the BAv ATP programme where students are introduced to the concept of two-pilot operations in light twin engine aircraft as part of the programme (Massey University Calendar, 2007). In the UK, the CAA requires all pilots to undergo multi-crew cooperation training prior to the issue of the first multi-crew type rating. Although this is a pre-requisite for entry into an airline, the MCC training is not normally incorporated into the basic training phase but is a stand alone course undertaken after the issue of the basic licences and instrument rating (UK CAA, 2007b).

The conclusion of airline pilots in the survey that basic pilot training was inadequate for multi-crew airline operations was reinforced by the information gained through the telephone survey in the fourth stage of the study. Here a majority of the airline pilots (77%) stated that some previous training in crew resource management would be of benefit to pilots beginning an airline career. The airline pilots participating in the survey also suggested that some airline role training should be given during basic training. CRM and airline role training would represent a major departure from the traditional 'training for the licence first then learning on the job' regime that is standard practice in New Zealand flight schools.

Airline role training at an early stage of basic training would be consistent with Alexander's model of domain learning (MDL) which was examined in the literature review (Alexander, 2003). The MDL proposed that domain knowledge should be developed in parallel with topic knowledge and the place for this is during the basic training and not as part of the more traditional on-the-job-training. This reinforces the view that basic pilot training should be preparing the student for the role of professional pilot and not just to pass exams and flight tests for licensing purposes. At the present time role training does not form part of the training curriculum of the civil pilot training providers in New Zealand although the RNZAF have been applying the concept for many years in their pilot's wings course.

The airline pilots' appreciation of people skills warrants some discussion. The literature does not offer a precise definition of "people skills" but a common theme seems to be the goal of successful interpersonal communication which is achieved by possessing empathy and understanding of other people, the ability to express thought and feelings clearly, having an appropriate degree of assertiveness, giving and receiving feedback, influencing how others think and act, conflict resolution, collaborating with others to achieve common goals rather acting alone and resolving unproductive relationships. People skills are also known as emotional intelligence and Goleman (1995) suggested an “emotional quotient” model consisting of five skills; self-awareness, self-management, self-motivation, empathy, and relationship management. The airline pilot subjects’ definition of people skills can be summed up as the ability to communicate successfully on the flight deck and with other company personnel such as ground handling staff and engineers, as well as other agencies such as air traffic control. Pilots from a regional airline using small commuter type aircraft recognised the importance of people skills when dealing with passengers. The first officer’s duties included some of the passenger handling duties allocated to cabin crew on larger aircraft.

Several subjects indicated that having good people skills could compensate for a lower level of technical skill as technical skills could be developed with experience in the airline but good people skills were a characteristic that the individual brought to the airline. While people skills may be thought of as inter-personal skills, personal attributes are a series of qualities and skills that may be considered to be intra-personal skills. Marsh (1985) defined intra-personal skills as skills individuals need to manage themselves. They are also a prerequisite to inter-personal skills. Table 4.5 gives a comparison of personal attributes from three different sources; a Royal Air Force officer recruiting brochure, a list of desirable personal attributes derived from the stage 3 airline pilot survey, and Spencer & Spencer's (1998) personal effectiveness competencies. These examples were chosen to demonstrate the similarities between the two aviation groups (RAF and airline pilots) and the more universal qualities suggested by the generic Spencer & Spencer model. The list of attributes is comprehensive and the individual may possess these qualities to a greater or lesser extent. Domain specific attributes for airline pilots as indicated in the table are an important component of the screening and selection process for new airline pilots.

Table 4.4 *Personal Attributes*

Royal Air Force Officer personal attributes *	New Zealand airline pilot desirable personal attributes.	Personal effectiveness competencies (Spencer & Spencer, 1993).
Appearance	Keenness and enthusiasm	Self-control
Self-confidence	Positive attitude	Self-confidence
Maturity	Willingness to learn	Flexibility
Ability to communicate	Awareness of the big picture	Organisational commitment
Academic ability Leadership	Communication skills Command potential	
Fitness	Motivation	
Teamwork	Level headedness	
Reasoning skills	Maturity	
Motivation	Ability to listen	
Breadth and depth of outlook	High personal standards	
	Good personality	
	Willingness to learn from mistakes	
	Willingness to conform	

* Retrieved June 21, 2007 from the World Wide Web: http://www.sn63.dial.pipex.com/personal-attributes.thm

4.4 Summary of Findings

4.4.1 Technical Skills

At the beginning of the study there was an expectation that a pilot's perception of the importance of the various technical skills would change with increasing experience. Basic aircraft handling skills, for example, might appear highly important to a student pilot but less important to the pilot of a large air transport aircraft where a high degree of automation was standard and where the emphasis might be on systems and navigational management rather than aircraft handling. The pilot's perception of the importance of the three technical skill groups actually remained unchanged with time and increasing experience, with all three pilot groups rating the technical skills as very important. Perceived training effectiveness in the technical skills however did produce some variation. Student pilots, general aviation pilots, and airline pilots, rated training in aircraft handling skills to be effective, however the airline pilots rated aircraft systems management and aircraft navigation management as being only moderately effective. It is suggested that while basic flight training programmes prepare student pilots and general aviation pilots for the CAA licensing requirements and are adequate for pilots employed in the general aviation industry, airline pilots perceive that training in systems and navigational management skills may not sufficiently effective to meet the needs of the airline industry.

4.4.2 Non-Technical Skills

With the non-technical skills, all three groups rated situational awareness and task management as being very important. The student pilots also rated cognitive functioning as very important. The remaining non-technical skills were rated moderately important. The three pilot groups were similar in their assessment of the training effectiveness of non-technical skills. The student pilot group rated situational awareness training as effective and task management and cognitive functioning being moderately effective. General aviation pilots and airline pilots rated situational awareness and task management training as being moderately effective. All pilot groups rated the training effectiveness for decision making, organisational focus and team working to be of minimal effectiveness. With the majority of the non-technical skills being recognised as important but with the training for these skills being perceived as being less than effective it is difficult to see how these skills, considered desirable by the airlines, can be expected to develop through experience alone during the graduate pilot's 'apprenticeship' as a general aviation pilot.

4.4.3 Skill Deficiencies in Multi-Crew Air Transport Accidents

While the research indicates that non-technical skill deficiencies are likely to be the primary and contributing causes of aircraft accidents rather than a lack of handling skills or deficient technical skills, the New Zealand airline pilots indicated that they had never, or only very rarely experienced situations where flight safety was endangered due to deficiencies in those skills. In the 12 years of New Zealand accidents and incidents reviewed, only two were attributable to technical skill deficiencies and one to non-technical skills. The small size of the New Zealand airline industry compare with its North American counterpart makes direct comparisons impossible. As reported by Spruston and O'Day (2001) the large air carrier sector of the New Zealand aviation industry is serving the country well with a good safety environment.

4.4.4 Basic Pilot Training Effectiveness

While the major carriers enjoy a good safety record the same cannot be said for the general aviation sector. The Spruston report (Spruston & O'Day, 2001) identified problems with the safety culture and attitude of small general aviation organisations. The report stated that the safety record of this sector compares poorly with other developed countries and poor operating techniques and a cavalier approach to safety is evident.

The study suggests that the training providers are adequately preparing pilots to meet the standard of technical skills required by the NZ CAA for professional licence issue. However, these skills need to be supplemented by further training before the graduate can be gainfully employed employment as a flight instructor or as a VFR commercial pilot, on air transport operations, aerial work or agricultural aviation. The problems identified by Spruston et al. indicate a lack of training and guidance during the formative stages of a pilot's career. These problems reflect shortcomings on the part of operators rather than the training providers. In the accident and incident reports issued by the TAIC during the period 1994 – 2006, a total of 29 involved general aviation aircraft on Part 135 operations. This compares with a total of 10 accidents and incidents on Part 121 and 125 operations for the same period. Of these 10 accidents two were attributable to deficient technical skills, one to deficient non-technical skills and the remaining seven to other causes such as unpredicted weather phenomena and mechanical problems. Of the 29 general aviation accidents and incidents ten were attributable to deficient technical skills, seven to deficient non-technical skills and the remainder to other causes.

4.4.5 Basic Pilot Training Effectiveness for Airline Entry

The questionnaire results and the airline pilot survey revealed that there was general satisfaction with the technical skills that most pilots had developed during their general aviation careers. There was also an acknowledgement that general aviation pilots often lacked practical IFR experience and knowledge and were not confident operating in bad weather conditions. There was general agreement that basic flight training in its present form did not prepare pilots for operating in a multi-crew airline environment. The training effectiveness of the non-technical skills in particular was rated as low by the airline pilots in the survey. In the airline pilot telephone survey poor personal attributes were cited as examples of bad skills and qualities that were seen in new pilots joining the airlines from the general aviation sector. Personal attributes form part of the people skills considered important by the airlines.

Chapter Five

Conclusions and Recommendations

5.1 Introduction

The study observed differences in the skills and attributes of graduates from New Zealand flight training schools and those skills and attributes which were perceived by the aviation industry to define a proficient air transport pilot. The study found evidence that there is a need for the newly licensed pilot graduating from basic pilot training to develop a range of role-related non-technical skills to supplement the technical skill orientated training leading to the issue of a commercial pilot licence and instrument rating. The NZ CAA Part 61 licensing requirements for professional pilots seeking an airline career should be changed to include the non-technical skills identified with the role of air transport pilot. As figure 5.1 illustrates, the non-technical skills associated with airline pilot proficiency should be used to support role-specific training at the basic training stage. This should result in a graduate pilot who will be suitably trained for direct entry into the airline training system or for a reduction of the general aviation experience required for those using that sector of the industry as a stepping stone to an airline career.

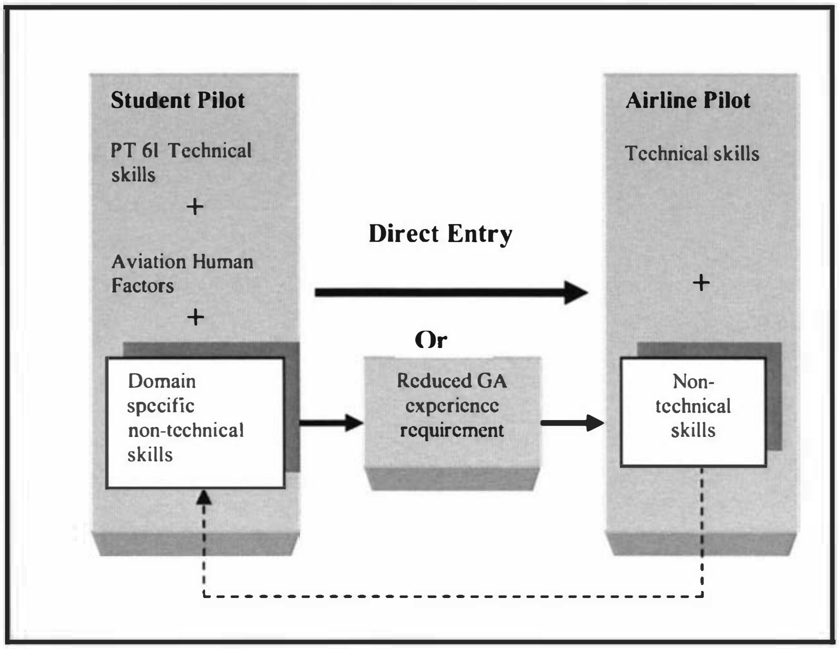

Figure 5.1 A model for closing the airline skill/knowledge gap

It is beyond the scope of the study to suggest specific curriculum changes or to prescribe how non-technical skill training should be implemented. The conclusions of the study together with some recommendations and suggestions for future research are presented.

5. 2 Conclusions

1. The present NZ CAA curriculum and experience requirements for the issue of professional pilot licences and ratings provides a sufficient standard of competency to allow graduate pilots to enter the aviation industry and to operate a light aircraft safely in a single pilot role.

2. Further technical and non-technical skill training is required before the new pilot can operate effectively at a standard required for general aviation air transport operations.

3. Because of The NZCAA Part 61 licensing focus on technical skills most of the training in the non-technical skills considered desirable by the airlines was of minimal effectiveness.

4. After flight school graduation, general aviation experience develops an adequate standard of aircraft handling skills for airline entry. General aviation experience alone however does not provide sufficient skill development in aircraft systems management and flight navigation management to airline entry standards.

5. The skill and knowledge gap between the graduates of New Zealand flight schools and the skill and knowledge requirements of the New Zealand Aviation Industry reported by Spruston and O'Day (2001) and Hunt (2000) is probably due to the lack of non-technical skill training during basic flight training.

6. There is a lack of structure and guidance for graduate pilots entering the general aviation industry with the expectation of gaining further experience in preparation for an airline career.

7. There is a case for airline role training and an introduction to multi-crew operations to be introduced during basic flight training for students intending to pursue an airline career.

8. Deficiencies in non-technical skill performance are more likely to be the primary cause of multi-crew, air transport aircraft accidents than deficiencies in technical skills.

9. New Zealand airline pilots are rarely exposed to situations where deficiencies in technical or non-technical skills may endanger flight safety.

5.3 Recommendations

This study provides a case for introducing training in non-technical skills as part of the basic pilot training programme. A greater emphasis needs to be placed on the development and assessment of these skills throughout the pilot's career. The survey identified several categories of non-technical skills and behaviours that are associated with role of air transport pilot. It is suggested that these categories should provide the focus for non-technical skill training during basic flight training.

There was recognition from the airline industry of the value of some form of role training being provided during this training. This is consistent with the philosophy of training for the job not just the qualification. Flight training providers who aim to supply the airline sector of the industry need to consider providing a broad education in the organisation and function of airlines.

There was support from the airline industry for some pre - airline entry training in multi-crew operations. The principles of crew resource management could be introduced during the basic training phase. The Massey University ATP programme model is an example of how such principles can be introduced using a flight training devices and light twin engine aircraft using the support pilot concept. Similarly, effective training could be introduced using a flight simulator which permits two pilot operations. For a more structured approach, consideration could be given to the introduction of a stand alone multi-crew course using both simulators and aircraft. This is now a requirement in the UK as a pre-requisite to obtaining an initial type –rating in a heavy aircraft.

There may also be a case for flight training providers to introduce a form of pre-selection so that candidates for training can demonstrate the possession of some of the non-technical skills identified in this research. While non-technical skills can be learnt or trained for, the possession of good intra and inter-personal skills, or the willingness to develop them, may indicate a person's suitability for the role of air transport pilot.

In chapter 1 reference was made to an ICAO proposal for the introduction of a multi-crew pilot licence (MPL). Based largely on flight simulator training, this new licence is not without controversy with conservative elements of the industry warning that the newly qualified pilots will lack the experience and fundamental skills that can only be acquired with time and participation in the role and which cannot be gained by flying a simulator (Learmount, 2007).

A practical alternative for the New Zealand air transport industry may be the introduction of a CRM based multi-crew course as a pre-requisite to airline employment. The course could be an extension of the multi-engine instrument rating training already provided for by the flight training organisations and could be largely based on the flight training and navigation devices now available to the general aviation industry without the expense of a full airline standard flight simulator .

5.4 Limitations of the Study

The main limitation of these studies is sample size. From the outset the research was focused on the needs of the New Zealand Aviation Industry. Initially consideration was given to wider global perspective; however the Spruston review of 2001 highlighted the need for an in depth study of the New Zealand aviation industry and it was anticipated that some benefits for the industry would evolve from the study. The New Zealand focus limited the study to a much smaller population. Although aviation plays a very important part of this country's transport system and the per capita impact of aviation is high, the total population actively employed as commercial pilots is relatively small and of that group even fewer are employed as air transport pilots.

Table 5.2 shows the small number of commercial fixed wing aircraft pilots holding class 1 medical certificates in New Zealand in July 2003. Of the numbers shown a large proportion of the commercial pilots are employed in agricultural flying and helicopter operations and were outside the scope of this study.

Table 5.1 *Fixed Wing Commercial Pilots in New Zea*land

Licence	Number
Airline Transport	1037
Commercial Pilot	1352
Total	2389

Source (Frampton & Walkington, 2003)

Overall, sufficient responses were received to achieve a modest degree of statistical integrity.

5.5 Future Research

This research revealed differences in the pilots' appreciation of skill importance and training effectiveness through three stages of their careers. Not unexpectedly the airline pilots, being an older and more experienced group, had a number of different views to new pilots still under training and general aviation pilots who were for the most part just beginning their career. There may be value in a longitudinal study of a selected group of pilots to track these changes on a formal basis.

The introduction of the new multi-crew pilot licence opens up opportunities for future research. This licence requires many of the skills identified in this study to be trained for from the beginning of pilot training including the early introduction of crew resource management.

Finally, it is suggested that flight school graduates who have had broad non-technical skill training, airline role training, and crew resource management training, should be monitored to see if they can function successfully in the airline environment without going through the traditional apprenticeship model and spending years gaining additional flying experience in the world of general aviation.

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Massey University

School of Aviation

College of Business

FRC

Name .... Date ....

Student ID .... Course ....

Flight Test Objective

The candidate is to demonstrate crew accomplishment in

Multi-crew, Multi-engine IFR Route Operations.

Emphasis will be placed on capability in **Aeroplane Command, Co-pilot Functioning and Flight Navigation Management** in Multi-engine, two pilot, light aeroplanes on Air Transport Operations under IFR.

Examiner The FRC will be conducted by an Annex E nominated flight examiner

Crew Roles

The test consists of four sectors with a landing after each sector. For the first pair of sectors, one candidate will be Pilot-in-Command and another candidate will be Co-Pilot. For the second pair, the roles will be reversed. In each pair of sectors, there will be a 'long sector' and a 'short sector'. It is intended that the 'long sector' will provide opportunities for consideration of examiner-nominated, non-normal scenarios.

The **Examiner's role** is that of *Examiner Observing*. The candidate will meet the manoeuvring accuracy standards specified in earlier flight tests and in the requirements for the Degree curriculum. Particular notice will be taken of crew interaction and it is crucial that candidates effectively verbalise all significant actions so that the Examiner knows what the candidates plan and are doing.

FRC

Name .... Student ID .... Course .... Date ....

A. Role: **Pilot-in-Command.** Function: **Pilot Flying (P/F)**

		Preflight			Comment
1.		Fitness for flight, promptness and dress when reporting for duty		☐	
2.		Providing evidence of legality and currency for the operation (Licence, Medical Certificate and Pilot Log Book)		☐	
3.	*	Obtaining and interpreting weather information	(254)	☐	
4.	*	Determining probable sector maximum one-engine-inoperative altitude		☐	
5.	*	Determining Freezing Level / MRAs		☐	
6.	*	Planning route	(254)	☐	
7.	*	Determining Take-off Distance Available and Take-off Distance Required		☐	
8.	*	Determining Destination Landing Distance Available, Landing Distance Required and Allowable Landing Weight		☐	
9.		Deciding flight load, equipment and disposition of load in aircraft		☐	
10.		Informing Copilot of Function and Duties		☐	
11.	*	Completing Load Sheet and Weight and Balance form	(254)	☐	
12.	*	Checking Flight Navigation Log		☐	
13.	*	Checking Fuel Analysis		☐	
14.	*	Checking ATC Flight Plan		☐	

Underlined Duties are performed by both pilots • These items are to be checked by other pilot ++ Discussions may be conducted on any sector 1

FRC

15. Preparing aircraft and placing and securing load and equipment ☐
16. Conducting pre-flight inspection ☐
17. Checking passenger security and briefing passengers ☐
18. * <u>Deciding to undertake, delay or cancel flight (at Holding Point)</u> ☐

<u>Take-off & Climb</u>

19. Being ready to start engines On Time ☐
20. * Receiving and interpreting ATIS & Flight Clearance ☐
21. * <u>Choosing take-off direction and point on runway for commencement of take-off</u> ☐
22. * <u>Using suitable taxying paths, and positions for runup and holding</u> ☐
23. * <u>Determining intial type of climb (max AOC/max ROC/en-route)</u> ☐
24. * Take-off Brief, including SID ☐
25. * Taking-off and establishing track ☐
26. * Establishing climb (type appropriate to situation) ☐
27. Checking on A/C performance in climb (power/speed/RoC) ☐
28. * Checking on climb gradient vs obstacle profile (e.g. DME Steps) ☐
29. * Confirming Top of Climb Point and ETA at TOC ☐
30. * Checking on revised Initial Waypoint and Destination ETAs ☐

<u>Underlined Duties are performed by both pilots</u>   * These items are to be checked by other pilot   ++ Discussions may be conducted on any sector

FRC

Cruise

31. Checking A/C performance in cruise (power/trim/speed) ☐

32. Performing Cruise Checks and Crew Brief, including allocating crew duties ☐

33. * Nominating and Identifying Navaids (Track, G/S checks, waypoint verification) ☐

34. * Checking Flight Navigation Log and revisions to ETAs ☐

35. * Operating Pitot Heaters and checking on Engine and Airframe Icing ☐

36. * Following route according to ATC Clearances (254) ☐

37. * Checking Engine-out and Terrain requirements en-route. ☐

38. * <u>Checking Fuel Howgozit and revising Fuel Reserves</u> ☐

39. * <u>Reviewing updated En-route, Destination and Alternate Weather</u> ☐

40. * <u>Reviewing intentions with respect to onward flight to Desination</u> ☐

41. * Anticipating and performing vertical and horizontal diversionary tactics for minimising turbulence, adverse winds and icing ☐

42. ++ Discussing examiner-nominated diversion exercise scenario ☐

43. ++ Discussing examiner-nominated engine failure in cruise exercise scenario ☐

44. ++ Discussing examiner-nominated airframe icing scenario in cruise exercise ☐

45. ++ Discussing examiner-nominated Loss of Comms scenario in cruise exercise ☐

46. * <u>Confirming Destination ATIS / Landing Data</u> ☐

<u>Underlined Duties are performed by both pilots</u> * These items are to be checked by other pilot ++ Discussions may be conducted on any sector

FRC

47. * Confirming Landing Distance Available and Landing Distance Required ☐

48. * Determining required descent performance and calculating TOD (254) ☐

Descent

49. * Giving Instrument Approach Brief and Crew Brief, including crew duties ☐

50. * Performing Descent Checks ☐

51. Managing speed/altitude in the Descent ☐

52. * Checking Descent Profile (as opposed to Instrument Approach profile) ☐

Approach & Landing

53. * Determining & Interpreting STAR or Positioning for Approach ☐

54. * Flying STAR or Positioning for Approach ☐

55. * Choosing runway, circuit pattern and point of touchdown ☐

56. * Performing Landing ☐

57. * Using suitable taxying paths and position for shutdown ☐

Postflight

58. * Checking ELT and terminating or amending Flight Plan ☐

59. * Completing flight documentation ☐

60. Tidying up A/C interior ☐

61. Inspecting A/C postflight, including securing of A/C ☐

Underlined Duties are performed by both pilots   * These items are to be checked by other pilot   ++ Discussions may be conducted on any sector   4

FRC

Overall

62. Managing priorities ☐

63. Ensuring that prime focus is on role duties ☐

64. * Monitoring other crew member's significant activities and calculations ☐

65. Handling non-normal occurences ☐

66. Communicating effectively with crew members (including examiner) ☐

67. Avoiding unnecessary and intrusive talk ☐

68. Using Check Lists correctly ☐

69. * Listening to and noting all R/T communications and using R/T correctly ☐

70. Maintaining an orderly/tidy flight deck ☐

71. • Flying within required accuracy tolerances ☐

72. Advising other pilot of one's own omissions or errors without fail ☐

73. Drawing other pilot's attention to their omissions, errors and excursions from acceptable flight accuracy requirements ☐

74. Managing crew ☐

75. Maintaining a tidy apearance on the ground. ☐

Underlined Duties are performed by both pilots * These items are to be checked by other pilot ++ Discussions may be conducted on any sector

FRC

A. Role: **Pilot-in-Command.** Function: **Pilot Flying (P/F)**

Departure Airfield	Runway	Departure........................	Route..
Intermediate Airfield....................	Runway............	Arrival..............................	Instrument Approach ....
Intermediate Airfield..................	Runway	Departure........................	Route..
Destination Airfield.....................	Runway............	Arrival..............................	Instrument Approach ....

Comments

FRC

B. Role: Copilot Function: Pilot Not Flying (PNF)

Preflight

1.	*	Confirming interpretion of weather information		☐
2.	*	Confirming determination of sector maximum one-engine-inoperative altitude		☐
3.		Determining Freezing Levels / MRAs		☐
4.	*	Confirming Planning of route		☐
5.	*	Confirming Take-off Distance Available and Take-off Distance Required		☐
6.		Confirming Destination Landing Distance Available, Landing Distance Required and Allowable Landing Weight		☐
7.	*	Confirming Load Sheet and Weight and Balance Form calculations		☐
8.	*	Preparing Flight Navigation Log	(254)	☐
9.	*	Preparing Fuel Analysis	(254)	☐
10.	*	Preparing & Filing ATC Flight Plan	(254)	☐
11.		Assisting with preparation of aircraft and equipment as directed		☐
12.		Checking passenger security and briefing passengers		☐
13.	*	Confirming decision to undertake, delay or cancel flight		☐

Take-off & Climb

14.	*	Obtaining, Recording and Interpreting ATIS & ATC Clearance	(254)	☐

Underlined Duties are performed by both pilots. * These items are to be checked by other pilot ++ Discussions may be conducted on any sector

FRC

15. * Confirming choice of take-off direction and point on runway for commencement of take-off ☐

16. * Using R/T to obtain Taxy Clearance & further directions for airfield positioning ☐

17. * Confirming suitability of taxying paths, and positions for runup and holding ☐

18. * Confirming determination of intial type of climb (max AOC/max ROC/en-route) ☐

19. * Confirming details of Take-off Brief and SID ☐

20. * Monitoring take-off ☐

21. * Monitoring establishment of track ☐

22. * Monitoring establishment of appropriate climb type ☐

23. * Entering Waypoint and Destination ETAs in Flight Log EARLY (254) ☐

24. * Determining TOC Point and ETA at TOC (254) ☐

Cruise

25. * Selecting, tuning and identifying radio aids for Track and G/S checks and Waypoint verification, as directed (254) ☐

26. * Revising ETAs (254) ☐

27. * Monitoring operating of Pitot Heaters and checks on Engine and Airframe Icing ☐

28. Recording the revision and reporting of Waypoint Passages and ETAs (254) ☐

29. * Monitoring Engine-out and Terrain requirements en-route ☐

30. * Calculating Fuel Howgozit and revising Fuel Reserves (254) ☐

Underlined Duties are performed by both pilots   * These items are to be checked by other pilot   ++ Discussions may be conducted on any sector

FRC

31. * Updating and reviewing En-route, Destination and Alternate Weathers ☐

32. * Reviewing intentions with respect to onward flight to Destination ☐

33. * Obtaining Destination ATIS / Landing Data ☐

34. * Determining Landing Distance Available and Landing Distance Required ☐

35. * Confirming Descent Performance and calculating TOD ☐

Descent

36. * Noting and Interpreting Instrument Approach Brief and Crew Brief, including crew duties ☐

37. * Monitoring Descent Profile (as opposed to approach profile) (254) ☐

Approach & Landing

38. * Receiving, recording & interpreting Approach Clearance (254) ☐

39. * Monitoring STAR / Positioning for Approach ☐

40. * Monitoring choice of runway, circuit pattern and point of touchdown ☐

41. * Monitoring landing ☐

42. * Assisting with Taxying paths, R/T and positioning of A/C for shutdown ☐

Postflight

43. * Checking ELT and terminating or amending Flight Plan (254) ☐

44. Completing Flight Navigation Log (254) ☐

FRC

45. * Completing flight documentation ☐

46. Tidying up A/C interior ☐

47. Assisting with inspecting of A/C postflight, including securing of A/C ☐

FRC

Overall

48. Managing priorities ☐

49. Ensuring that prime focus is on role duties and assigned functions ☐

50. Making decisions appropriate to role and function ☐

51. Performing duties unobtrusively ☐

52. * Monitoring pilot-in-command's significant activities and calculations ☐

53. Assisting with handling of non-normal occurences as directed ☐

54. Communicating effectively with crew members (including examiner) ☐

55. Avoiding unnecessary and intrusive talk ☐

56. Recording Clearances and R/T Frequencies in use ☐

57. Using Check Lists correctly ☐

58. * Using R/T correctly ☐

59. Maintaining an orderly/tidy flight deck ☐

60. * Monitoring that flying is within required accuracy tolerances ☐

61. • Advising Pilot-in-Command of personal ommissions or errors without fail ☐

62. * Drawing Pilot-in-Command's attention to ommissions, errors and excursions from acceptable flight accuracy requirements in a timely, firm and tactful manner, without fail ☐

63. Maintaining a tidy personal appearance on the ground. ☐

Underlined Duties are performed by both pilots   * These items are to be checked by other pilot   ++ Discussions may be conducted on any sector

FRC

B. Role: Copilot Function: Pilot Not Flying (PNF)

Departure Airfield	Runway	Departure........................	Route..
Intermediate Airfield....................	Runway............	Arrival................................	Instrument Approach ....
Intermediate Airfield	Runway	Departure........................	Route..
Destination Airfield......................	Runway............	Arrival................................	Instrument Approach ....

Comments

Underlined Duties are performed by both pilots * These items are to be checked by other pilot ++ Discussions may be conducted on any sector

T6FE

Name .... Student ID .... Course .... Date ....

A.	Role:	**Command**	Function:	Pilot Flying	(P/F)	
	Focus:	P/F Duties		(Left Seat)		Competent / Proficient
	Focus:	Command		(Left Seat)		Competent / Proficient
B.	Role:	**Copilot**	Function:	Pilot Not Flying	(PNF)	
	Focus:	PNF Duties		(Right Seat)		Competent / Proficient
	Focus	Team Functioning		(Right Seat)		Competent / Proficient

Mark for 190.254 Flight Navigation Management .... /190 .... % .... /10

Pilot in Command potential **Competent / Proficient**

Potential for <u>Copilot</u> role in Part 125 or Part 121 operations **Competent / Proficient**

Examiner... Signature .... Date ....

FRC TEST ITEMS IN NOTECHS CATEGORIES

Non-technical Skills Development

CATEGORY - LEADING AND MANAGING

Element-Using Authority and Assertiveness

Behaviours

Briefing take-off and departure

Managing Crew

Managing passengers - security and briefing

Element - Maintaining Standards

Behaviours

Reporting for duty

Legality and currency

Maintaining a tidy aircraft interior

Maintaining tidy personal appearance

Maintaining orderly/tidy flight deck

Avoiding unnecessary and intrusive talk

Element - Planning and Coordinating

Behaviours

Obtaining and interpreting weather information and NOTAMS

Determining TODA, TODR

Confirming ATIS

Determining LDA and LDR

Determining freezing level and MRA

Completing load sheet

Planning route

Deciding flight load, equipment and disposition

Checking flight plan and log

Checking fuel analysis

Checking ATC flight plan

Confirming destination ATIS and landing data

Confirming LDA and LDR

Determining descent performance and TOD

Element - Workload Management

Behaviours

Managing priorities

CATEGORY - SITUATIONAL AWARENESS

Element - Systems Awareness

Behaviours

Checking climb performance

Checking cruise performance

Checking for carb. Ice

Monitoring fuel and revising reserves

Element - Environmental Awareness

Behaviours

Checking climb gradient and terrain clearance

Reviewing and updating weather information

Diversionary tactics for weather avoidance

Checking descent profile

Element - Time Keeping

Behaviours

Departing on time

Confirming ETA for TOC

Checking and revising waypoint and destination ETA

CATEGORY - CO-OPERATION

Element-Team Building and Maintaining

Behaviours

Communicating effectively with instructor

Element - Conflict Solving

Behaviours **Not tested**

CATEGORY - DECISION MAKING

Element - Defining and Diagnosing Problems

Behaviours

Loss of communications

In flight diversion

Engine failure

Element - Generating Options

Behaviours

Selecting take-off direction and starting point

Choosing taxiway and run up area

Proceed with or cancel flight

Determining initial climb type

Choosing touchdown point

KDP#5 (proceed with landing)

Choosing taxiway and shut down position

Parking and securing

Elements - Generating Options

Behaviours Not tested

A Description of the New Zealand Civil Aviation Rules Referred to in the Study

1. NZCAA Rule Part 61

Part 61 prescribes rules relating to the requirements for the issue and holding of pilot licenses and ratings and student pilots, including conditions, privileges and limitations associated with those licences and ratings and student pilots.

2. NZCAA Rule Part 141.

Part 141 prescribes rules governing the certification and operation of organisations conducting aviation training and assessments that are required by Civil Aviation Rules to be conducted by an organisation certified under the Part.

3. NZCAA Rule Part 135

Part 135 prescribes the operating requirements for air operations conducted by a holder of an airline air operator certificate or a general aviation air operator certificate issued in accordance with Part 119 using –

(1) an aeroplane that has a seating configuration of 9 seats or less, excluding any required crew members seat, and a maximum certified take-off weight of 5700kg or less, except for a single engine aeroplane used for an air operation carrying a passenger under IFR; or

(2) a helicopter

4. NZCAA Rule Part 121

Part 121 prescribes the operating requirements for air operations conducted by a holder of an Airline Air Operator Certificate issued in accordance with Part 119 using an aeroplane that has—

(1) a seating configuration of more than 30 seats, excluding any required crew member seat; or

(2) a payload capacity of more than 3410 kg.

5. Advisory Circular AC 61-1

Civil Aviation Authority Advisory Circulars contain information about standards, practices, and procedures that the Director has found to be an Acceptable Means of Compliance (AMC) with the associated rule. The AMC is not intended to be the only means of compliance with a rule, and consideration will be given to other means of compliance that may be presented to the Director. The Advisory Circular contains guidance material to facilitate compliance with the rule requirements.

PILOT COMPETENCY QUESTIONNAIRE

ADVANCED STUDENTS

R.J. de Montalk

Determining Air Transport Competencies

Information Sheet

Introduction

I am a Massey University PhD student researching the development of proficiency in professional pilots. I have over 40 years experience in the aviation industry both in New Zealand and overseas and hold an Airline Transport Pilot Licence and an A Category Flight Instructor Rating. I am currently employed by Massey University as Safety Manager for the School of Aviation.

My research targets three distinct pilot groups in the New Zealand aviation community; pilot trainees undergoing training for professional pilot qualifications, general aviation pilots who hold professional pilot qualifications and who are employed as pilots or who are seeking employment in this field, and professional air transport pilots who are employed by Part 121 or Part 125 operators.

Participants will be invited to complete questionnaires which will canvass their views on the importance of thirty distinct pilot competencies which my research has indicated are characteristic of professional pilots, and to rate the effectiveness of the training received in these competencies during professional pilot training. General aviation and air transport pilots will also be asked to indicate if they have experienced occasions where these competencies have been associated with lapses in flight safety. All participants will be asked to complete items of biographical data.

The research is conducted by myself and is supervised by Dr L Jeffrey and Dr A Gilbey who have been appointed by the Massey University Doctoral research Committee.

Participant Recruitment

All professional fixed wing flight training providers in New Zealand have been invited to participate. The largest possible number of participants is sought for statistical robustness.
No discomfort or risks for participants has been identified.

Project Procedures

Statistical data from the questionnaires will be analysed to determine if there is a change in perception of the importance of the pilot competencies and the adequacy of basic flight training in those competencies with increasing flight and industry experience. From the data strategies will be developed for improving professional flight training.
The data will be stored indefinitely by the researcher on an electronic database. On completion of the survey a summary of the research findings will be sent to each participating organisation for the information of individual respondents. The results will also be available from the researcher by December 2007. Additionally the results will be published on the Massey University School of Aviation web site.

Participant Involvement

Participant will be requested to complete a simple questionnaire. Trial runs have indicated that the survey can be completed in no more than 30 minutes.

Participants Rights

This is an anonymous questionnaire Completion and return of the questionnaire implies consent. Participants have the right to decline to answer any particular question.

Project Contacts

Researcher Ritchie de Montalk
Massey University School of Aviation
06 350 9200 extension 8213
R.J.demontalk@massey.ac.nz

Supervisor – Dr L M Jeffrey
09 414 0800 extension 9282

Supervisor – Dr A Gilbey
06 350 5323 extension 4767

Participants are invited to contact the researcher or supervisors at any time on any matter concerning the research.

Massey University Human Ethics Committee Statement

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A. Application 05/95. If you have any concerns about the conduct of this research, please contact Dr John O'Neill, Chair, Massey University Human Ethics Committee: Southern A. telephone 06 350 7599 X 8635. email humanethicsoutha@massey.ac.nz.

The Purpose of this Questionnaire.................

The survey is designed to discover your perceptions of the competencies required by professional pilots . Traditionally, the basic piloting skills ("stick and rudder skills") have been the focus of pilot training and are usually directed towards the gaining of the required licences and ratings for entry into employment as a professional pilot. The basic piloting skills represent *threshold* competencies—the minimum skills required to get the job done. To achieve superior performance additional skills are required especially for leadership roles such as aircraft captaincy. These involve the development of *distinguishing* competencies, the capabilities that set superior performers apart from average ones. These are the competencies that will develop in the pilot as their career progresses. Distinguishing competencies are largely *soft* or non-technical in nature and can be recognized to varying degrees in all occupations.

The survey should take no more than 30 minutes to complete. Please return the completed questionnaire using the envelope provided.

If you have any enquiries regarding this research please contact me at the following address.

R.J. de Montalk
Massey University School of Aviation
Private Bag 111 222
Palmerston North
New Zealand

Email R.J.demontalk@massey.ac.nz
Telephone 06 350 9213

ADVANCED STUDENTS

Part 1—Competencies and Training Effectiveness

How important are these competencies for a professional pilot?

How effective was the training you received in these competencies to CPL/IR level?

IMPORTANCE	TRAINING EFFECTIVNESS
0 = Not sure	0 = Not sure
1 = Of no importance	1 = No training received
2 = Of minor importance	2 = Minimal training received
3 = Of moderate importance	3 = Moderately effective training
4 = Very important	4 = Effective training received
5 = Of utmost importance	5 = Highly effective training

(1) Using Authority and Assertiveness	Importance	Training effectiveness
Examples: - taking the initiative to ensure the involvement of crew or team to ensure successful task completion, crew or team-management, passenger management	0 1 2 3 4 5	0 1 2 3 4 5
(2) Maintaining Standards		
Examples: - Intervening if task completion deviates from required standard, ensuring SOP compliance	0 1 2 3 4 5	0 1 2 3 4 5
(3) Planning and Coordinating		
Examples: - clearly stating intentions and goals, encouraging crew or team participation in planning and task completion	0 1 2 3 4 5	0 1 2 3 4 5

IMPORTANCE	**TRAINING EFFECTIVNESS**
0 = Not sure	0 = Not sure
1 = Of no importance	1 = No training received
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4 = Very important	4 = Effective training received
5 = Of utmost importance	5 = Highly effective training

(4) Workload Management	**Importance**	**Training effectiveness**
Examples: - allocating sufficient time to complete tasks, delegating tasks appropriately, using automation appropriately	0 1 2 3 4 5	0 1 2 3 4 5
(5) Organisational Awareness		
Examples: - understanding the organisation, knowing constraints, power and political astuteness, knowledge of company culture	0 1 2 3 4 5	0 1 2 3 4 5
(6) Customer Awareness		
Examples: - helping and service orientation, focusing on passenger needs and comfort, actively seeking to help passengers	0 1 2 3 4 5	0 1 2 3 4 5
(7) Leadership		
Examples: - being in charge of a crew or aircraft, vision, concern for subordinates, building a sense of group purpose within crew or organisation	0 1 2 3 4 5	0 1 2 3 4 5

IMPORTANCE	TRAINING EFFECTIVNESS
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5 = Of utmost importance	5 = Highly effective training

(8) Organisational Commitment	**Importance**	**Training effectiveness**
Examples: - aligning self and others to organizational needs, business mindedness, operating in a financially responsible way, putting organisations interests before self interest	0 1 2 3 4 5	0 1 2 3 4 5
(9) Self Control		
Examples: - stamina, resistance to stress, staying calm, resisting temptation, being able to calm others	0 1 2 3 4 5	0 1 2 3 4 5
(10) SelfConfidence		
Examples: - possessing strong self concept, positive ego strength, decisive, accepting responsibility	0 1 2 3 4 5	0 1 2 3 4 5
(11) Flexibility		
Examples: - adaptability, perceptual objectivity, staying objective, resilience, behavior is contingent on the situation	0 1 2 3 4 5	0 1 2 3 4 5
(12) Systems Awareness		
Examples: - having awareness of aircraft system status, configuration and performance	0 1 2 3 4 5	0 1 2 3 4 5

IMPORTANCE	TRAINING EFFECTIVNESS
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4 = Very important	4 = Effective training received
5 = Of utmost importance	5 = Highly effective training

(13) Environmental Awareness	**Importance**	**Training effectiveness**
Examples: awareness of meteorological conditions, operating environment, air traffic, crew or team-morale and well being	0 1 2 3 4 5	0 1 2 3 4 5
(14) Time Keeping		
Examples: - adhering to schedules and reporting for duty times, carrying out duties and tasks efficiently, attending to time recording, log keeping	0 1 2 3 4 5	0 1 2 3 4 5
(15) Analytical Thinking		
Examples: - thinking for self, reasoning, practical intelligence, planning skills, problem analyzing, carrying out duties and tasks in a systematic way	0 1 2 3 4 5	0 1 2 3 4 5
(16) Conceptual Thinking		
Examples: - pattern recognition, insight, critical thinking, problem definition, generating hypotheses, linking	0 1 2 3 4 5	0 1 2 3 4 5

IMPORTANCE	TRAINING EFFECTIVNESS
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(17) Team Building and Maintaining	**Importance**	**Training effectiveness**
Examples: fostering group facilitation and management, motivation of others, creating and maintaining a good workplace climate	0 1 2 3 4 5	0 1 2 3 4 5
(18) Considering Others		
Examples: - taking condition of other crew or team members into account, avoiding overloading other crew or team members	0 1 2 3 4 5	0 1 2 3 4 5
(19) Supporting Others		
Examples: - helping other crew or team members and company personnel in demanding situations, encouraging others	0 1 2 3 4 5	0 1 2 3 4 5
(20) Conflict Resolution		
Examples: - resolving interpersonal conflicts, concentrating on what is right rather than who is right	0 1 2 3 4 5	0 1 2 3 4 5
(21) Developing Others		
Examples: - training, helping others develop, coaching and mentoring, positive regard for others	0 1 2 3 4 5	0 1 2 3 4 5

IMPORTANCE	**TRAINING EFFECTIVNESS**
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5 = Of utmost importance	5 = Highly effective training

(22) Relationship Building	**Importance**	**Training effectiveness**
Examples: networking, establishing rapport, use of contacts, concern for passengers, organisations interests	0 1 2 3 4 5	0 1 2 3 4 5
(23) Defining and Diagnosing Problems		
Examples: reviewing causal factors with other crew or team members and or organisation personnel	0 1 2 3 4 5	0 1 2 3 4 5
(24) Generating Options		
Examples: - asking other crew or team members and or organisation personnel for options, determining alternative courses of action	0 1 2 3 4 5	0 1 2 3 4 5
(25) Risk Assessment and Option Choosing		
Examples: - considering and sharing risks of alternative courses of action	0 1 2 3 4 5	0 1 2 3 4 5
(26) Reviewing Outcomes		
Examples: - checking outcomes against plans, debriefing crew or team on outcomes	0 1 2 3 4 5	0 1 2 3 4 5

IMPORTANCE	**TRAINING EFFECTIVNESS**
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4 = Very important	4 = Effective training received
5 = Of utmost importance	5 = Highly effective training

(27) Aircraft Handling Skills	**Importance**	**Training effectiveness**
Examples: displaying competency at aircraft control, operating the aircraft within all tolerances and limitations and SOPs	0 1 2 3 4 5	0 1 2 3 4 5
(28) Aircraft Systems Management		
Examples: displaying competency at managing aircraft systems within operating limits and in accordance with SOPs	0 1 2 3 4 5	0 1 2 3 4 5
(29) Aircraft Navigation Management		
Examples: - displaying competency at navigating the aircraft within organization's navigational standards and tolerances, and SOPs	0 1 2 3 4 5	0 1 2 3 4 5
(30) Other competencies that you may feel should be considered (use extra paper if required)		
	0 1 2 3 4 5	0 1 2 3 4 5
	0 1 2 3 4 5	0 1 2 3 4 5
	0 1 2 3 4 5	0 1 2 3 4 5

PART 2 – Biographical and General Data

DIRECTIONS: Please complete the following biographical data. Your answers will remain confidential. You are not obliged to answer all or any questions.

1. How old are you?

- ☐ < 20
- ☐ 21 – 30
- ☐ 31 – 40
- ☐ > 40

2. What type of professional pilot employment will you be seeking on graduation?

- ☐ Part 121 airline
- ☐ Part 125 airline
- ☐ Part 135 general aviation
- ☐ Corporate (private) air transport
- ☐ Flight training
- ☐ Other (specify) ....

3. **Approximately how long have you been training as a pilot?**

☐ < 12 months

☐ 1 – 5 years

4. **Have you had previous experience as a military pilot or aircrew member?**

☐ Yes

☐ No

5. **Gender**

☐ Male

☐ Female

6. **Total flying experience**

- ☐ < 50 hours
- ☐ 51 – 100 hours
- ☐ 101 – 150 hours
- ☐ 151 – 200 hours
- ☐ 201 – 250 hours
- ☐ 251 – 500 hours
- ☐ > 500 hours (How many?..........)

7. **Where did you do most of your training to CPL/Instrument rating level?**

- ☐ Aero Club
- ☐ Flying School
- ☐ Both Aero Club and Flying School
- ☐ Military
- ☐ Tertiary aviation programme
- ☐ Other (specify)...

8. What pilot qualifications do you hold?

- ☐ PPL
- ☐ PPL/IR
- ☐ CPL/IR

9. What is your highest educational qualification?

- ☐ No formal qualifications
- ☐ School certificate
- ☐ University entrance
- ☐ NCEA
- ☐ Polytechnic based Certificate or Diploma
- ☐ Undergraduate university Diploma
- ☐ University Bachelor Degree
- ☐ University Masters degree
- ☐ Doctorate degree
- ☐ Other academic qualification (s) (specify)..

10. **Most airlines require new pilot applicants to have more flying experience than the minimum required for the issue of a CPL/IR. If you intend to eventually join an airline which of the following best describes how you would obtain this experience? (more than one category may apply)**

☐ Flight instructing

☐ General aviation – non air transport

☐ General aviation air transport

☐ Other (specify)..

☐ Not applicable

PILOT COMPETENCY QUESTIONNAIRE

AIRLINE PILOTS

R.J. de Montalk

Determining Air Transport Competencies

Information Sheet

Introduction

I am a Massey University PhD student researching the development of proficiency in professional pilots. I have over 40 years experience in the aviation industry both in New Zealand and overseas and hold an Airline Transport Pilot Licence and an A Category Flight Instructor Rating. I am currently employed by Massey University as Safety Manager for the School of Aviation.

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Participants will be invited to complete questionnaires which will canvass their views on the importance of thirty distinct pilot competencies which my research has indicated are characteristic of professional pilots, and to rate the effectiveness of the training received in these competencies during professional pilot training. General aviation and air transport pilots will also be asked to indicate if they have experienced occasions where these competencies have been associated with lapses in flight safety. All participants will be asked to complete items of biographical data.

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Statistical data from the questionnaires will be analysed to determine if there is a change in perception of the importance of the pilot competencies and the adequacy of basic flight training in those competencies with increasing flight and industry experience. From the data strategies will be developed for improving professional flight training.
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This is an anonymous questionnaire. Completion and return of the questionnaire implies consent. Participants have the right to decline to answer any particular question.

Project Contacts

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Massey University School of Aviation
06 350 9200 extension 8213
R.J.demontalk@massey.ac.nz

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09 414 0800 extension 9282

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The Purpose of this Questionnaire..................

The survey is designed to discover your perceptions of the competencies required by professional pilots . Traditionally, the basic piloting skills ("stick and rudder skills") have been the focus of pilot training and are usually directed towards the gaining of the required licences and ratings for entry into employment as a professional pilot. The basic piloting skills represent *threshold* competencies—the minimum skills required to get the job done. To achieve superior performance additional skills are required especially for leadership roles such as aircraft captaincy. These involve the development of *distinguishing* competencies, the capabilities that set superior performers apart from average ones. These are the competencies that will develop in the pilot as their career progresses. Distinguishing competencies are largely *soft* or non-technical in nature and can be recognized to varying degrees in all occupations.

The survey should take no more than 30 minutes to complete. Please return the completed questionnaire using the envelope provided.

If you have any enquiries regarding this research please contact me at the following address.

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Palmerston North
New Zealand

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AIRLINE PILOTS

Part 1—Competencies , Training Effectiveness, and Flight Safety

How important are these competencies for a professional pilot?

How effective was your training in these competencies to CPL/IR level?

Have you ever observed behavior associated with these competencies that has directly endangered flight safety?

IMPORTANCE	TRAINING EFFECTIVNESS	FLIGHT SAFETY
0 = Not sure	0 = Not sure	0 = Not sure
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5 = Of utmost importance	5 = Highly effective training	

(1) Using Authority and Assertiveness	Importance	Training effectiveness	Flight safety
Examples: - taking the initiative to ensure the involvement of crew or team to ensure successful task completion, crew or team management, passenger management	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(2) Maintaining Standards			
Examples: - Intervening if task completion deviates from required standard, ensuring SOP compliance	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
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Examples: - clearly stating intentions and goals, encouraging crew or team participation in planning and task completion	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4

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(4) Workload Management	**Importance**	**Training effectiveness**	**Flight Safety**
Examples: - allocating sufficient time to complete tasks, delegating tasks appropriately, using automation appropriately	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
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Examples: - understanding the organisation, knowing constraints, power and political astuteness, knowledge of company culture	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
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Examples: - helping and service orientation, focusing on passenger needs and comfort, actively seeking to help passengers	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
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Examples: - possessing strong self concept, positive ego strength, decisive, accepting responsibility	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
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(17) Team Building and Maintaining	**Importance**	**Training effectiveness**	**Flight Safety**
Examples: fostering group facilitation and management, motivation of others, creating and maintaining a good workplace climate	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(18) Considering Others			
Examples: - taking condition of other crew or team members into account, avoiding overloading other crew or team members	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
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(22) Relationship Building	**Importance**	**Training effectiveness**	**Flight Safety**
Examples: networking, establishing rapport, use of contacts, concern for passengers, organisations interests	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(23) Defining and Diagnosing Problems			
Examples: reviewing causal factors with other crew or team members and or organisation personnel	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(24) Generating Options			
Examples: - asking other crew or team members and or organisation personnel for options, determining alternative courses of action	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(25) Risk Assessment and Option Choosing			
Examples: - considering and sharing risks of alternative courses of action	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(26) Reviewing Outcomes			
Examples: - checking outcomes against plans, debriefing crew or team on outcomes	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4

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(27) Aircraft Handling Skills	**Importance**	**Training effectiveness**	**Flight Safety**
Examples: displaying competency at aircraft control, operating the aircraft within all tolerances and limitations and SOPs	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(28) Aircraft Systems Management			
Examples: displaying competency at managing aircraft systems within operating limits and in accordance with SOPs	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(29) Aircraft Navigation Management			
Examples: - displaying competency at navigating the aircraft within organization's navigational standards and tolerances, and SOPs	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(30) Other competencies that you may feel should be considered (use extra paper if required)			
	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4

PART 2 – Biographical and General Data

DIRECTIONS: Please complete the following biographical data. Your answers will remain confidential. You are not obliged to answer all or any questions.

1. **How old are you?**

- ☐ < 20
- ☐ 21 – 30
- ☐ 31 – 40
- ☐ > 40

2. **What best describes your present employment as a professional pilot?**

- ☐ Part 121 airline
- ☐ Part 125 airline
- ☐ Corporate (private) air transport
- ☐ Retired

3. **What is your present or most recent appointment as an airline pilot?**

- ☐ Captain
- ☐ First Officer
- ☐ Second Officer

4. **Approximately how long have you been employed as an airline pilot?**

☐ < 12 months

☐ 1 – 5 years

☐ 5—10 years

☐ 10-20 years

☐ > 20 years

5. **Have you had previous experience as a military pilot or aircrew member?**

☐ Yes

☐ No

6. **Gender**

☐ Male

☐ Female

7. **Total flying experience**

- ☐ 1000 - 2500 hours
- ☐ 2500—5000 hours
- ☐ 5000-10000 hours
- ☐ 10000-15000 hours
- ☐ 15000—20000 hours
- ☐ > 20000 hours

8. **Where did you do most of your training to CPL/Instrument rating level?**

- ☐ Aero Club
- ☐ Flying School
- ☐ Both Aero Club and Flying School
- ☐ Military
- ☐ Tertiary aviation programme
- ☐ Other (specify)..

9. What pilot qualifications do you now hold or have held?

- ☐ CPL/IR
- ☐ CPL/IR/Instructor rating
- ☐ ATPL
- ☐ ATPL/Instructor rating

10. What is your highest educational qualification?

- ☐ No formal qualifications
- ☐ School certificate
- ☐ University entrance
- ☐ NCEA
- ☐ Polytechnic based certificate or diploma
- ☐ Undergraduate university diploma
- ☐ University bachelor degree
- ☐ University masters degree
- ☐ Doctorate degree

11. **Most airlines require new pilot applicants to have more flying experience than the minimum required for the issue of a CPL/IR. Which of the following best describes how you gained this experience prior to being employed as an airline pilot? (more than one category may apply)**

- ☐ Flight instructing
- ☐ General aviation – non air transport
- ☐ General aviation air transport
- ☐ Other (Specify) ……………………………………….
- ☐ Not applicable

12. **How well do you think your flight training to CPL/IR prepared you for employment as an airline pilot?**

- ☐ Very well
- ☐ Largely satisfactory
- ☐ Barely adequately
- ☐ Inadequately

13. **How well did your training to CPL/IR prepare you for multi-crew operations?**

- ☐ Very well
- ☐ Largely satisfactory
- ☐ Barely adequately
- ☐ Inadequately

14. In addition to your line flying duties what other duties and responsibilities do you have with your organisation? (More than one may apply)

- ☐ None
- ☐ Management
- ☐ Flight Safety
- ☐ Check and Training
- ☐ ALPA representation
- ☐ Technical instruction
- ☐ Other (specify) ....

15. What other aviation related activities are you involved with outside of your organisation? (More than one may apply)

- ☐ None
- ☐ General Aviation flight/ground instruction
- ☐ Flight Safety
- ☐ Aviation consultency
- ☐ Managing/owning an aviation enterprise
- ☐ RAeS membership
- ☐ GAPAN membership
- ☐ Other (specify) ....

END

PILOT COMPETENCY QUESTIONNAIRE

GENERAL AVIATION PILOTS

R.J. de Montalk

Determining Air Transport Competencies

Information Sheet

Introduction

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2 = Of minor importance	2 = Minimal training received	2 = Very rarely
3 = Of moderate importance	3 = Moderately effective training	3 = Occasionally
4 = Very important	4 = Effective training received	4 = Frequently
5 = Of utmost importance	5 = Highly effective training	

(22) Relationship Building	Importance	Training effectiveness	Flight Safety
Examples: networking, establishing rapport, use of contacts, concern for passengers, organisations interests	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(23) Defining and Diagnosing Problems			
Examples: reviewing causal factors with other crew or team members and or organisation personnel	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(24) Generating Options			
Examples: - asking other crew or team members and or organisation personnel for options, determining alternative courses of action	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(25) Risk Assessment and Option Choosing			
Examples: - considering and sharing risks of alternative courses of action	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(26) Reviewing Outcomes			
Examples: - checking outcomes against plans, debriefing crew or team on outcomes	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4

How important are these competencies for a professional pilot?

How effective was your training in these competencies to CPL/IR level?

Have you ever observed behavior associated with these competencies that has directly endangered flight safety?

IMPORTANCE	TRAINING EFFECTIVNESS	FLIGHT SAFETY
0 = Not sure	0 = Not sure	0 = Not sure
1 = Of no importance	1 = No training received	1 = No
2 = Of minor importance	2 = Minimal training received	2 = Very rarely
3 = Of moderate importance	3 = Moderately effective training	3 = Occasionally
4 = Very important	4 = Effective training received	4 = Frequently
5 = Of utmost importance	5 = Highly effective training	

(27) Aircraft Handling Skills	Importance	Training effectiveness	Flight Safety
Examples: displaying competency at aircraft control, operating the aircraft within all tolerances and limitations and SOPs	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(28)Aircraft Systems Management			
Examples: displaying competency at managing aircraft systems within operating limits and in accordance with SOPs	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(29) Aircraft Navigation Management			
Examples: - displaying competency at navigating the aircraft within organization's navigational standards and tolerances, and SOPs	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
(30) Other competencies that you may feel should be considered (use extra paper if required)			
	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4
	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4

PART 2 – Biographical and General Data

DIRECTIONS: Please complete the following biographical data. Your answers will remain confidential. You are not obliged to answer all or any questions.

1. How old are you?

- ☐ < 20
- ☐ 21 – 30
- ☐ 31 – 40
- ☐ > 40

2. What best describes your present employment as a professional pilot?

- ☐ Part 121 airline
- ☐ Part 125 airline
- ☐ Part 135 general aviation
- ☐ Corporate (private) air transport
- ☐ Flight training
- ☐ Not yet employed
- ☐ Other (specify) ……………………………………………………………..

3. **Approximately how long have you been employed as a professional pilot?**

- ☐ < 12 months
- ☐ 1 – 5 years
- ☐ > 5 years
- ☐ Not yet employed

4. **Have you had previous experience as a military pilot or aircrew member?**

- ☐ Yes
- ☐ No

5. **Gender**

- ☐ Male
- ☐ Female

6. **Total flying experience**

- ☐ 201 - 250 hours
- ☐ 250 - 500 hours
- ☐ 501 – 1000 hours
- ☐ 1000 - 2500 hours
- ☐ >-2500 hours

7. **Where did you do most of your training to CPL/Instrument rating level?**

- ☐ Aero Club
- ☐ Flying School
- ☐ Both Aero Club and Flying School
- ☐ Military
- ☐ Tertiary aviation programme
- ☐ Other (specify)..

8. **What pilot qualifications do you hold?**

- ☐ CPL/IR
- ☐ CPL/IR/Instructor rating
- ☐ CPL/Instructor rating
- ☐ Other (Specify)..

9. **What is your highest educational qualification?**

- ☐ No formal qualifications
- ☐ School certificate
- ☐ University entrance
- ☐ NCEA
- ☐ Polytechnic based Certificate or Diploma
- ☐ Undergraduate university Diploma
- ☐ University Bachelor Degree
- ☐ University Masters degree
- ☐ Doctorate degree
- ☐ Other academic qualification (s) (specify)..

10. Most airlines require new pilot applicants to have more flying experience than the minimum required for the issue of a CPL/IR. If you intend to eventually join an airline which of the following best describes bow you would gain this experience? (more than one category may apply)

- ☐ Flight instructing
- ☐ General aviation – non air transport
- ☐ General aviation air transport
- ☐ Other (Specify) ....
- ☐ Not applicable

11. In general how well do you think your flight training has prepared you for employment as a professional pilot?

- ☐ Very well
- ☐ Largely satisfactory
- ☐ Barely adequately
- ☐ Inadequately

12. **Considering the CPL/IR curriculum for the theory examinations how well do you think these subjects have prepared you for employment as a professional pilot?**

a. Flight navigation and flight planning

- ☐ Very well
- ☐ Largely satisfactory
- ☐ Barely adequately
- ☐ Inadequately

b. Meteorology

- ☐ Very well
- ☐ Largely satisfactory
- ☐ Barely adequately
- ☐ Inadequately

c. Aircraft technical knowledge

- ☐ Very well
- ☐ Largely satisfactory
- ☐ Barely adequately
- ☐ Inadequately

d. Aircraft performance

- ☐ Very well
- ☐ Largely satisfactory
- ☐ Barely adequately
- ☐ Inadequately

e. *Aviation human factors*

- ☐ Very well
- ☐ Largely satisfactory
- ☐ Barely adequately
- ☐ Inadequately

f. Air law

- ☐ Very well
- ☐ Largely satisfactory
- ☐ Barely adequately
- ☐ Inadequately

Occurrence	FAA Reference	Probable cause	Primary factor	Contributing Factors
1	AAR 7/03	The pilot's decision to continue flight under visual flight rules into an area of turbulent, reduced visibility weather conditions, which resulted in the pilot's spatial disorientation and loss of control of the helicopter.	DM	SA
2	AAR 7/02	The flight crew's failure to effectively monitor and maintain airspeed and comply with procedures for deice boot activation on the approach, which caused an aerodynamic stall from which they did not recover.	SA	AHS
3	AAR 7/01	1) The pilots' unprofessional behaviour, deviation from standard operating procedures, and poor airmanship, which resulted in an in-flight emergency from which they were unable to recover, in part because of the pilots' inadequate training; (2) the pilots' failure to prepare for an emergency landing in a timely manner, including communicating with air traffic controllers immediately after the emergency about the loss of both engines and the availability of landing sites; and (3) the pilots' improper management of the double engine failure checklist, which allowed the engine cores to stop rotating and resulted in the core lock engine condition.	TM	ASM
4	AAB 06-07	The captain's inappropriate decision to fly a non standard route and his failure to maintain adequate terrain clearance, which resulted in the in flight collision with mountainous terrain.	DM	
5	AAB 06-06	The flight crew's failure to adequately monitor and cross-check the flight instruments during the approach.	TM	
6	AAB 06-05	The failure of the flight crew to maintain terrain clearance during a VFR departure, which resulted in controlled flight into terrain	TM	SA
7	AAB 06-04	Loss of airplane control for undetermined reasons.	Undeter mined	
8	AAB 06-03	Fuel starvation resulting from the captain's decision not to follow approved fuel cross feed procedures.	DM	ASM

9	AAR 06-02	The flight crew's failure to identify and arrest the helicopter's descent for undetermined reasons, which resulted in controlled flight into terrain.	AHS	
10	AAR 06-01	The pilots' failure to follow established procedures and properly conduct a non precision instrument approach at night in IMC, including their descent below the minimum descent altitude (MDA) before required visual cues were available	TM	
11	AAB 06-01	The flight crew's failure to properly execute the published instrument approach procedure, including the published missed approach procedure, which resulted in controlled flight into terrain	TM	
12	AAR 05-02	The captain's failure to execute proper techniques to recover from the bounced landings and his subsequent failure to execute a go-around.	AHS	TM
13	AAR 05-01	The first officer's failure to properly apply crosswind landing techniques to align the airplane with the runway centre line and to properly arrest the airplane's descent rate (flare) before the airplane touched down; and 2) the captain's failure to adequately monitor the first officer's performance and command or initiate corrective action during the final approach and landing.	AHS	TW
14	AAR 04-03	The pilot's failure to adequately manage the airplane's performance after the engine failed.	AHS	
15	AAR 04-04	The in-flight separation of the vertical stabilizer as a result of the loads beyond ultimate design that were created by the first officer's unnecessary and excessive rudder pedal inputs	AHS	
16	AAR 04-02	The captain's and first officer's failure to establish and maintain a proper glide path during the night visual approach to landing.	TM	TW
17	AAB 04-01	The pilot's excessive takeoff rotation, during an aft center of gravity (c.g.) Takeoff, a rearward migration of fuel during acceleration and takeoff and consequent shift in the airplane's aft c.g. To aft of the aft limit.	AHS	
18	AAR 03-03	The flight crew's failure to maintain adequate airspeed, which led to an aerodynamic stall from which they did not recover.	AHS	

19	AAR 03-02	Loss of pitch control resulting from the disconnection of the right elevator control tab. The disconnection was caused by the failure to properly secure and inspect the attachment bolt	Maintenance	
20	AAR 03-01	The pilot's spatial disorientation resulting from his failure to maintain positive manual control of the airplane with the available flight instrumentation.	SA	
21	AAR 02-01	Loss of airplane pitch control resulting from the in-flight failure of the horizontal stabilizer trim system jackscrew assembly's acme nut threads.	Maintenance	
22	AAB 02-05	The flight crew's failure to ensure an adequate fuel supply for the flight, which led to the stoppage of the right engine due to fuel exhaustion and the intermittent stoppage of the left engine due to fuel	ASM	
23	AAB 02-03	The flight crew's operation of the airplane below the minimum descent altitude without an appropriate visual reference for the runway.	TM	
24	AAB 02-02	The pilot's failure to control the airplane while manoeuvring because of spatial disorientation.	SA	
25	AAR 01-02	The flight crew's failure to discontinue the approach when severe thunderstorms and their associated hazards to flight operations had moved into the airport area and the crew's failure to ensure that the spoilers had extended after touchdown.	TM	ASM
26	AAB 01-02	The pilot's decision to continue visual flight into instrument meteorological conditions (IMC) in an area of cloud-covered mountainous terrain.	DM	
27	AAB 01-01	The failure of the flight crew to maintain a proper pitch attitude for a successful landing or go-around.	AHS	
28	AAB 00-01	Incapacitation of the flight crewmembers as a result of their failure to receive supplemental oxygen following a loss of cabin pressurization, for undetermined reasons.	Undetermined	

29	AAR 00-02	The captain's over control of the airplane during the landing and his failure to execute a go-around from a destabilized flare.	AHS	DM
30	AAR 00-01	The captain's failure to adequately brief and execute the non precision approach and the first officer's and flight engineer's failure to effectively monitor and cross-check the captain's execution of the approach.	TM	TW
31	AAR 01-01	Loss of control of the airplane resulting from the movement of the rudder surface to its blow down limit.	Not Pilot Error	
32	AAR 00-03	An explosion of the centre wing fuel tank (CWT), resulting from ignition of the flammable fuel/air mixture in the tank. The source of ignition energy for the explosion could not be determined	Not Pilot Error	
33	AAR 99-01	Loss of control of the airplane resulting from the movement of the rudder surface to its blow down limit. The rudder surface most likely deflected in a direction opposite to that commanded by the pilots as a result of a jam of the main rudder power control unit servo valve secondary slide to the servo valve housing offset from its neutral position and over travel of the primary slide.	Not Pilot Error	
34	AAR 98-04	The Federal Aviation Administration's (FAA) failure to establish adequate aircraft certification standards for flight in icing conditions, the FAA's failure to ensure that a Centro Tecnico Aeroespacial/FAA-approved procedure for the accident airplane's deice system operation was implemented by U.S.-based air carriers, and the FAA's failure to require the establishment of adequate minimum airspeeds for icing conditions, which led to the loss of control when the airplane accumulated a thin, rough accretion of ice on its lifting surfaces.	Not Pilot Error	
35	AAR 98-03	An in-flight cargo fire of undetermined origin	Not Pilot Error	

36	AAR 97-05	The inappropriate control inputs applied by the flying pilot during a stall Recovery attempt, the failure of the non flying pilot-in-command to recognize, address, and correct These inappropriate control inputs	AHS	TW
37	AAR 97-03	The inability of the captain, because of his use of mono vision contact lenses, to Overcome his misperception of the airplane's position relative to the runway during the visual Portion of the approach.	SA	
38	AAR 97-02	The pilot in command's improper decision to Take off into deteriorating weather conditions (including turbulence, gusty winds, And an advancing thunderstorm and associated precipitation) when the airplane Was overweight and when the density altitude was higher than he was accustomed To, resulting in a stall caused by failure to maintain airspeed.	DM	SA
39	DCA05 MA099	Following a bounced landing, the pilot in command activated his side stick controller while the first officer was in control of the airplane, which subsequently resulted in the over control of pitch and a tail strike. Contributing to the circumstances of this accident were the pilot-in-command's failure to properly activate his side stick takeover push button prior to his remedial action, and the operator's insufficient emphasis on bounced landing recovery techniques and tail strike avoidance procedures.	AHS	
40	CHI05F A077.	The captain's failure to adequately compensate for the crosswind conditions, and his failure to maintain directional control during landing. Contributing factors include the captain's failure to land at the nearest suitable airport after an in-flight mechanical problem.	AHS	DM
41	IAD05L A044.	The first officer's miss judgment of a perceived threat, which resulted in the captain's excessive braking and subsequent injury to a flight attendant. A factor was the night lighting conditions.	DM	TW
42	ANC05L A025.	The pilot's inadequate compensation for the gusty crosswind wind condition, which resulted in a loss of control during the landing roll, and the collapse of the nose landing gear. Factors associated with the accident were the crosswind and wind gusts.	AHS	

43	DCA05 MA004.	The pilots' failure to follow established procedures and properly conduct a non precision instrument approach at night in IMC, including their descent below the minimum descent altitude (MDA) before required visual cues were available (which continued un moderated until the airplane struck the trees) and their failure to adhere to the established division of duties between the flying and non flying (monitoring) pilot. Contributing to the accident was the pilots' failure to make standard callouts and the current Federal Aviation Regulations that allow pilots to descend below the MDA into a region in which safe obstacle clearance is not assured based upon seeing only the airport approach lights. The pilots' unprofessional behaviour during the flight and their fatigue likely contributed to their degraded performance.	TM	TW
44	DCA04 MA082.	The pilot's over-rotation during a go-around manoeuvre initiated because of a bounced landing.	AHS	
45	FTW04L A225	The first officer's failure to maintain aircraft control.	AHS	
46	DCA04 MA068.	Fuel starvation resulting from the captain's decision not to follow approved fuel cross feed procedures. Contributing to the accident were the captain's inadequate pre flight planning, his subsequent distraction during the flight, and his late initiation of the in-range checklist. Further contributing to the accident was the flight crew's failure to monitor the fuel gauges and to recognize that the airplane's changing handling characteristics were caused by a fuel imbalance.	DM	TW
47	NYC04L A174.	The pilot's excessive manoeuvring in response to a TCAS alert, which resulted in a serious injury to the flight attendant.	AHS	
48	DCA04 MA045	The captain's failure to execute proper techniques to recover from the bounced landings and his subsequent failure to execute a go-around.	AHS	DM

49	CHI04L A086.	The captain's improper decision due to his attempt to taxi back onto the runway after coming to a stop in the grass, and the resulting collapse of nose landing gear.	DM	TM
50	DCA04 MA011	The first officer's failure to properly apply crosswind landing techniques to align the airplane with the runway centre line and to properly arrest the airplane's descent rate (flare) before the airplane touched down; and 2) the captain's failure to adequately monitor the first officer's performance and command or initiate corrective action during the final approach and landing.	AHS	TW
51	MIA03L A155.	The pilot-in-command's failure to sufficiently deviate to avoid known weather, and his failure to activate the seatbelt sign to ensure flight attendants and passengers were seated, which resulted in a passenger receiving serious injuries when the flight encountered turbulence.	TM	
52	FTW03 MA160	The flight crew's failure to align the airplane's ground track with the runway centre line before touchdown and the flight crew's failure to maintain directional control of the airplane after touchdown. Contributing to the accident was the flight crew's decision to continue the approach and to land with a thunderstorm (with associated gusty and variable winds) reported at the airport and the heavy rain, which reduced the flight crew's visibility on short final	AHS	SA
53	NYC03L A114A	The inadequate visual lookout and inadequate crew coordination of the Dassault DA-50 flight crew while taxiing, which resulted in an on ground collision with a taxing Saab 340B. A factor in the accident was the dark night.	SA	
54	DEN03F A07	The flight crew's failure to maintain aircraft control, which resulted in engine start with the throttles advanced and the subsequent impact with the tug. Contributing factors include, the flight crew's improper procedures/directives and failure to re-accomplish the before start checklist, the captain's diverted attention.	AHS	TW

55	ANC03L A043.	The failure of the captain to maintain adequate clearance between the airplane's wingtip and a parked vehicle	SA	
56	ANC03L A024.	The captain's inadequate compensation for crosswind conditions, and his failure to maintain directional control during the landing roll on an icy runway, which resulted in an excursion from the runway and collision with a snow berm.	TM	AHS
57	NYC03F A035.	The captain's failure to attain a proper touchdown on runway, and his subsequent failure to perform a go-around, both of which resulted in a runway overrun.	AHS	DM
59	NYC02L A187.	The captain's failure to follow existing company procedures for stabilized approach, and use of speed brakes.	TM	
59	LAX02F A266.	The captain's failure to maintain directional control and his inadvertent application of asymmetrical engine thrust while attempting to move the #1 thrust lever out of reverse. A factor in the accident was the crew's inadequate coordination and crew resource management.	AHS	TW
60	DCA02 MA054.	The captain's and first officer's failure to establish and maintain a proper glide path during the night visual approach to landing. Contributing to the accident was a combination of the captain's and first officer's fatigue, the captain's and first officer's failure to adhere to company flight procedures, the captain's and flight engineer's failure to monitor the approach, and the first officer's colour vision deficiency.	TM	TW
61	CHI02L A170.	The inadequate flare by the flying pilot and the remedial action not performed by the company check airman.	AHS	TW
62	CHI02L A111.	The flight crew's failure to follow weather avoidance procedures and their delay in activating the seat belt sign	TM	TW
63	ANC02L A015.	The pilot's decision to continue an unstabilised approach to landing. A factor associated with the accident is the pilot's failure to attain proper alignment with the runway.	DM	TM

64	CHI07C A058.	The pilot's failure to maintain aircraft control during an in flight manoeuvre which resulted in the design stress limits of the airplane being exceeded.	AHS	
65	DFW07L A016.	The loss of engine power due to fuel starvation as a result of the pilot's improper fuel management.	ASM	
66	ANC06L A134.	The pilot's failure to adequately compensate for wind conditions during the landing roll, which resulted in a loss of control, and subsequent collision with a ditch when the airplane departed the runway.	AHS	
67	ANC06C A115.	The pilot's failure to compensate for the wind conditions during the takeoff roll, which resulted in a collision with a tree.	AHS	
68	ANC06L A109.	The pilot's failure to abort the takeoff at his predetermined reference point, which resulted in a collision with the shore during takeoff-initial climb, and structural damage to the airplane.	DM	
69	ANC06L A103.	The pilot's failure to maintain altitude/clearance during approach, which resulted in the airplane impacting the surface of the water.	SA	
70	ANC06C A088.	The pilot's inadequate weather evaluation, which resulted in the airplane encountering a severe downdraft during takeoff initial climb, and an in-flight collision with terrain. Factors associated with the accident were a thunderstorm and a downdraft.	SA	DM
71	SEA06L A112.	The pilot's misjudgement of the airplane's height above the water during a precautionary landing which resulted in a hard landing. Contributing factors were glassy water conditions, fog, and the pilot's inadvertent VFR flight into IMC.	AHS	
72	ANC06L A059.	The pilot's inadequate evaluation of the weather conditions, and his selection of unsuitable terrain (rough water) for takeoff, which resulted in a collision with ocean swells during takeoff initial climb, and a hard emergency landing and a roll over	SA	TM
73	ANC06L A049.	The pilot's inadvertent stall/mush during takeoff-initial climb, which resulted in an in-flight collision with trees and terrain. Factors associated with the accident were the pilot's excessive loading of the airplane, his inadequate pre flight planning, and a slush-covered runway.	AHS	TM

74	DFW06C A089.	The pilot's failure to execute a missed approach after losing visual contact with the runway, which resulted in a collision with approach lights.	TM	DM
75	DEN06L A050.	The pilot's attempted flight into adverse weather conditions and improper in-flight planning which resulted in loss of control and subsequent impact with trees	DM	SA
76	SEA06F A068.	The second pilot's failure to follow the published instrument approach procedure and the captain/PIC's inadequate supervision.	TM	TW
77	ANC06L A032.	The pilot's failure to maintain altitude/clearance from trees on final approach, which resulted in an in-flight collision with trees.	TM	
78	SEA06F A055.	The pilot's failure to maintain terrain clearance during descent. Factors contributing to the accident were the high mountains, mountain obscuration, the dark night condition, and the pilot's improper in-flight planning/decision making.	TM	DM
79	ANC06L A017.	The pilot's selection of unsuitable terrain for takeoff, and his delay in aborting the takeoff, which resulted an overrun and subsequent collision with an embankment.	DM	
80	SEA06F A039	The pilot's failure to maintain the published minimum descent altitude and not adhering to the published missed approach procedures, which resulted in an in-flight collision with trees and terrain.	TM	
81	CHI06L A058.	The Captain's failure to maintain adequate airspeed during the landing which resulted in a stall/mush.	AHS	
82	ANC06C A012.	The pilot's inadequate compensation for crosswind conditions, which resulted in the left wing striking the ground while taxiing.	AHS	
83	LAX06C A061.	The pilot's failure to abort the takeoff. A factor in the accident was the snow covered runway.	TM	DM
84	NYC06C A043.	The pilot's failure to maintain directional control during the takeoff run. A factor was the snow-covered runway.	AHS	
85	ANC06C A011	The pilot's inadequate compensation for gusting crosswind conditions, which resulted in the airplane exiting the runway	AHS	
86	CHI06C A042.	The pilot's failure to maintain control of the airplane during the landing roll due to the icy runway.	AHS	

87	CHI06F A026.	The pilot's failure to pre flight the airplane, the pilot's improper in-flight decision not to land the airplane on the runway when he had the opportunity, and the inadvertent stall when the pilot allowed the airspeed to get too low.	TM	DM
88	DFW06C A017.	The pilot-in-command's failure to attain proper runway alignment.	AHS	
89	CHI06C A008.	The pilot misjudged his altitude and airspeed while landing which resulted in the airplane stalling 20 feet above the runway. A factor associated with the accident was the pilot's execution of the approach when reported weather conditions were below the minimums required for the approach.	TM	DM
90	MIA06C A003.	The pilot's improper use of the normal brakes during the landing roll and his delay in performing a go-around resulting in an emergency descent/landing on grass past the departure end of the runway and subsequent collapse of the left main landing gear.	TM	DM
91	ANC05C A141.	The pilot's inadequate compensation for a gusty crosswind, which resulted in a loss of control and an inadvertent ground-loop during the landing roll.	AHS	
92	ANC05C A132.	The pilot's inadequate compensation for wind conditions during takeoff-initial climb, which resulted in a loss of control, and subsequent in-flight collision with a creek.	AHS	
93	ANC05L A125.	The pilot's misjudged distance/altitude on final approach, which resulted in a nose over following an undershoot and in-flight collision with rough/uneven terrain.	TM	
94	DFW05F A202.	The pilot’s failure to fly a stabilized instrument approach at night which resulted in controlled flight into terrain.	TM	
95	ANC05L A104.	The pilot's failure to compensate for wind conditions and his failure to maintain directional control of the airplane during the landing roll, which resulted in an excursion off the side of the runway and a nose over.	AHS	
96	DEN05L A111.	The pilot's improper flare resulting in the hard landing and the fractured nose gear attachment, and the subsequent loss of control. Factors contributing to the accident were the high airspeed on approach, the pilot's improper in-flight planning/decision, and the pilot's inability to maintain directional control after the gear failure.	AHS	DM

97	ANC05C A099.	The pilot's delay in aborting the landing, which resulted in the airplane running off the end of the runway and nosing over	TM	DM
98	SEA05L A141.	The pilot's excessive airspeed on final for the current runway surface conditions, and the intentional obstruction avoidance manoeuvre he executed when it became clear the aircraft was about to go off the end of the runway. Factors include the pilot's improper decision to land on a surface that he had not first inspected from the air, clouds and rain in the area, and a wet, muddy landing surface.	TM	DM
99	CHI05L A160.	The pilot not maintaining climb airspeed leading to the airplane's impact with the fence and terrain during takeoff. Factors in the accident were the pilot's inaccurate pre flight planning calculations, the fence, and the levee.	TM	
100	DFW05L A165.	The loss of engine power to both engines due to fuel starvation as a result of the pilot's improper fuel management.	ASM	
101	LAX05L A178.	The pilot's failure to lower the landing gear prior to landing. A factor to the accident was the pilot's diverted attention due to the flap system anomaly.	TM	
102	ANC05L A045.	The pilot's delay in performing a go-around, and his failure to maintain obstacle clearance.	TM	
103	ANC05L A041.	The pilot's failure to maintain directional control of the airplane during the landing roll, which resulted in a departure from the runway and collision with a snow bank.	AHS	
104	LAX05F A092.	The pilot's in-flight loss of control due to the flight's encounter with unforecasted localized mountain wave activity with severe to potentially extreme turbulence, downdrafts, and rotors.	TM	SA
105	DCA05 MA031.	The pilots' failure to ensure the airplane was loaded within weight and balance limits and their attempt to takeoff with the centre of gravity well forward of the forward takeoff limit, which prevented the airplane from rotating at the intended rotation speed.	TM	TW

106	ANC05L A068.	The pilot's misjudged distance/speed while on final approach to land, which resulted in an overrun during the landing roll. Factors associated with the accident are the pilot's inadequate weather evaluation, and a gusty tailwind.	TM	SA
107	DFW05L A034.	The pilot's failure to maintain directional control as result of his improper runway selection for takeoff. A contributing factor was the prevailing right quartering tailwind.	TM	
108	DEN05F A034.	The pilot's failure to maintain minimum controllable airspeed during the night visual approach resulting in a loss of control and uncontrolled descent into terrain.	AHS	
109	NYC05F A028.	The pilot's failure to maintain adequate altitude\clearance while on approach, which resulted in an in-flight collision with trees	TM	
110	SEA05F A025.	The pilot's failure to maintain aircraft control while on approach for landing in icing conditions.	AHS	
112	IAD05F A023.	The captain's inappropriate decision to fly a non standard route and his failure to maintain adequate terrain clearance, which resulted in the in flight collision with mountainous terrain.	DM	TM
113	SEA05L A014.	The pilot's failure to maintain the required glide path, and his failure to maintain obstacle clearance after visual contact with the runway during the instrument approach.	TM	
114	SEA05L A010.	The pilot's failure to follow the instrument approach procedure, which resulted in a premature descent below the decision height and subsequent collision with a building.	TM	
115	ANC04L A113.	The pilot's improper in flight planning which resulted in an in flight encounter with weather (low ceilings and thunderstorms), his loss of aircraft control, and an in flight collision with the ocean during uncontrolled descent.	TM	SA

116	ANC04L A113.	The pilot's inadequate compensation for wind conditions, and his intentional flight into adverse weather conditions, which resulted in a loss of control and collision with terrain during takeoff-initial climb. Factors contributing to the accident were high and gusty wind conditions, and the pilot's inadequate pre flight planning.	TM	SA
117	CHI04L A278.	The pilot's failure to maintain altitude during the circling manoeuvre. Contributing factors were the pilot's improper decision to execute the approach when weather conditions were below minimums and the low light (dark night) conditions.	TM	DM
118	ANC04L A117.	A failure of the pilot-in-command to extend the landing gear, which resulted in a gear-up landing and structural damage to the airplane.	TM	
119	NYC04C A207.	The pilot's improper decision to abort the takeoff with insufficient runway remaining. A factor was the wet runway.	DM	
120	ANC04L A096.	The pilot's selection of unsuitable terrain for landing, which resulted in a collision with a rock and subsequent main landing gear collapse during the landing roll.	DM	
121	SEA04F A166.	The pilot's failure to maintain adequate terrain clearance during cruise, which resulted in the in-flight collision with mountainous terrain.	TM	
122	SEA04C A164.	The pilot's failure to maintain clearance with the power lines on final approach which resulted in a hard landing.	TM	
123	ANC04L A091	The pilot's misjudged distance/altitude during the final approach phase of landing, which resulted in an undershoot and subsequent collision with terrain.	AHS	
124	ANC04C A085.	The pilot's failure to extend the landing gear, which resulted in an inadvertent wheels up landing.	TM	
125	ANC04F A063.	The pilot's failure to follow proper IFR procedures by not adhering to the published missed approach procedures, which resulted in an in-flight collision with tree-covered terrain.	TM	
126	IAD04F A021.	The pilot's failure to maintain airspeed during a sharp turn, which resulted in an inadvertent stall and subsequent impact with terrain.	AHS	

127	LAX04F A190.	The pilot's continued flight into adverse weather conditions that resulted in an in-flight collision with mountainous terrain.	DM	SA
128	NYC04L A088.	The co-pilot's failure to maintain airspeed, and the captain's delayed remedial action, which resulted in an inadvertent stall and the subsequent hard landing.	TM	TW
129	ANC04L A032.	The pilot's inadequate planning and decision to initiate a takeoff into a crosswind that exceeded the airplane's demonstrated crosswind component, which resulted in a loss of directional control during the takeoff roll, and subsequent collision with terrain and nose over.	TM	DM
130	ANC04L A018.	The pilot's continued flight into adverse weather conditions, and his failure to maintain clearance from terrain, which resulted in an in-flight collision with terrain.	DM	TM
131	CHI04L A042.	The pilot's failure to maintain the proper descent rate and his inadequate flare	TM	
132	NYC04L A047.	The pilot's improper procedure with regard to the cabin heater, which resulted in the over temperature of the heater and subsequent fire	ASM	
133	ANC04L A010.	The pilot's inadequate evaluation of the weather conditions, and his failure to maintain adequate altitude/clearance, which resulted in a collision with terrain during the final landing approach.	SA	TM
134	MIA62A 0003	Probable cause(s) co pilot failed to extend landing gear pilot in command - inadequate supervision of flight	TM	TW
135	CHI62A 0009	Probable cause(s) pilot in command - misjudged speed pilot in command - exercised poor judgment	TM	DM
136	MIA62A 0007	Probable cause(s) pilot in command - misjudged distance	TM	
137	CHI62A 0017	Probable cause(s) pilot in command - misjudged speed pilot in command - exercised poor judgment		
138	NYC62A 0013	Pilot landed under conditions of poor braking, 10k downwind.Unable to stop aircraft. Attempted ground loop, lid off runway.	TM	DM

139	ANC62A 0008	Pilot in command - failed to follow approved procedures,directi ons etc. Pilot in command - exercised poor judgment	TM	DM
140	ANC62A 0009	Probable cause(s) Copilot - misjudged distance and altitude pilot in command - inadequate supervision of flight	TM	TW
141	MIA62A 0026	Probable cause(s) Copilot - improper operation of flight controls Pilot in command - failed to follow approved procedures,directi ons,etc.	AHS	TM
142	FTW62A 0028	Probable cause(s) pilot in command - failed to obtain/maintain flying speed pilot in command - exercised poor judgment	AHS	TM
143	NYC62A 0037	Pilot in command - misjudged distance and speed	TM	
144	OAK62A 0015	Probable cause(s) copilot - misjudged distance pilot in command - inadequate supervision of flight	TM	TW
145	MIA62A 0026	Probable cause(s) copilot - improper operation of flight controls pilot in command - failed to follow approved procedures,directi on,etc.	AHS	TM
146	MIA62A 0034	Probable cause(s) pilot in command - inadequate preflight preparation and/or plan ning miscellaneous acts,conditions - improperly loaded aircraft-weight- and/or c.g. pilot in command - improper level off pilot in command - failed to obtain/maintain flying speed	TM	
147	MIA62A 0073	Probable cause(s) pilot in command - failed to follow approved procedures,directi ons,etc. Miscellaneous acts,conditions - seat belt sign off weather - turbulence, associated w/clouds and/or thun derstorms	TM	SA

148	ANC62A 0027	Probable cause(s) pilot in command - inadequate preflight preparation and/or plan ning	TM	
149	FTW62A 0052	Probable cause(s) pilot in command - diverted attention from operation of aircraft miscellaneous acts,conditions - intentional wheels-up	TM	
150	MIA62A 0055	Probable cause(s) pilot in command - misjudged distance and speed pilot in command - improper level off	TM	
151	MIA62A 0056	Probable cause(s) pilot in command - failed to follow approved procedures, directions,etc.	TM	
152	MIA62A 0061	Probable cause(s) pilot in command - improper operation of brakes and/or flight c ontrols check pilot - inadequate supervision of flight	AHS	TW
153	MIA62A 0070	Probable cause(s) pilot in command - improper operation of powerplant & powerplant controls	ASM	
154	MIA62A 0072	Probable cause(s) pilot in command - improper level off weather - unfavorable wind conditions pilot in command - improper recovery from bounced landing	TM	
155	NYC62A 0099	Probable cause(s) pilot in command - failed to follow approved procedures, directives,etc.	TM	
156	NYC62A 0108	Pilot in command - improper in-flight decisions or planning	DM	TM
157	NYC62A 0128	Probable cause(s) pilot in command - failed to follow approved procedures ,directives,etc.	TM	

158	MIA62A 0090	Probable cause(s) pilot in command - failed to follow approved procedures, directives,etc.	TM	
159	LAX62A 0131	Probable cause(s) pilot in command - incapacitation miscellaneous acts,conditions - pilot suffered heart attack	TW	
160	MKC62 A0052	Probable cause(s) copilot - improper ifr operation pilot in command - inadequate supervision of flight	TM	TW
161	CHI62A 0129	Probable cause(s) pilot in command - misjudged distance and speed	TM	
162	ANC63A 0059	Probable cause(s) pilot in command - continued vfr flight into adverse weather co nditions pilot in command - improper in-flight decisions or planning	DM	
163	FTW63A 0119	Crews lack of vigilance,for undetermined rea son, in not checking descent before striking water.	TW	TM
164	SEA63A 0071	Pilot in command - failed to obtain/maintain flying speed pilot in command - failed to follow approved procedures, directives,etc.	TM	
165	NYC63A 0160	Factor(s) pilot in command - failed to maintain directional control	AHS	
166	CHI63A 0156	Probable cause(s) pilot in command - improper ifr operation	TM	
167	NYC63A 0184	Probable cause(s) pilot in command - failed to assure the gear was down and locked	ASM	

168	MIA63A 0133	Probable cause(s) pilot in command - failed to extend landing gear remarks- crew silenced gr warning horn during descent.	ASM	TW
168	ANC63A 0073	Probable cause(s) pilot in command - selected unsuitable terrain pilot in command - inadequate preflight preparation and/or planning	DM	TM
169	CHI63A 0183	Probable cause(s) pilot in command - inadvertently retracted gear remarks- lndg gr selector and fine pitch lever in close proximity.	SA	TM
170	FTW63A 0173	Probable cause(s) pilot in command - improper level off pilot in command - improper recovery from bounced landing	TM	AHS
171	NYC63A 0198	Pilot in command - improper in-flight decisions or planning	DM	
172	DCA64A 0008	Probable cause(s) pilot in command - exercised poor judgment weather - thunderstorm activity	DM	SA
173	MIA68A 0008	Probable cause(s) weather - turbulence in flight,clear air pilot in command - failed to follow approved procedures, directives,etc.	TM	SA
174	ANC64A 0005	Probable cause(s) pilot in command - misjudged distance and speed check pilot - inadequate supervision of flight	TM	TW
175	CHI64A 0027	Probable cause(s) pilot in command - misjudged distance and altitude	TM	

176	LAX64A 0008	Pilot in command - improper in-flight decisions or planning pilot in command - exercised poor judgment	DM	TM
177	MIA64A 0024	Probable cause(s) copilot - failed to assure the gear was down and locked pilot in command - inadequate supervision of flight	TM	TW
178	NYC64A 0029	Probable cause(s) pilot in command - misjudged distance and speed pilot in command - failed to initiate go-around pilot in command - improper level off	TM	DM
179	MIA64A 0039	Pilot in command - delayed action in aborting takeoff	DM	TM
180	MIA64A 0041	Probable cause(s) pilot in command - improper operation of powerplant & powerplant controls miscellaneous acts,conditions - thrust reversal-asymetrical factor(s) pilot in command - failed to initiate go-around	ASM	DM
181	FTW64A 0031	Pilot in command - inadequate preflight preparation and/or planning	TM	
182	MIA64A 0055	Pilot in command - exercised poor judgment	TM	
183	NYC64A 0074	Probable cause(s) pilot in command - improper ifr operation miscellaneous acts,conditions - poorly planned approach	TM	
184	MIA64A 0063	Pilot in command - inadequate supervision of flight	TW	

185	DEN64A 0039	Probable cause(s) pilot in command - improper in-flight decisions or planning pilot in command - exercised poor judgment	DM	
186	SEA64A 0032	Copilot - improper level off copilot - improper recovery from bounced landing pilot in command - inadequate supervision of flight	TM	TW
187	LAX64A 0036	Probable cause(s) pilot in command - improper operation of flight controls pilot in command - retracted gear prematurely	TM	
187	NYC64A 0154	Probable cause(s) pilot in command - misjudged distance and altitude	TM	
188	NYC65 0096	Probable cause(s) pilot in command - misjudged distance and altitude	TM	
189	DCA65A 0005	Probable cause(s) pilot in command - spatial disorientation	SA	
190	NYC65A 0110	Probable cause(s) pilot in command - inadequate supervision of flight	TW	
191	NYC68A 0014	Probable cause(s) copilot - improper operation of brakes and/or flight c ontrols pilot in command - inadequate supervision of flight	TM	TW
192	FTW65A 0093	Probable cause(s) copilot - improper level off copilot - improper recovery from bounced landing pilot in command - inadequate supervision of flight	TM	TW
193	MIA65A 0109	Probable cause(s) pilot in command - misjudged distance and altitude	TM	

194	CHI65A 0095	Pilot in command - inadequate supervision of flight	TW	
195	ANC66A 0009	Probable cause(s) pilot in command - misjudged distance and altitude pilot in command - continued vfr flight into adverse weather co nditions	TM	DM
196	CHI66A 0026	Probable cause(s) pilot in command - improper ifr operation pilot in command - failed to follow approved procedures, directives,etc.	TM	
197	MIA66A 0042	Probable cause(s) pilot in command - misjudged distance,speed,and altitude	TM	
198	DCA66A 0003	Probable cause(s) pilot- plts did not monitor altimeters durng apprch	TM	TW
199	SEA66A 0035	Probable cause(s) pilot in command - selected wrong runway relative to existing wind pilot in command - failed to initiate go-around	SA	DM
200	DCA66A 0005	Probable cause(s) pilot in command - spatial disorientation	SA	

201	DEN66A 0043	Probable cause(s) pilot in command - inadvertently retracted gear	TM	
201	ANC66A 0024	Probable cause(s) pilot in command - premature lift-off pilot in command - inadequate preflight preparation and/or plan ning	TM	
202	MIA66A 0101	Probable cause(s) pilot in command - improper operation of powerplant & powerplant controls pilot in command - improper operation of brakes and/or flight c ontrols	ASM	
203	MIA66A 0102	Pilot in command - failed to follow approved procedures, directives,etc. Pilot in command - failed to use or incorrectly used misc.equipment	TM	
204	NYC66A 0104	Probable cause(s) copilot - improper level off pilot in command - inadequate supervision of flight	TM	TW
205	DEN66A 0069	Probable cause(s) pilot in command - improper level off	AHS	
206	LAX66A 0073	Probable cause(s) copilot - improper level off pilot in command - inadequate supervision of flight remarks- pilot in command assumed control too late to prevent a hard touchdown.	AHS	TW
207	NYC66A 0106	Probable cause(s) pilot in command - improper level off	AHS	
208	OAK66A 0044	Probable cause(s) copilot - failed to maintain directional control pilot in command - inadequate supervision of flight	TM	TW

209	DCA66A 0006	Probable cause(s) pilot in command - incapacitation miscellaneous acts,conditions - pilot suffered heart attack	TW	
210	CHI66A 0099	Probable cause(s) pilot- inadequate visual contact to avoid collision personnel - miscellaneous- personnel: pilot of other aircraft	SA	
211	MIA66A 0151	Probable cause(s) weather - turbulence, associated w/clouds and/or thun derstorms pilot in command - diverted attention from operation	TM	
212	MKC66 A0069	Probable cause(s) pilot in command - improper operation of brakes and/or flight c ontrols	ASM	
213	DEN67A 0011	Probable cause(s) copilot - improper operation of brakes and/or flight c ontrols pilot in command - inadequate supervision of flight pilot in command - failed to maintain directional control pilot in command - failed to abort takeoff	TM	TW
214	NYC67A 0025	Pilot in command - improper starting procedures	ASM	
215	MIA67A 0042	Probable cause(s) copilot - improper ifr operation pilot in command - inadequate supervision of flight	TM	TW
216	CHI67A 0052	Pilot in command - misjudged distance,speed,and altitude	TM	
217	FTW67A 0046	Probable cause(s) pilot in command - inadequate supervision of flight pilot in command - misjudged distance,speed,and altitude copilot - misjudged distance,speed,and altitude	TM	TW

218	NYC67A 0073	Probable cause(s) pilot in command - misjudged distance and altitude	TM	
219	MIA67A 0058	Probable cause(s) pilot- descended below obstructing terrain.	TM	
220	NYC67A 0089	Pilot in command - spontaneous-improper action pilot in command - improper operation of powerplant & powerplant controls	TM	ASM
221	CHI67A 0071	Pilot in command - failed to maintain directional control	AHS	
222	MIA67A 0080	Probable cause(s) pilot in command - misjudged distance,speed,and altitude	AHS	
223	CHI67I0 099	Probable cause(s) pilot in command - continued vfr flight into adverse weather co nditions pilot in command - delayed in initiating go-around pilot in command - improper ifr operation	DM	TM
224	SEA67A 0047	Pilot in command - inadequate preflight preparation and/or plan ning	TM	
225	ANC67A 0058	Probable cause(s) pilot in command - failed to extend landing gear	TM	TW
226	SEA68A 0039	Probable cause(s) pilot in command - misjudged distance and altitude	TM	
227	MIA68A 0047	Pilot in command - failed to follow approved procedures, directives,etc.	TM	
228	ANC68A 0030	Probable cause(s) pilot in command - continued vfr flight into adverse weather co nditions pilot in command - improper level off pilot in command - improper recovery from bounced landing	DM	TM

229	DCA68A 0002	Probable cause(s) pilot in command - misjudged altitude copilot - misjudged altitude	TM	TW
230	MIA68A 0051	Probable cause(s) pilot in command - failed to maintain directional control	AHS	
231	DCA68A 0005	Probable cause(s) pilot in command - improper in-flight decisions or planning pilot in command - exceeded designed stress limits of aircraft	DM	AHS
232	NYC71A N047	Probable cause(s) pilot in command - improper ifr operation pilot in command - spatial disorientation	TM	SA
233	CHI71IC 027	Probable cause(s) pilot in command - improper level off	AHS	
234	DCA71A Z009	Probable cause(s) pilot in command - improper ifr operation pilot in command - failed to follow approved procedures, directives,etc. Pilot in command - failed to initiate go-around	TM	DM
235	NYC72A N008	Probable cause(s) weather - turbulence, associated w/clouds and/or thun derstorms pilot in command - failed to follow approved procedures, directives,etc.	TM	
236	DCA74A Z005	Probable cause(s) pilot in command – improper ifr operation	TM	
237	DCA74A Z006	Probable cause(s) pilot in command - continued vfr flight into adverse weather co nditions pilot in command - improper in-flight decisions or planning pilot in command - failed to follow approved procedures, directives,etc.	DM	TM
238	LAX77A A048	Probable cause(s) pilot in command - initiated flight in adverse weather conditions weather - wind shear	DM	SA