Anxiety as a Factor in Student Pilot Performance In a University Aviation Degree Programme

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Abstract

Student Pilots in a University Aviation Degree Programme are required to perform not only academically, but also in the mastery of practical skills associated with the flying and operation of light aircraft and flight simulators.

Flight training is a dynamic process during which the student pilot is subject to many pressures both physiological and psychological, many of which may be outside his or her immediate control. Considerations such as the expensive nature of flying training, weather constraints, workload, peer pressure, and an on-going requirement to achieve practicum and academic goals in an environment of continual examination, assessment, and testing, place a burden on the student pilot that is not encountered in the traditional university programmes. Considerable research has been done on anxiety in high school and tertiary educational settings but there is a lack of information about its application to aviation, particularly where the practical assessment and flight testing of student pilots are concerned.

This study examines the effects of anxiety on student pilot performance during flight training and flight-testing. To achieve this, questionnaires were developed from existing state and trait anxiety questionnaires and adapted for use in the aviation environment. This enabled the student's state and trait anxiety levels to be measured at different stages of their flight training and during flight-testing and helped identify specific areas of concern and anxiety causing factors. The results of the research confirmed that trait and state anxiety can be measured in student pilots and that test anxiety was also detectable. While no measurable effects of anxiety on hours to first solo or flight test scores results were obtained some evidence of the validity of the interactional model of anxiety was detected.

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Contents

List of Tables

List of Figures

List of Appendices

Chapter One

INTRODUCTION

1.1 Background

The purpose of this study is to examine the effects of anxiety on the human performance of student pilots enrolled in a structured university aviation degree course. While most student pilots progress through their training programme with no major problems there are inevitably some students who experience difficulties and struggle to complete the course or to keep up with their fellow students. Such problems may have a variety of causes, however, this study focuses on anxiety and its effects on flight training.

The effectiveness of a flight-training programme may be gauged by the quality of the student pilot's performance as measured by flight tests, instructor assessments, and the efforts and resources expended to achieve that performance. In common with many other pursuits, the resources in flight training are often in limited supply and the student and the organisation are constrained by aircraft operating costs, the need for the student to move progressively through the training, and the competition for resources such as aircraft, simulators and flying instructors. The underachieving student often requires extra flying hours to achieve the required standard. This adds cost, which must be recovered from the student, and also tends to clog up the system causing pressure on other students, instructors, and other resources. In some cases the student will drop out of the programme voluntarily, being unable to afford the additional expense. In other cases the training organisation may have to re-course the student or in extreme cases terminate the training.

Difficulties experienced by student pilots during flight training may be attributed to a number of causes. It is often stated that the

average light training aeroplane is a less than ideal "classroom", as the student and the instructor are frequently exposed to engine and radio noise, temperature changes, and distractions such as turbulence, "g" loading, and a constantly changing environment and visual perspective outside the aircraft. These factors are detrimental to both learning and teaching effectiveness.

Instructor-student relationships may be another cause of difficulty. The requirements for the issue and renewal of flying instructor qualifications are stringent and are determined by the state civil aviation authority. While these authorities ensure that the holder of the qualification is technically competent and can meet prescribed standards of teaching ability, this alone does not guarantee a successful interactive relationship between the student and instructor nor a positive effect of personality factors on the learning process.

Learning difficulties may also be attributable to various internal factors affecting the individual student. Foremost amongst these factors are the conditions of *fear, stress,* and *anxiety.* This study will examine these factors and attempt to establish relationships between them and their affect on the learning process. The thesis will examine particularly the effect of *anxiety* on the student pilot and how this construct is significant during flight instruction and when undergoing assessment and evaluation flights.

1.2 The Learning Environment

In a paper on the use of tranquillisers in flight training, Melton, Hoffman, and Delafield (1969) concluded that the stresses experienced by the student in pilot flight training were equivalent in intensity to those experienced by combat pilots and astronauts. The observations by Melton and his colleagues resulted from studies made on student pilots at a civil flying school, and the researchers concluded that the stresses experienced by the students, measured primarily from heart rates, arose from the fear and anxiety felt by the student in in-flight situations where there were many unfamiliar elements and where the potential for failure or embarrassment was great. (Melton, Hoffman, and Delafield, 1969)

In order to understand the environment in which such stresses occur it is necessary to consider the flying training process and the various options available for people wishing to undergo flying training.

Universally, flying training takes place at military training schools, civil flying schools and flying clubs or aero clubs. In New Zealand civilian training is shared between a number of aero clubs and flying schools. MacPherson (1995) identified forty-five aero clubs and an equal number of flying schools that were in existence in 1995. Research completed by Rendel (1975) indicates that the first New Zealand aero club was formed in 1909 at Sockburn, Christchurch and was soon followed by the Aero Club of New Zealand in Auckland in 1910. New Zealand's first significant flying school was formed in 1915 by the Walsh brothers initially at Orakei and later Kohimaramara, Auckland. The following year Henry Wigram established the Canterbury Aviation Company at Sockburn, Christchurch and by the end of WW1 had trained 182

pilots to the Walsh brothers 110. In 1923 and 1924 the New Zealand Government took over both flying schools and these became the basis for the first military flying school in the country. (Rendel, 1975)

An aero club and a flying school provide fundamentally similar levels of training to the private pilot level with the club environment catering more for the recreational pilot by offering a variety of social activities. The flying school on the other hand, frequently but not exclusively caters for the student pilot who wishes to go beyond the private pilot licence and gain further professional qualifications. The manner in which the learning takes place can also differ between schools and clubs depending on the type of qualification the student is seeking. For example, private pilot training is often provided on demand with the student receiving one to one instruction from one or several instructors as time and money permits. The quality of the training depends very much on the skill, experience and dedication of the instructor, and the student's progress is governed by the frequency of instruction.

In the flying school situation the student aspiring to professional qualifications is more likely to join a structured course for at least the post Private Pilot licence training. The training course is likely to have some form of approval or recognition from a Civil Aviation Authority (CAA) charged with the responsibility by the State for the issuing of pilot licences and ratings. The Authority will normally require the training to be delivered according to a set syllabus and timetable and the instructors will probably have to meet some minimum qualifications and experience requirements. The course will be conducted under the scrutiny of the CAA and will be subject to regular audits and inspections. Because of the structured nature of the training, the student will need to have in place adequate financial arrangements and will need to have the time available to devote to the course.

The environment in which the aero club or flying school student pilot learns contrasts significantly with the military environment.
The military student pilot undergoes a stringent selection process to attain a select place on an aircrew course in competition with other highly qualified and determined aspirants. Once selected, the military student pilot will undergo a highly structured course of training, will be paid during training rather than paying for training, and will be clothed, accommodated and fed by the tax payer. The military student pilot is thus freed from some of the more mundane pressures experienced by their civilian counterparts. On the other hand, the military student pilot is under considerable pressure to perform at all stages of the course and graduation from the course is dependent on maintaining progress and achieving high standards both in the air and on the ground.

Sharing features of both civil flying schools and military pilot training establishments is the university aviation school. Pilot training at tertiary level has been available overseas for a number of years particularly in the United States of America. In New Zealand, Massey University has offered the Bachelor of Aviation degree for a number of years and provides a unique environment for professional pilot training in this country.

Similar to military pilot training, the Massey University Bachelor of Aviation pilot training course is a structured course with theoretical and practical instruction delivery being highly integrated. The university student pilot is faced with high course fees and the need to attend a full time course for at least two years with little opportunity to earn an income. Unlike the military student pilot there is no rigorous selection process for students entering the university course. The entrance requirements are the basic university entrance ones together with the ability to finance the fees and being able to meet class one medical standards.

The student pilot who elects to train at an aero club or some of the flying schools may experience different pressures. The courses are likely to be much less structured or formal and will often be tailor-made to the individual student's requirements in respect to frequency and duration of instruction. Some costs may be less, particularly if the student decides to train at a local club or school and can enjoy the benefits of living at home. There may be an opportunity for the student to hold down a full or part time job and fly during spare time, which may assist with financing the course. On the other hand, the whole training process will be protracted and the quality of instruction may be compromised by a lack of continuity, a problem not so likely to be experienced with a more structured course.

1.3 The Flying Training Syllabus

The process of learning to become a pilot; the syllabus, methods of instruction, and the order in which the course content is taught, is similar whether the student is learning at an aero club for recreational purposes or is receiving training at a school for professional pilots or in a military service, particularly in the *ab initio* or basic stages.

Typically a private pilot licence course syllabus allows for about 40 to 50 hours of dual and solo training leading to the issue of a private pilot licence, while professional qualifications (commercial pilot licence and instrument rating) involve about 200 to 250 hours of flight training. In comparison a typical military "wings" course will be in the order of 250 hours training.

During the training process distinct phases of training can be identified. The initial or *ab initio* phase involves periods of dual instruction leading up to the student's first solo flight. This phase typically takes between about 8 to 15 hours of flight instruction and the student's progress will depend on a number of factors including continuity of training, quality of instruction, instructor/student relationship, and influences such as physiological and psychological factors.

The immediate post first solo phase consists of a period of solo consolidation where the student carries out solo flying exercises interspersed by dual check flights. The objective is to allow the student to gain confidence in aircraft handling and operation. After the initial consolidation more advanced handling exercises are introduced during periods of dual instruction The student then practices solo until mastery has been achieved. During this time the student is introduced to navigation, night, and instrument flying. The student gradually transitions from basic aircraft handling to the application of *a priori* aircraft skills to operational flight.

During the training the student will be subject to frequent assessments and appraisals. This may involve the formal or informal assessment of individual flying sorties by the student's own instructor, either by means of written assessments and grades in the student's training record or by a post-flight de-brief where the instructor will critique the student's performance. More formal assessments come in the form of flight tests conducted by flight examiners usually marking the completion of a particular block of training. At a typical non-military school, flight tests will be conducted to confirm that the student has achieved proficiency at the PPL (private pilot licence) standard as defined by the state licensing authority, proficiency in navigation to commercial pilot standard, advanced aircraft handling to the state prescribed

commercial pilot standard, and competency in operating aircraft under IFR (instrument flight rules).

The RNZAF and Massey University School of Aviation employ a similar series of flight tests with the exception that the School of Aviation students undergo a total of seven tests as opposed to the four flight tests required by the CAA. The outcome of the various tests and assessments are of particular significance to the progress of the student through the training programme.

Earlier in this chapter reference was made to the "effectiveness" of flight training. For a training programme to be effective the student must be able to progress steadily through each phase to enable the training resources to be employed efficiently. In a highly structured course the student's progress will depend on how well he or she meets flight test and sortie objectives. Poor assessments will prevent the student from progressing and continuing poor performance may result in the student being removed from the programme. In a less structured environment the student may be able to continue with many repeated attempts until the standard is met; the limiting factor being the student's ability to finance the additional flying training required. It may be argued that the student on a structured course will be under considerably more pressure to perform both during assessed dual flights and formal flight tests because of scheduling requirements and competition from peers. The student's actual performance may be influenced by his or her reaction to these pressures and the individual's predisposition to anxiety may be an indicator of performance in flight tests.

The tables in Appendix A provide an overview of the Massey University School of Aviation Flight Crew Development Major for the Bachelor of Aviation degree and a summary of part of the flying syllabus is shown in Appendix B. An examination of these tables will show that there is an intensive period of dual instruction spread over a total of 30 sorties (ground and air) culminating in the student's first solo flight. It is during this period that the student will be introduced to flying and thus exposed to a new, strange, and possibly threatening environment. The student, at this stage of the training, will have a high reliance on his or her instructor for security and comfort in this alien environment. Additionally the instructor will be relied upon for the guidance and direction of the student's progress during this early phase of training.

The student's introduction to flight training is therefore challenging and demanding. While the initial pressure and stress may decline as experience and familiarity increases, further demands are placed on the student with the requirement to perform in the various flight tests. These tests conducted by an independent flight examiner, and therefore away from the comfort zone of the instructor/student relationship, will determine whether the student progresses to the next stage of training and will also contribute marks to final paper grades. In some cases an unsatisfactory outcome will require a further financial commitment by the student to finance more flight training and in extreme cases there is the possibility of the student's training being terminated through lack of progress with the consequent waste of resources and effort.

1.4 The Organisation of the Thesis

Chapter One outlines the purpose and background of the study and discusses some of the sources of the stress experienced by a student pilot undergoing training in a university professional pilot programme. The learning environment is discussed in some detail and a brief history is given of flying training in New Zealand, including examples of flight training syllabuses.

Chapter Two reviews the literature with an emphasis on pilot training and how it has evolved over the years. The chapter examines some of the reasons that motivate people to become pilots and seek a flying career, and an in-depth analysis is made of the fundamental flying skills and the constructs of stress, arousal, anxiety, and fear and how these constructs affect the fundamental flying skills. This leads to a discussion on test anxiety and the effects of "worry" and "emotionality" on the student pilot's performance under flight test conditions.

Chapter Three presents the methodology used in the research for the thesis and examines subjects, sample characteristics, and test instruments. Spielberger's STAI inventory (Spielberger, Gorsuch, and Lushene, 1970) is discussed and modifications are suggested to adapt it for use in a pilot training context.

The results of the research are presented in Chapter Four including data analysis, and the findings of the various research questions that were investigated.

The final chapter provides discussion of the results together with some recommendations on how the study can be used to improve pilot training. The limitations of the study are discussed and suggestions for further studies are made. References are given at the end of the text.

Chapter Two

LITERATURE REVIEW

In reviewing the literature on anxiety and learning it became apparent that considerable research has been done in the context of general education, childhood development, learning and difficulties with tests and examinations (for example see Wine, 1971; Wittmaier, 1972; Hunsley, 1985; Soric, 1999). There is a smaller volume of literature that has resulted from research into the effects of anxiety and its allied constructs, on flying training. What is also apparent is that much of this research has not found its way into traditional or contemporary standard aviation texts.

2.1 Aviation Literature

Early research recognised a connection between personal comfort and learning. For example the official Royal Airforce flight instructor's handbook, AP 3225, published by the Air Ministry, (1950), observed that pupils who are cold or have badly fitting flying equipment, and who cannot see or hear properly, will not learn readily. The same publication recognised the importance of the instructor/pupil relationship and exhorts the instructor to develop the qualities of patience, perseverance, and sympathy, while exercising restraint in language, however exasperated he may feel. A later edition of this publication (Air Ministry, 1984) refers to the effects of fear, stress, and anxiety on the student pilot while continuing to emphasise the theme of comfort in the cockpit. The publication states that at early stages of flying, the fear of failure and the desire to create the right impression loom large in the student's mind and that this, coupled with the unfamiliar and possibly claustrophobic effect of the cockpit and flying equipment,

may cause a significant number of student pilots to experience nausea and air-sickness.

A popular British civil flying training manual, (British Light Aircraft Centre, 1969) contains no references to the effect of anxiety but advises the instructor to avoid high "g" loading manoeuvres and extreme attitudes. The manual warns that such manoeuvres can undermine a student's confidence. It further states that if after several hours of training the student still displays signs of nervousness, it may be the indication of unsuitability for further training.

In a later publication, Campbell (1985) also stresses the comfort theme stating that the student's ability to learn can be considerably affected by discomfort or the inability to hear the instructor clearly. Campbell noted that a student who was seated comfortably in the aircraft would learn more quickly and warns the flying instructor to be on the lookout for signs of airsickness in the student and to discontinue the flight if necessary.

A contemporary flying training manual, widely used in New Zealand and Australia, (Thom, 1993) advises the student to sit comfortably in the aircraft seat and relax, and observes that fresh air is obtainable through vents, which may be directed towards the body and face to improve the cockpit environment. Thom also warns the student to expect a feeling of apprehension when the instructor sends them on their first solo flight.

The publications mentioned above have been prominent among the recommended texts for flying training in most commonwealth countries since WWII. (For example see Hunt, 1996; Aviation Services Ltd Recommended Texts, 2000). These texts share a common emphasis on the effects of physical considerations on the

student pilot's progress and largely ignore any psychological factors.

American aviation publications on the other hand do attempt to look beyond the actual physical impediments to student pilot progress and consider in varying degrees the effects of fear, stress, and anxiety on student pilot performance.

The US Department of Transportation (1977) recognises anxiety as probably the most significant psychological factor affecting flight instruction and suggests that anxiety can be countered by reinforcing the student's enjoyment of flying and by teaching them how to cope with their fears. The publication also links anxiety with the performance of certain flight manoeuvres and operations.

The recognition that fear and anxiety distracts the student from paying attention and harms learning rate was made by Kershner (1994). He also identified the physical evidence of anxiety such as excessive face or palm sweating or trembling. Gilbert (1993) identified fear, anxiety, and timidity as three obstacles to learning that can be grouped together because of common characteristics. The manual observed that students working under stress exhibit a high level of trial and error responses and a low level of planned responses. Gilbert (1993) recognised that emotion could induce forgetfulness with strong emotion or shock producing amnesia. According to Gilbert (1993), an emotional situation occurring immediately after learning has taken place may also retard recall.

Philips (1991) observed that while the FAA expects flight instructors to be "practical psychologists" most aren't trained as such and are totally occupied with teaching "procedures". He noted that many well-intentioned aviation publications emphasised the importance of pilots controlling their anxiety levels but did not actually offer any advice how to do so.

From the literature it appears that while there is an awareness of the need to attend to the student pilots' psychological and physiological needs during flight training, the emphasis is on the student's physical well being. This is evident in most of the standard texts in use in New Zealand at the present time. While there is an association between anxiety and psychological factors and lower performance levels, flight training may be improved if the nature of this relationship is better understood.

2.1.1 Learning to Fly: The Psychological and Economic Motives.

As a result of working with thousands of mentally-wounded Air force Combat Pilots during WW2, and after researching and documenting 65 case histories, Grinker and Spiegel (1963) offer an interesting insight into the motivation of people learning to fly for a career. They argue that to attract potential students flying must be an emotionally fulfilling experience, that is, it must be enjoyable and it must be rewarding. The enjoyment of flying stems from the fact that most individuals like to feel that they have control over their physical environment. To the earth-bound, this control is two dimensional, flat, and rather limited. To the aviator flying is the apotheosis of the desire for control and mastery. As a child, fairy tales and toys fulfil dreams of omnipotence and control. According to Grinker and Spiegel (1963) these desires usually weaken with age only to resurface at a more mature age in the budding aviator by virtue of the aeroplane. Grinker and Spiegel (1963) refer to the aeroplane as a "super toy" which allows the aviator to escape the usual limitations of time and space. In learning to fly the aviator achieves a feeling of mastery over time and space and is rewarded with a sense of accomplishment when this has been successfully achieved.

They observe that the appeal of flying is universal and many respond to it out of a perfectly healthy interest. On the other hand, it is also a very satisfying compensation for feelings of inferiority as it is a purposeful and socially acceptable escape from, and compensation for, personal defeats among ground-based humans. It is the perfect prescription for those who are weak, hesitant or frustrated on earth. This is where the rewards of flying originate. While a flying career may be financially rewarding it is also recognised that there are other rewards of a more exhibitionistic nature. The dash and glamour of an active participation in aviation may provide an ego boost which may disguise a real and underlying sense of inferiority. Grinker and Spiegel (1963) regard this an unhealthy motivation. They argue that while in most aspiring student pilots the urge to fly is felt as an impulse and is not subjected to introspection or analysis, the underlying emotional factors such as feelings of inferiority, frustration, and indecision outlined above remain largely unconscious and may not emerge until the student pilot is exposed to the rigors and stresses of the training process. In some cases these emotional factors do not emerge until much later in the pilot's career and only then when the pilot is faced with stressful situations. While the research done by Grinker and Spiegel (1963) was directed towards pilots exposed to the terrifying experiences arising from aerial combat situations it may be argued that their findings are also valid for pilots exposed to various degrees of stress in non-combat situations. Their conclusion was that neither the emotional nor intellectual motivations which induce men or women to apply for flying training are in themselves a guarantee of future success in the field and that the more healthy and realistic the motivation, the greater the chance of success.

2.1.2 Identifying the fundamental flying skills.

The process of learning to fly involves the development of a series of cognitive and psychomotor abilities that appear to be affected by stress to some extent (Stokes & Kite, 1994). The manipulation of the aircraft controls or 'stick and rudder" skills which were once the fundamental skills of operating an aircraft have now been largely replaced by automated flight systems in modern air transport aircraft. For the student pilot however, the challenge is to acquire and develop these basic skills and psychomotor processes to a level where the aircraft can be manoeuvred smoothly, accurately and automatically. The operation of an aircraft involves planning, navigating, communicating, problem solving and many more functions over and above the actual manipulation of the controls. In order to facilitate this a wide variety of cognitive skills, which rely on short term or working memory, are developed. These functions include the ability to comprehend and use clearances, call signs, briefings, and to be able to remember them for as long as is necessary. Also associated with working memory capacity are the essential visual-spatial processes including three-dimensional space orientation. It is these functions that allow the aviator to maintain situational awareness and build mental pictures of the flight's progress, runway orientation and air traffic movement (Green, Muir, James, Gradwell & Green, 1991). High degrees of cognitive skill are also required to analyse situations and interpret a broad range of incoming cues such as visual, (attitude interpretation from the real horizon or by instrument interpretation), auditory, (engine and airflow noise, radio transmissions, warning sounds, etc.), and kinaesthetic, ("g" effects, "seat of pants" sensations) as well as cues obtained from pre-flight briefings, in-flight reports, weather reports, and similar sources. Other important cognitive functions involve information retrieval skills where appropriate information is recalled from the long-term memory and applied to the present situation.

Of similar significance to the psychomotor and memory functions mentioned above are the attentional processes. According to Stokes and Kite (1994) these processes include attention focusing or the ability to concentrate, and the conceptually opposite quality of divided attention or the ability to timeshare between multiple tasks. Another important attentional skill identified by Stokes and Kite (1994) is prioritisation or the ability to plan ahead and rank tasks according to importance. Prioritisation means that pilots allocate attention in efficient, task driven ways and avoid preoccupation with low priority or off-task intrusions. This includes idle, non-task-related conversations and self-referential thoughts such as worrying or fretting about one's performance. Another attentional skill is vigilance or the ability to remain alert and focused on a task without lapses of attention. In the aviation world the pilot's ability to remain "vigilant" is constantly being threatened by increasing levels of task automation.

A cognitive function of paramount importance in aviation is that of judgement and decision making. Research suggests that many pilot error accidents are attributable in varying degrees to suboptimal decision making and that stress can profoundly exacerbate this problem (Prince, Bowers, & Salas, 1994).

2.1.3 The effect of stress on the fundamental flying skills

There is evidence that "stick and rudder", or psychomotor skills degrade significantly with stress although there is a scarcity of formal research on the effects of high stress states on aircraft control. Idzikowski and Baddeley (1983) observed from studies of divers and British Paratroopers that in the former case manual dexterity became impaired the more dangerous the dive and in the latter, tracking task performance deteriorated immediately prior to a parachute jump. In the paratroop tests it was reported that

Territorial Army troops who were the least experienced in parachuting were the most impaired while regular army trainees were less impaired. It was also noted that regular army paratroopers who were fully trained in the skill were least affected. Grinker & Spiegel (1945), while describing anxiety in United States Air Force personnel, observed that combat pilots who felt constantly jittery and apprehensive or displayed severe tension over the target area, were still be able to carry on the tasks of flying the aircraft. They found that aircraft control problems seem to start during moderate anxiety states where the above symptoms may have progressed to the point where the pilot makes mistakes in aircraft handling and now has his own incapacity to fly the aircraft properly to fear, as well as the other conscious and unconscious sources of anxiety. Grinker (1945) noted that while severe anxiety states occurred in ground combat personnel who were submitted to more prolonged, continuous, and severe punishment, such states were rarely observed in pilots, possibly as the pilots did not survive to be interviewed. Another view was proposed by Duffy (1962) who cites US Army Air Force pilots in WW2 as reporting that fear led to an improvement of their performance in combat, with mild fear being more advantageous than intense fear.

From current literature it seems that there is very little solid information on the effect of stress on aircraft control although Grinker and Spiegel (1945) observe that some stressed or anxious pilots seem to "fight" the aircraft, overcontrolling and creating an appreciable additional workload, while other pilots, undercontrol or may even freeze at the controls. In general terms, novice pilots tend to correct flight path deviations only after a noticeable deviation has occurred and display reactive, compensatory control handling as opposed to more experienced pilots who make more frequent but smaller, anticipatory control inputs. A typical reaction from a novice pilot when attempting to fly an aircraft down the final approach path is to "chase" the airspeed by overcontrolling with

elevator to such an extent that airspeed deviations are grossly overcompensated. Similarly, coarse use of ailerons to counteract the effects of gusts at approach speeds can induce a secondary yawing effect, which the novice tends to try and correct by even more aileron input. In such cases the instructor's advice is usually to encourage the novice to 'relax' and loosen the grip on the control column. Another common error observed by Stokes and Kite (1994), is that novices frequently neglect to use the elevator trim to advantage with the result that they often 'fight" against an out of trim aircraft with the result that frequent, unnecessarily coarse control inputs are resorted to in order to attempt to maintain a steady flight path. From reviewing the literature it seems that there are no clear indications as to whether "stress" causes such control mishandling or that the natural control mishandling of a novice pilot during the learning process, causes or compounds stress.

There is greater evidence of the effects of stress on the short term or working memory functions of pilots. During a typical flight the pilot constructs a mental model of the flight and the aircraft's progress. The mental model is constructed by monitoring inputs from the aircraft instruments, information received via the aircraft radio, the status of the aircraft systems and log keeping. As the flight progresses the mental picture is constantly updated. Research conducted by Hockey (1986) indicated that anxiety could be linked to a reduction in working memory capacity and selected attention to the detriment of decision-making processes. An experiment conducted by Wickens, Stokes, Barnett, and Hyman (1991) to explore the effects of stress on pilot judgement in a simulator, showed that situations involving a high demand for spatial operations in working memory were particularly sensitive to the degrading influence of stress. In such situations, they argued that some pilots diverted part of their working memory to worrying about irrelevant matters when under stressful conditions with the result that less working memory was available for the allocated

task. In contrast, long term memory retrieval processes seemed to be less affected by stress. According to Wickens, Stokes, Barnett, and Hyman (1991), highly experienced aviators who can retrieve familiar information from long term memory are relatively immune to the effects of stress. For example an experienced pilot may immediately recognise a pattern of instrument readings as attributable to an underlying failure mode whereas a novice pilot may have to figure things out in a stress-prone working memory.

Flying an aircraft involves extensive ground training in competencies that are highly specific to the task of aircraft operations. From experiments Wickens, Stokes, Barnett, and Hyman (1991) concluded that book knowledge was fairly resistant to stress and could be retrieved from long term memory, even under difficult or extreme conditions, while more general cognitive abilities degraded significantly under conditions of stress.

2.2 Defining the Terms.

2.2.1 Stress

In the foregoing review of pilot training texts, the student pilot's comfort is emphasised as a prerequisite for learning in the air. It has already been observed that the aeroplane cockpit is a less than ideal classroom because of the environment both in and outside the aircraft in flight. The factors that cause the student pilot's discomfort or degrade the classroom properties of the cockpit are widely regarded as "stress inducing" in the same way that a multitude of factors and events cause people to feel stressed in their everyday life.

The scientific use of the word stress is by no means universal or standardised. It has been used as a catchall term for actual or presumed anxiety eliciting events, for psychological and emotional states, and for behavioural and physiological responses to

particular events or circumstances. In an early attempt to define stress a medical pioneer, Seyle (1978), defined the medical concept of stress as "the rate of wear and tear in the body" and in a more general sense as the "non-specific response of the body to any demand." According to Seyle (1978) a non-specific element in medicine was recognised twenty-four centuries ago by Hippocrates who taught his disciples in Greece the concept of the *vis medicatrix naturae* or Natures healing force which cures from within. In modern terms Seyle (1978) defined the healing force as "the individual's psychophysical response, mediated largely by the autonomic nervous system and endocrine glands to any demand made on the individual". This non-specific element is now known as *stress.*

Stress research was handicapped for many years by a lack of objective, measurable indices by which it could be assessed. In the 1930's however, Seyle (1978) discovered that stress caused certain structural and chemical changes in the body and that these changes could be accurately assessed. This led to the concept of the *stress syndrome* or *general adaptation syndrome* (G.A.S.); general, because it is produced by agents which have a general effect on large portions of the body, adaptive, because it stimulates defence and thereby helps in the acquisition and maintenance of a stage of inurement and syndrome, because its individual manifestations are co-ordinated and even partly dependent on each other. Selye's studies introduce the hypothetical construct known as "arousal" (Selye, 1978). This construct is taken to mean the basic energetical state of an organism and as we shall see later in this paper arousal has considerable significance in the learning process. While by no means the first to observe and describe the phenomenon of physiological arousal, Selye (1978), through his General Adaptation Syndrome recognised a relationship between stress and arousal.

In an aviation context, Stokes and Kite (1994) referred to three basic approaches to stress research. These included stimulus based models, response-based models, and transactional models. The three models were not mutually exclusive and emphasised respectively situational variables, generalised responses (particularly biochemical responses), and intervening psychological responses or individual assessment of threat.

The stimulus-based model focuses on external events and conditions and is the basis of popular conceptions of stress. A large list of stress factors exists covering every imaginable physical, environmental, and social condition. The model has a serious limitation in that while stressors may be easily identified and labelled as such it does not necessarily follow that individuals will actually experience stress or discomfort. In other words supposed stressors such as heat, noise, or vibration might cause considerable stress and discomfort to some student pilots while others may experience no, or little, ill-effects. According to Stokes and Kite the limitation of the stimulus-based model is that in human stress responses, individuals do not respond identically or consistently. What may be stressful to one person may not be so to another and what may be regarded as stressful on this flight may not be stressful to the same person on the next flight. (Stokes & Kite, 1994).

The response-based model does not focus on external causes of stress but on the individual's reaction to stress. With the response model, the responses or the patterns of responses resulting from a given situation are considered to be the defining stress parameters. While many categories of responses such as behavioural, affective, cognitive and others may exist, historically only the physiological type of stress response has been studied. The work of Selye (1978) is often cited as being influential in response based approaches to stress as well as the popular

conception of stress in general. Stokes and Kite (1994) observed that as a result of the development of Selye's G.A.S. model, considerable empirical research on stress responses has assumed that physiological arousal is essentially a measure of psychological distress.

Also in the context of aviation, Melton, McKenzie, Kelln, Hoffmann, and Saldivar (1975), proposed the following working view on stress;

> "Stress," commonly called "tension" by flight instructors, is difficult to define. The indicators of it are many....usually a battery of measurements is employed, encompassing biochemical estimates of adrenomedullary, adrenocortical, and other glandular outputs into the blood and urine together with physiological appraisals of the condition of the nervous system as reflected in the heart rate, blood pressure, respiration, and skin resistance. Additional measurements sometimes employed include the electro-oculogram, electrocephalogram, and electromyogram.,[p.11]

while Sive and Hattingh (1991, cited in Stokes and Kite, 1994) observed stress related endocrine effects including elevated plasma phospholipids, in B737 pilots facing a simulated birdstrike emergency. Heightened urinary catecholamine excretion in trainee fighter pilots and in student pilots practicing spins, has been reported by Krahennbuhl, Marett, and Reid (1978, cited in Stokes and Kite, 1994), elevated testosterone in F-16 fighter pilots during simulated emergencies, and increased adrenaline output under conditions of emotional stress were reported by Vaernes, Warncke, Myhre, and Aavaag (1988) and Debijadji, Perovic, and Varagic, (1970, cited in Stokes and Kite ,1994). While such studies produce quantitative, objective, scientific data there are difficulties in determining what these results tell us about stress. The examples mentioned above are all associated with some serious aviation situations, but similar adrenergic arousal symptoms can be

associated with a diversity of conditions and constructs such as exhilaration, illness, effort, keen anticipation, and sexual activity.

The difficulty with the stimulus based and response based models is that both tend to consider stress in terms of a direct cause-effect relationship and fail to consider behavioural, affective, or cognitive appraisal or mediation by the individual. As a consequence there is no consideration of how the perception of threat influences stress. In other words the individual aviators' interpretations of events in a particular situational context are not considered and as a result these popular concept of stress have limited usefulness.

The transactional model, according to Stokes and Kite (1994), represents a radical redirection in stress research (See figure 1). Instead of focusing on precipitating factors or stimuli, as in the stimulus-based approach or on the responses to these factors, as in the response-based model, the transactional approach emphasises the role of cognitive appraisal in human stress response. The model regards stress as inhering neither in the person nor in the environment but in the transaction between the two. Stress therefore, in terms of the transactional approach is dependent on the individuals' beliefs, goals, hopes, and fears and how these relate to their perception of the environment with its associated threats, challenges, opportunities, and risks. Events do not become stressors unless they have been identified as such by cognitive appraisal. The transactional model is congruent with the argument by Lazarus (1982) that there are three distinct forms of cognitive appraisal. In the context of stress these include: Primary appraisal, where an environmental situation is identified as being stressful, helpful, or irrelevant to the individuals' wellbeing; secondary appraisal, where the individual's resources to cope with the situation are reviewed; and re-appraisal, where the stimulus and coping strategies are reviewed and the primary and secondary appraisals are modified as appropriate.

According to Stokes and Kite (1994) the transactional model represents an emerging consensus among psychologists specialising in stress research, particularly in the context of workplace stress and high stress events. They observe however that the influence of the transactional approach is only just beginning to be felt among aviation psychologists and aviation human factors specialists, many of whom were schooled in the earlier stimulus or response based stress models. Cognitive appraisal introduces an element of subjectivity, as its central theme is the individuals' perception of the demands of the situation and the individuals' perception of the resources available to cope with the demand.

Jones (1991) defines stress as a mismatch between individual's perceptions of demand and coping. Therefore a pilot who overestimates the available resources (for example, fuel, time, altitude, and personal flying skill), or underestimates his or her ability to cope with the situation may respond in a negative way and experience feelings of resignation and helplessness. Such misinterpretations can result in unnecessary stress and decision making errors. In the flying training environment, a student pilot who for example may have previously trained as an operator of heavy earthmoving equipment may perceive cockpit noise levels as being less stressful than the student pilot who comes from, say, the legal profession. On the other hand the lawyer, who has probably experienced years of tests, assessment, and examinations at university and as a law clerk while training in the profession, may perceive the prospect of undergoing a PPL flight test as a relatively non-stressful event while the earthmover who may have left school with little formal education may very well perceive the task to be a significant challenge of ability and hence stressful.

Another view of the cognitive appraisal process is offered by McGrath (1976) who defined stress in terms of three elements: perceived demand, perceived ability to cope, and the perception of the importance of coping. The perception of the importance of coping is an important dimension. A modest imbalance between demand and coping ability may be very stressful to a pilot during low-level aerobatics, while a profound skill deficit may be of little concern if the situation is one where the pilot has no need or expectation to excel, such as during a student pilot's first aerobatics lesson performed at a safe height under the supervision of a skilled instructor.

Warburton (1979) suggested that a fourth significant element in the cognitive appraisal model might be 'uncertainty'. For example a student pilot who has not prepared sufficiently for a flight test and is convinced that failure of the test is inevitable may possibly experience less stress when undergoing the test than a student who has prepared diligently but feels underconfident about the outcome. With uncertainty, small imbalances of demand and coping ability may create stress where a successful outcome is important. Stress will also occur where the ability to cope is perceived as positive, but marginal, and risks are perceived as being high.

Earlier it was suggested that the effectiveness of a flight-training programme could be gauged by measuring the quality of a student pilot's performance and comparing it with the effort and resources expended to achieve that performance. The effectiveness of a flight-training programme is illustrated by Hobfoll (1988) who suggested a transactional model of behaviour in stressful circumstances based on the notion of conservation of resources. In this model stress is defined as a reaction to the environment where there is either the threat of a loss of resources, an actual loss of resources, or the failure to gain resources following an investment

of resources. The resources that Hobfoll (1988) referred to included a broad range of items such as financial resources, reputation, skill, power, security, affection or almost anything valued by an individual or expended by an individual to achieve gain. Students in the flight-training programme therefore may experience stress if, after the expenditure of considerable financial expense, time, and effort, they perceive a failure to gain value such as lack of employment prospects after completing training, or good examination grades or flight test results. In a more subtle form, loss of resources such as self-esteem, loss of medical fitness, loss of employment and the threatened loss of personal identity can be highly stressful. Hobfoll's model also defines the general direction of the applied coping strategies when a loss or a potential loss of resources is recognised, for example by the conservation of resources and the minimisation of loss in order to maximise gain (Hobfoll,1988). Under some conditions expending or investing further resources can minimise stress. For example, to a student pilot experiencing stress as a result of being unable to secure employment after the expenditure of considerable resources to obtain flying qualifications, the expenditure of even more resources by obtaining a B737 type rating, can lead to an overall gain in, or conservation of, resources if such an investment can be expected open the door to future employment.

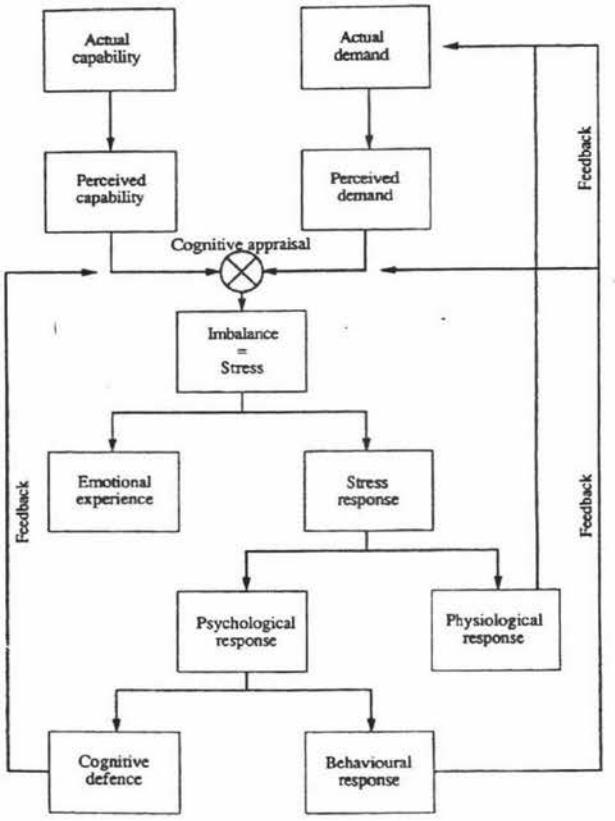

Figure 1 *Transactional model of stress*
Source: Cox and Mackay (1976) cited in Stokes and Kite (1994)

It is important to distinguish between stress itself, and stressors, which are the things that cause stress. Stressors can be environmental events, personal deficiencies and interpersonal conflict. Stress reactions are the responses to stress and if left uncontrolled may be disruptive and maladaptive.

Campbell and Bagshaw (1991) distinguished between stress that occurs during flight and stress that pilots bring with them to the flight deck as a result of work, family, and life pressures. Their approach to stress follows the transactional model in that they recognise that the impact of stress depends on how the individual

reacts to the stressor rather than the stressor itself. Campbell and Bagshaw identified three significant sources of stress: Environmental stressors, life stressors and reactive stressors. Environmental or physical stressors are created by factors such as noise, vibration, heat, lack of oxygen, presence of carbon monoxides and the onset of fatigue. Other environmental stressors relate to the tasks involved in flying and will vary in degree from flight to flight. When good weather prevails and the pilot is familiar with the route or flying task, stress will be minimal. On the other hand, flying an unfamiliar route or in poor weather conditions may result in a much higher stress level. The stress imposed on the pilot can also vary according to flight phase. En route flying in good weather for example is less stressful than landing or taking off in a strong cross wind. In the past, environmental stressors have been the main culprits identified in aviation texts as being detrimental to learning to fly.

Life or psychological stressors are associated with everyday life events such as domestic and financial problems, deaths, lifestyle, and personal activities such as excessive drinking and smoking. These factors add to the operational stressors with which the pilot has to cope in flying operations.

Reactive stressors stem from the body's reaction to specific events. An engine failure with its element of surprise and need for sudden, positive action or a sudden encounter with a down draught on short finals are examples of reactive stressors. Added to pre-existing environmental and life stressors the pilot may be very close to not being able to successfully cope with the additional stress. In the flying training context reactive stressors may have a significant effect on the student pilot as the learning curve steepens and becomes more demanding.

Campbell and Bagshaw (1991) suggest that everyone has a personal stress limit and that if this is exceeded a "stress overload" occurs. As a result of a stress overload the individual rapidly looses the ability to cope with even a minor workload. They recognise that this personal stress limit is affected by the individuals' physiological and psychological characteristics and results in a downgraded performance.

The ability to perform in the sense in which it applies to a pilot undergoing flying duties, requires an examination of the relationship between stress and arousal. As previously proposed by Selye (1978) in his General Adaptation Syndrome there is a relationship between stress and arousal as measured by various biochemical and pschycophysiological indices. While Selye's response based model has now been overtaken by the transactional model there exists a variety of overlapping and intermingling notions and definitions of the arousal construct in much the same manner that we have seen with stress (Selye,1978).

Stokes and Kite (1994) observed that a significant amount of aviation psychology literature as well as almost all of the popular flying journals perpetuates notions of stress, arousal and performance that are simplistic and misleading. They cite as an example the unquestioned dominance of the "inverted U" curve as a representation of how stress effects performance. Stokes and Kite challenge the frequently expressed notion that high and low levels of stress are bad for performance while intermediate or moderate levels enhance performance. They further state that the nature of the performance itself is not generally explicit and the reader is left to decide which of the myriad of functions that makes up a pilot's job is a performance. Stokes and Kite argue that there is little or no evidence that the performance of any piloting task is optimal under moderate levels of 'real world' stress (Stokes & Kite,

1994). In contrast to this view, Campbell and Bagshaw (1991) assert that an optimum amount of stress is needed for efficient functioning in flying operations. They liken a person's state of arousal to the person's preparedness to undertake a difficult task. According to Campbell and Bagshaw (1991) a certain degree of stress is needed in order to raise a person's arousal state to an optimum level for best performance. Too little or too much arousal takes the person outside the optimum range. In common with a lot of researchers Campbell and Bagshaw (1991) state their assertions on the "inverted U" law as proposed by Yerkes-Dodson as a demonstration of this relationship. While Campbell and Bagshaw's view promotes the notion that arousal is a synonym for stress, there is evidence that this is an oversimplification of what is a more complex relationship (Campbell & Bagshaw, 1991). Questions have been raised as to the veracity of the Yerkes-Dodson curve as it is applied by aviation researchers (See figure 2). Stokes and Kite (1994) provide the following summary:

> Looked at overall, research supports, at best, a correlation, but not a causal interpretation of the U curve relationship between arousal and performance. This is very weak, the equivalent to merely observing that a number of aircraft have vanished in an area called the "Bermuda Triangle", without ascribing their loss to the infamous Bermuda Triangle. The analogy can be driven a little further. The Bermuda Triangle is any triangle you may care to draw. Its parameters, size, shape, even duration, apparently vary from author to author, depending upon which disappearances each author wishes to include and 'explain' by the Triangle's malign, but unspecified power. The reason that the Bermuda Triangle is not a useful explanatory concept is because it (a) accounts for everything and cannot be refuted, and (b) because it provides no causal mechanism for the events associated with it.
>
> Similarly the inverted U curve is pretty much any inverted U that can be drawn. Its parameters are not specified in advance or anchored. 'Optimal arousal' varies from task to task and is never predicted in absolute terms. Virtually all data potentially fit the curve....The claim that performance will be best at some level of arousal between coma and uncontrolled frenzy, is as irrefutable as it is trivial. [p.43]

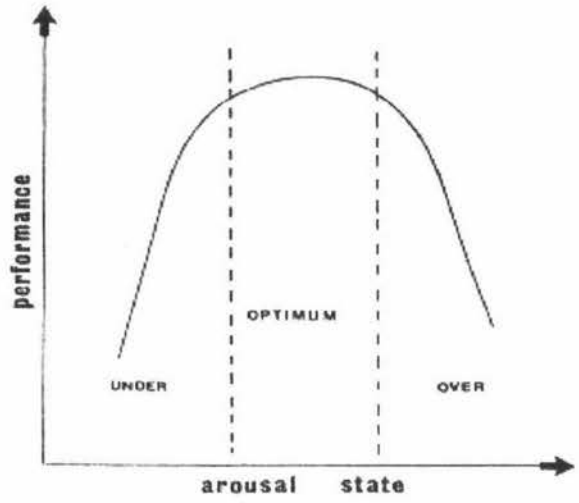

Figure.2 *Performance and arousal after Yerkes and Dodson from Campbell and Bagshaw (1991, p.106)*

The experiments on which the law was based involved a relatively simple situation as opposed to the more complex multitask cognitive performances appropriate to aircraft flight decks. The original experiments involved mice learning to discriminate between a white and a black passageway. On traversing the black passageway the mice received an electric shock. There was no shock associated with the white passageway. The strength of the shock was varied by five different levels. The vertical axis of the inverted U graph represented performance which in fact was the number of attempts the mice made before they learned not to venture down the black passageway. The horizontal axis, which supposedly represented stress or arousal, was not derived from the direct assessment of the mice themselves but simply reflected the strength of the electric shocks. It was discovered that the most rapid learning occurred at some medium shock level and not at its highest or lowest levels. From this information two principles were established which became known as the Yerkes-Dodson law.

Firstly it was claimed that performance is best at some intermediate level of stress and secondly that that the optimum level of stress is inversely related to the difficulty of the task. The latter being explained by the observation that as the mice were confronted with increasingly difficult discriminations, shocks of lower and lower intensity produced the fastest learning.

Neiss (1988), having reviewed a large number of studies of arousal and human performance using electric shocks as the stressor, concluded that there was little evidence to support the inverted U hypothesis, and that the evidence available often contradicted it. Stokes and Kite (1994) suggested that another indication that stress and arousal are not identical phenomena can be seen in the observation that humans often find low levels of arousal such as boredom and sensory deprivation unpleasant while a wide variety of high arousal activities can be pleasant and desirable. Apter and Svebak (1989), suggest that individuals have a preferred state of arousal at any given time and that stress does not vary directly as a function of arousal level but rather it results when the actual level of arousal does not match the desired level. Stress therefore can be experienced in both high and low arousal states. Apter and Svebak (1989) identified a telic state in which an individual avoids arousal "wanting a bit of peace and quiet", and a paratelic state where the individual seeks high arousal and does things for 'kicks", or seeks action.

Further evidence that stress and arousal are not identical may be found in an experiment conducted by Schachter and Singer (1962). Their experiment involved administering adrenalin to unknowing subjects and then requiring them to complete a questionnaire that contained a number of questions of a personal nature which were intended to be provocative. At the same time a confederate, briefed to react in an angry manner, was also given the questionnaire to complete in the presence of the other subjects. Acting as

instructed, the confederate repeatedly expressed annoyance at the nature of the questions in the questionnaire and eventually tore up the questionnaire, threw the pieces on the floor, and stormed out of the room. When the subjects were later questioned by the researchers on their emotional state during the exercise the answer was given that the nature of the questionnaire caused the subjects to feel angry to the extent that physiological effects in the form of an increased heart rate were experienced. These symptoms were in fact caused by the adrenaline but were incorrectly attributed by the subjects to external cues generated by the nature of the questions and the apparent effect it had on the volunteer. In a concurrent experiment a confederate who had been briefed to behave in a highly exuberant manner was introduced to subjects who had been injected with the adrenaline under the same conditions as the former group. Under these conditions the subjects attributed their increased heart rates to "high spirits".

From the results of these experiments Schachter and Singer (1962) concluded that:

> Given a state of physiological arousal for which an individual has no immediate explanation, he will label this state and describe his feelings in terms of the cognition's available to him. To the extent that the cognitive factors are potential determiners of emotional states, it should be anticipated that the same state of physiological arousal could be labelled "joy" or "anger" or "jealousy" or any of a great diversity of emotional labels depending on the cognitive aspects of the situation.[p.318]

Traditionally arousal was considered to be the general level of activation of an organism and involved a unidimensional continuum of excitation with coma or hibernation at one end of the scale and frenzied cognitive and physiological activity at the other. Contemporary thinking however recognises a componential approach involving two dimensions of arousal.

For example Thayer (1989) suggests a continuum from energetic to tired and from tense to calm. This two dimensional model could explain why after a long and eventful flight, a pilot can be left feeling fatigued but too tense to achieve sleep readily. With the unidimensional model, fatigue is more likely to be associated with low arousal and tenseness with high arousal. An earlier model proposed by Pribram and McGuinness (1975) consisted of three distinct but interactive neural systems. In this model one of the systems controls arousal, resulting from input; a second controls the preparatory activation of response mechanisms; and a third operates to co-ordinate arousal and activation, an operation requiring effort. According to Neiss (1988a) arousal from immediate external sources (for example a sudden in-flight emergency) is associated with activity from the right hemisphere and parental areas of the brain, and is controlled by the secretion of adrenalin and noradrenalin. Activation, on the other hand, is internally oriented, associated with the left hemisphere and frontal regions of the brain, and controlled by doperminergic transmission.

Stokes and Kite (1964) suggest that these hypothethses are closer to the truth than unidimensional ones and cite the experimental evidence of McClelland, Patel, Stier, and Brown (1993) that showed that arousal could either be dominated by challenge or threat stressors and characterised by increased adrenalin production (power arousal), or be dominated by a type of stress that arises from such sources as divorce or bereavement, this is called affiliative arousal and is associated with increased dopamine levels as opposed to elevated adrenergetic activity. In-flight emergencies and incidents as well as stress associated with learning to fly, flight tests and evaluation are more likely to be associated with power arousal while general life stresses are likely to be of an affiliative type.

As a summary Stokes and Kite (1994) conclude:

> Stress and arousal are not only not identical constructs, they are not even similar – although they may be related in more or less complex and systematic ways. Stress cannot be said to cause or be caused by a generic unidimensional arousal; rather, various cognitive, biochemical and psychophysiological functions are likely to be influenced differentially depending on the eliciting conditions. These changes, however, need not necessarily be associated with any general alteration in performance. Similarly pilot or controller performance is inadequately and misleadingly represented when depicted as a single continuum on a graph, even if team performance variables are excluded. Cognitive performance is made up of many elements, and the nature of any stress related change in cognitive performance will obviously depend upon the specific cognitive structure or requirements of tasks as complex as flying an aircraft or controlling air traffic.
>
> Each flight or ATC task can be though of as a specific suite or profile of cognitive demands or components (e.g., memory, inference, judgement, motor control, and so forth). The profile for any single task is not necessarily fixed across individuals, however, because of individuals' preferred strategies and styles.... The particular cognitive demand profile of a flight task or situation acts in conjunction with the particular stress characteristics of the situation, and the biopsychological characteristics of the individual....From the viewpoint of individual differences interacting with a broad range of multifactor situations, we would anticipate that these interactions are complex but nevertheless lawful. The task of modelling stress effects upon individual performance would, from this perspective, involve identifying these systematic relationships, rather than depending upon the reflexive invocation of the Yerkes-Dodson 'Law'.[p.45]

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2.2.2 Anxiety and Fear

Having examined stress, and the relationship between stress, arousal, and performance in aviation, it is necessary to examine anxiety and fear in similar detail, as the three constructs are often confused and used loosely in the aviation context.

Historically, the word anxiety was included under the general rubric of 'fear' according to Lazarus & Averill (1972). Miller (1951) and Mowrer (1939) described fear as a conditioned response to pain. They argued that if an animal experienced pain in a particular situation, stimuli that were present during the experience tend thereafter to elicit the emotional and avoidance tendencies that were initially elicited by the pain. These conditioned or anticipatory reactions are known as 'fear'. While pain motivates escape from a currently destructive situation, fear motivates avoidance of the situation ahead of time and thus extends the animal's protective shield in time and space. From this viewpoint there is no fundamental distinction between fear and anxiety in so far as the response state is concerned. Miller (1951) however differentiated between fear arising from a known source and fear arising from an unknown source. In the latter case fear was designated 'anxiety'.

More recently Strongin (1987) defined fear as the reaction to an external threat to the individual's physical welfare, and anxiety as the emotional reaction to a symbolic threat to the individual's physical or psychological welfare. Strongin (1987) argued that fear and anxiety can either coexist or develop separately and that fear can be experienced and be subsequently symbolised, thus becoming anxiety:

> For example, a fear of spins and stalls can become symbolised as anxiety associated with having another pilot in control of the aircraft. Remembered fears, such as fears of paternal retribution can be symbolised as anxiety associated with flying. A recent life event can bring suppressed anxiety to the surface. For example the death of an admired flight instructor as a result of an aircraft accident can awaken anxieties of vulnerability and helplessness. These anxieties can lead to counterphobic defences such as reckless behaviour and risk taking. [p.263]

The term 'anxiety' did not gain currency in the psychological literature until the 1930's. Since then several thousands of books

and articles have been published on anxiety and its use today is widespread not only among psychologists, but among educators, other professional people, and lay people generally

Chandler (1969, cited in Phillips, Martin, & Meyers, 1972) notes in reference to anxiety:

> Though the indefiniteness of its referent has caused some confusion in psychological research, the same lack of precision, together with the combination of somatic and psychoanalytical connotations, may explain its wide, popular use. [p.4]

Notwithstanding this popular use, a comprehensive and widely held theory of anxiety has failed to emerge. Chandler attributes this to the fact that anxiety as a hypothetical construct has been defined operationally with reference to many diverse criteria.

A diversity of views of anxiety exists. For example Cattell (1966) stated that anxiety arises from a threatened deprivation of an anticipated satisfaction when the threat does not carry complete cognitive certainty, while Izard & Tomkins (1966) regarded anxiety as a negative affect and postulated that there were eight innate affects which could be expressed behaviourally as facial responses of which anxiety was subsumed under the affect "fear-terror". They used anxiety and fear interchangeably on the grounds that there is no useful distinction between them whereas Cattell (1966) considered anxiety to be only generically similar to fear. In contrast to Izard (1966) and Cattell (1966), Grinker (1966) related anxiety to stress, associating anxiety to whatever stresses an individual is susceptible to. Grinker (1966) reported that blocking interpersonal communication was a significant way of arousing anxiety. Malmo (1966) introduced the concept of pathological anxiety. He associated this type of anxiety with the possibility of physiological overreaction to stress with the consequent loss of behavioural efficiency, while Wolpe (1966) defined neurotic anxiety as a

conditioned emotional habit involving a sympathetic-dominated pattern of automatic responses. A multi dimensional stress response concept was suggested by Lazarus and Opton (1966) with components of physiological arousal (in the various organ systems), subjective phenomenology, and objective behavioural reactions. Mandler and Watson (1966) argued that when an organised behaviour sequence is interrupted, 'arousal' would be evoked under certain conditions. Anxiety will then follow when there is no response available whereby the arousal initiated by the interruption can be terminated. When no alternative behaviour is available, helplessness and disorganisation is produced, which is anxiety. Spence and Spence (1966), who helped to develop the Manifest Anxiety Scale (MAS), identified two components to anxiety, drive (D), and drive stimulus (Sd), which affect performance in terms of their interaction with learning. Spielberger (1966) proposed a state-trait conception of anxiety, which distinguished between trait-anxiety (the disposition to respond anxiously), and state anxiety (the anxiety experienced in a given situation). An earlier, psychoanalytically oriented researcher Freud (1949) defined anxiety in terms of three characteristics: (1) it has a specific unpleasurable quality, (2) it involves efferent or discharge phenomena, and (3) it consists of a perception of these.

The diversity of views on anxiety becomes apparent from the small cross-section of key ideas presented above. Phillips, Martin and Meyers (1972) make the observation that while each of these theories deal with somewhat different variables and concepts, they tend to be more complementary than contradictory in what they say about anxiety and their formulations show a tendency to converge at a number of points as follows.

Anxiety is manifested physiologically, phenomenologically, and behaviourally. Discrepancies between these indicators of anxiety may be attributed in part to defensiveness. Anxiety has a two-part

conceptual status, including what is referred to as trait, neurotic, or chronic anxiety, and what is called state, objective, or situational anxiety. Trait anxiety is dispositional in nature, is construed to be a proneness to be anxious, is primarily a function of past experiences, and has an internalised or intrapsychic locus; while state anxiety is situational in nature, is directly a function of stressful conditions, and has a contemporary locus. Moreover, these two variables interact in a manner such that anxiety proneness influences the extent of anxiety reaction. Anxiety is elicited by psychological stress, and stress is reflected in the threatened deprivation of an anticipated satisfaction. In addition, uncertainty associated with external or environmental and internal or cognitive factors, is a key ingredient in whether an anxiety reaction to stressful conditions occurs. Anxiety usually occurs as a response to stress in conjunction with other affects such as defensiveness and other coping reactions. The consequences of anxiety are usually negative, interfering and debilitating in nature, although all consequences depend on the demands and requirements of situations. Therefore, the consequences are complex and interactional in nature and, as a result, are sometimes facilitating, helpful, and enhancing to adaptation, performance, and adjustment.

Philips, Martin, and Meyers (1972) suggested that a further alignment of these theories appeared to occur if anxiety was regarded as something that is 'experienced' and cite Bruner (1965) as identifying three levels of experiencing, the enactive, iconic, and symbolic. Sullivan (1953) identified three modes of experience, the prototaxic, the parataxic, and the syntaxic, all of which are applicable to infant development. The prototaxic mode refers to the first kind of experience an infant has where there is no sense of past and future and the infant is not aware of being a separate entity from the rest of the world. In the parataxic mode, awareness of various experiences is developed although there is no logical thought to relate or connect experiences and they tend to exist as a

series of unrelated events. In the final syntaxic mode the child learns consensually validated symbol activity and begins an appreciation of language in its widest sense. In contrast, Freud (1949) organised stages of experiencing in terms of different bodily systems and satisfactions associated with them, while Berlyne (1957) identified a sensori-motor, a perceptual, and a conceptual stage of development.

Sullivan (1953), Freud (1949),and Berlyne (1957), viewed experiencing in developmentally determined hierarchical modes and independently achieved a level of agreement of the general nature of experiencing where the first level is represented by sensori-motor, physiological, and body responses, the intermediate level of experiencing by perceptual, preconceptual responses, heavily infused with idiosyncratic, egocentric meanings, and the third level represented by conceptual responses in which widely shared common symbols and meanings are utilised. Philips, Martin, and Meyers (1972) argued that since experiencing can be described in this way, these levels of experiencing may be applied to the experiencing of anxiety. Thus as an individual interacts with his or her environment, anxiety may be experienced in one or more of these modes of experiencing. The idiosyncratic character of experience, and its dependence on internal referents, means that anxiety in the second mode of experiencing is probably best revealed in projective and projective-like processes and materials .

The third level of experiencing involves conceptional functioning where symbolism and meaning are shared. According to Phillips, Martin and Meyers (1972), this level anxiety may be experienced as negative evaluations of self obsessive-compulsive thought processes, regressive behaviour, and other defensive tendencies.

In the following illustration Philips (1972) proposed a view of anxiety, which emphasised a number of the elements referred to above, including the trait and state components of anxiety as well as the different origins of these types of anxiety

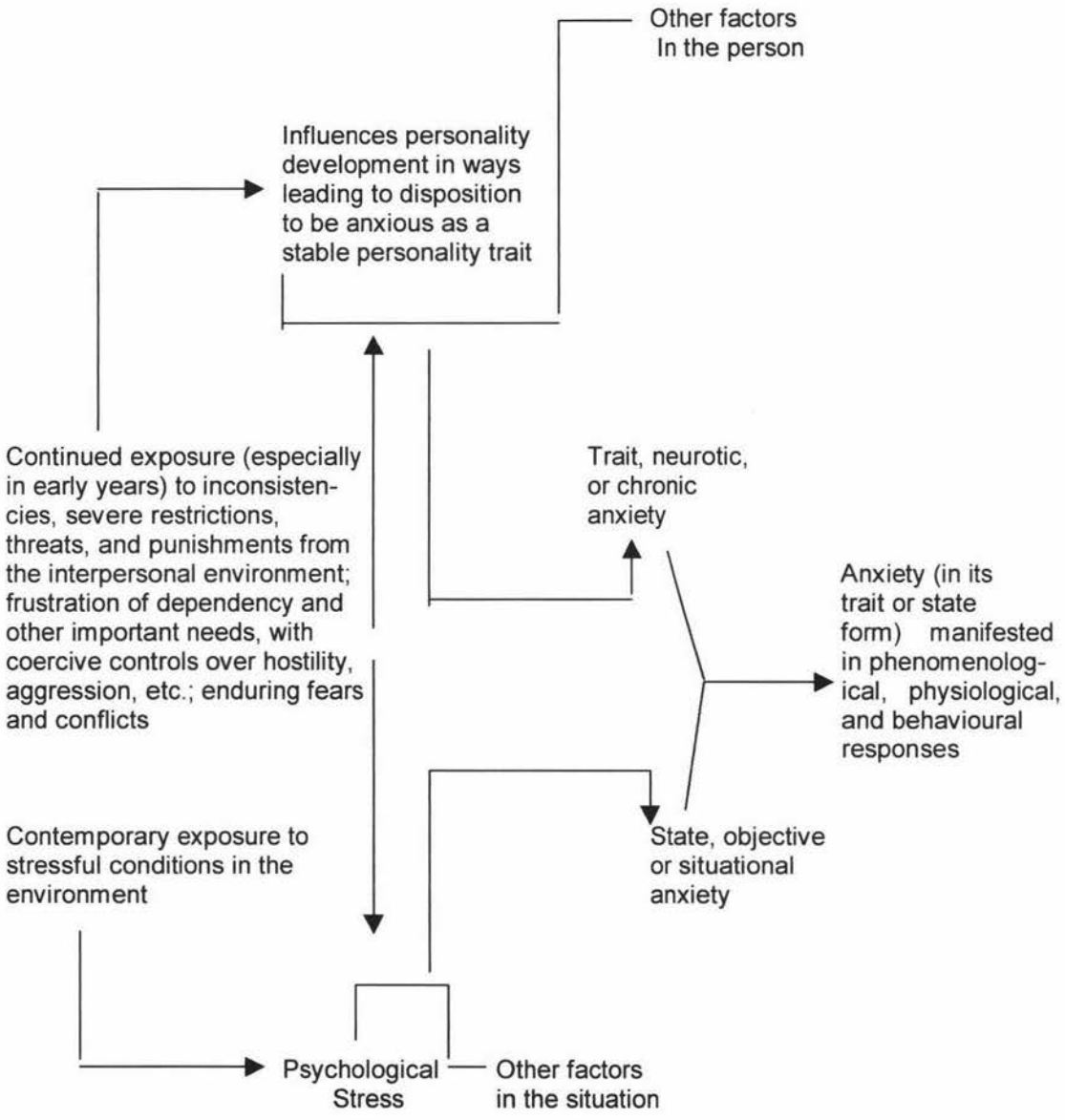

Figure 3. *A general developmental overview of the nature of anxiety*

From Phillips, Martin and Meyers (1972) cited in Spielberger (1972 p.414)

The diagram shows how general relationships, factors in persons and situations, and aspects of anxiety result in a general overview of anxiety.

The following illustration by Phillips, Martin, and Meyers (1972) shows the antecedents, concomitants and consequences of anxiety.

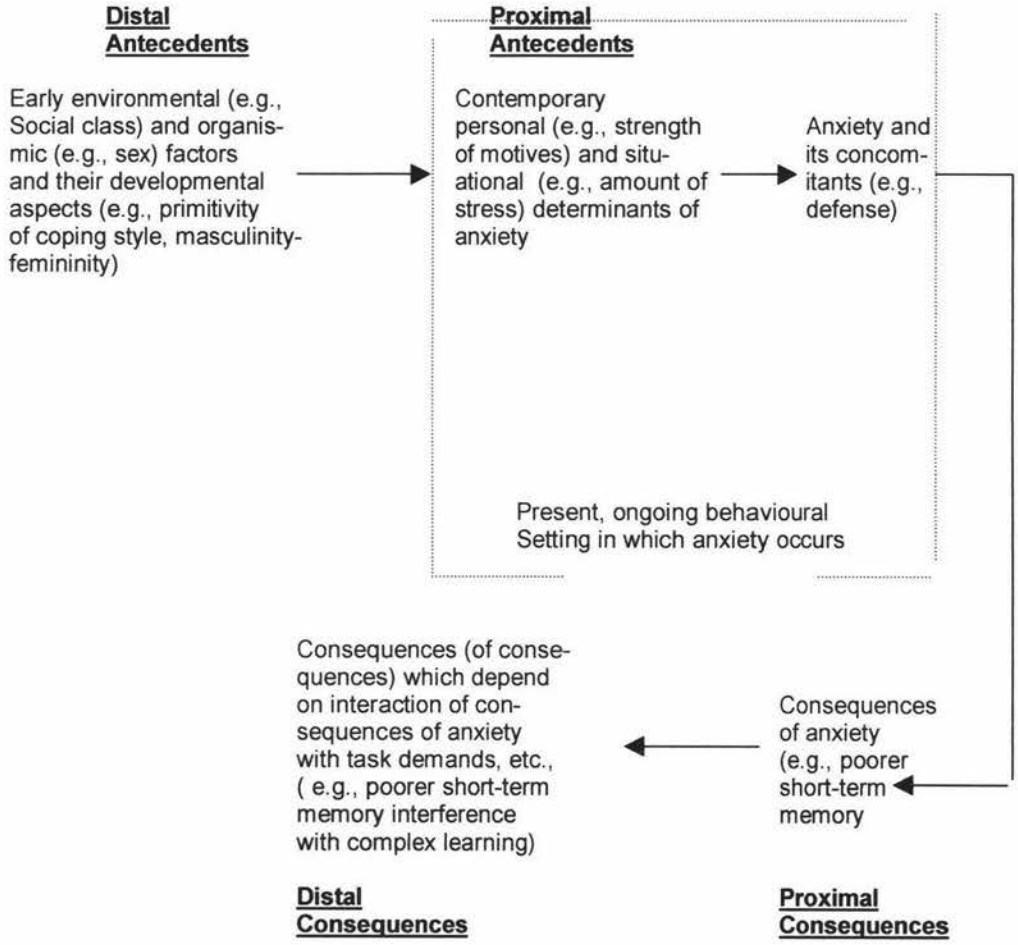

Figure 4. *A diagram showing the types of variables pertinent to a systematic consideration of anxiety. From Phillips, Martin, and Meyers (1972) cited in Spielberger (1972 p. 415)*

The antecedents are conceptualised on two levels: proximal and distal. The illustration shows the general relationships between different classes of variables and highlights aspects of potential interventions in relation to anxiety.

According to Phillips, Martin, and Meyers (1972), proximal antecedents are the factors which are immediately and directly responsible for causing anxiety reactions. The factors can be either associated with the particular, ongoing behavioural setting in which anxiety occurs or they may result directly from personal characteristics. Examples of proximal factors associated with behavioural situations are;

(a) Stress conditions, or conditions that lead to threatened deprivations of anticipated satisfactions.
(b) Ambiguity as to the nature of the threat.
(c) Situational constraints associated with psychological stress and threat.
(d) Power of harm producing factors in the environment (in relation to the perceived threat).
(e) Availability of increased interpersonal contacts, which enhance the possibility of mobilisation of resources.

Examples of proximal factors in persons, identified by Phillips, Martin, and Meyers (1972) include;

(a) Strength of the motive(s) endangered by stressful conditions.
(b) Conflicts engendered in the situation, e.g. where one of the goals pertinent to the situation is endangered by gratification of another goal.
(c) Degree of felt uncertainty about what can be done to cope with threat
(d) Degree of intolerance and ambiguity.

Distal antecedents on the other hand are identified by Phillips, Martin, and Meyers (1972) as being environmental or organismic factors that also contribute to anxiety reactions but in a more indirect way. They are responses to stress conditions and the perceived threats posed by these conditions. Some of the distal environmental factors identifies by Phillips, Martin, and Meyers include:

(a) Specific past experiences, especially in early life, in which important motives have been thwarted.
(b) Racial-ethnic minority status and /or lower social class status,
(c) Aspects of parent – child relationships.
(d) Pattern of socialisation of threat reactions.

(Phillips, Martin & Meyers,1972)

Distal organismic factors identified by Phillips, Martin, and Meyers include:

(a) Sex and sex role identification.
(b) Birth order.
(c) The individual's beliefs about the environment and their relationship to it.
(d) The individuals counterharm resources, for example intellectual capabilities.

(Phillips, martin & Meyers,1972)

Phillips, Martin, and Meyers (1972) recognised various concomitants of anxiety and categorised them in two primary groups of variables. The first group consists of factors which are directly associated with anxiety or are actual indicators of anxiety. These factors include; fear, guilt feelings and guilt proneness, emotional instability, and disposition towards being anxious, and various physiological reactions including; blood pressure. heart rate, skin conductance, muscular qualities, facial expressions, and speech disturbance. The second group consists of factors closely

associated with anxiety but which are usually never considered to be part of anxiety. This group includes; defensive tendencies (including the classic defence mechanisms), acquiescence, social desirability, cognitive avoidance, negative self-concept, preoccupation with the demands of self (rather than situational and task demands) and strong inhibitory tendencies.

The model proposes two distinct consequences of anxiety; proximal consequences and distal consequences. Phillips, Martin and Meyers (1972) associated the proximal consequences of anxiety and its concomitants with:

(a) Cautiousness, perseveration, rigidity, and stereotyped thinking.
(b) Dependency, direction-seeking, conforming tendencies.
(c) Reduced responsiveness to the environment.
(d) Interference with a variety of cognitive and meditational processes.
(e) Increased drive or motivational level.

Even more importance is placed on distal consequences since they depend on the interaction of the consequences of anxiety with situational demands. To illustrate this, Phillips, Martin and Meyers (1972) use the example of the effect of anxiety on short-term memory. A direct consequence of anxiety might be poorer short-term memory functioning. The relationship between anxiety and poor short-term memory in this case is an example of a proximal consequence. If consequently, the downgraded short-term memory proved deleterious to the performance of some essential task, the downgraded performance would be a distal consequence of anxiety. In other words it is a "consequence of a consequence". Rarely, a proximal consequence of anxiety may be associated with improved performance but usually the results are debilitating (Philips, Martin,& Meyers, 1972). Another example used by Phillips, Martin, and Meyers (1972) is that hostility and aggressive behaviour

may be a nonanxious reaction to stress but the reaction of others to this aggression and indeed the aggressors own guilt feelings about being aggressive may become the source of secondary anxiety and thus a distal antecedent of secondary anxiety. The example illustrates the complexity of anxiety relations and the difficulties confronting the anxiety researcher.

Examples of distal consequences include; deterioration in complex intellectual problem solving, achievement and learning activities, increased responsiveness to reinforcement, increased susceptibility to persuasion, and the behaviour of models, preoccupation with demands of self rather than the demands of learning situations, leading to reduced incidental learning, Increased isolation from others, with heightened affiliation needs, and enhanced learning of certain types of tasks.

As previously stated the causes, consequences and relationships of anxiety in its many forms are complex and Phillips, Martin and Meyers (1972) caution that the model is meant to be heuristic model designed to give an overview of the types of variables and the general relationships between different classes of variable.

Spielberger (1966) differentiated between anxiety as a transitory state (condition) that varies in intensity and fluctuates over time and anxiety as a personality trait (predisposition to being anxious). Spielberger (1966) cites the factor analytic studies of Cattell and Scheier (1961) and credits those researchers for identifying two distinct anxiety factors which they label trait anxiety (A–Trait), and state anxiety (A–State) on the basis of the procedures by which these factors were isolated and the variables which loaded on them. In the study the trait anxiety factor was interpreted as measuring stable individual differences in a unitary, relatively permanent personality characteristic. The state anxiety factor was based on a pattern of variables that covaried over occasions of

measurement, defining a transitory state of the organism. Spielberger (1966) suggested that trait anxiety reflected anxiety proneness which he defined as differences between individuals in the probability that anxiety states will be manifested under circumstances involving varying degrees of stress. Trait anxiety is assumed to reflect residues of past experiences that in some way determine individual differences in anxiety proneness. According to Spielberger (1966) those experiences might even date back to childhood and may involve parent-child relationships centring on punishment situations. Spielberger (1966) suggested that a person with elevated trait anxiety is more likely than the average person to respond with state anxiety and is also more likely to experience anxiety states than other people. An important consideration, however, is that even though a person may possess a high level of trait anxiety this does not necessarily translate into a high level of state anxiety unless the person interprets the present situation as being threatening or dangerous. This is attributed to the fact that people with extreme trait anxiety such as anxiety neurotics may have defences against anxiety and when occupied with non-threatening tasks or situations there may be diversion from the internal stimuli that otherwise would trigger state anxiety responses.

Spielberger (1966) uses the analogy of the physical concepts of kinetic energy and potential energy where state anxiety is a type of kinetic energy which is an empirical process or reaction that is taking place *now* at a given level of intensity. Trait anxiety fits the concept of potential energy and indicates a latent disposition for a reaction of a certain type if it is triggered by appropriate stressful stimuli. Spielberger concluded that anxiety as a personality trait implied a motive or acquired behavioural disposition that predisposed an individual to perceive a wide range of objectively non-dangerous circumstances as threatening, and to respond to these with state anxiety reactions disproportionate in intensity to

the magnitude of the objective danger. The predisposition to see things as threatening was an important qualification according to Spielberger who observed that the level of trait anxiety does not always influence state anxiety responses to all stimuli. Spielberger (1966) claimed that stimuli that had little or no threat value were unlikely to elicit a state anxiety response (A-STATE) while on the other hand, the threat of an objectively painful stimulus such as an electric shock may be sufficient to generate higher A-State responses in individuals irrespective of their level of trait anxiety (A-Trait).

Perhaps the most significant conclusion that Spielberger (1966) reached in his consideration of the trait-state conception of anxiety was that differences in task performance of individuals with high and low trait anxiety (A-TRAIT) were most often found under conditions of failure or ego-involvement or under circumstances which involve risk of failure such as in academic achievement situations.

It may be argued therefore that for the student pilot, A-Trait may be significant where there is a fear of failure motive such as when confronted with a flight test or other demanding training situations, where the student is being assessed or is expected to achieve a prescribed standard of performance. Under these conditions the student may perceive the circumstances to be challenging or threatening. This fear of failure leads to a consideration of the concept of "test anxiety".

2.2.3 Test Anxiety.

The research of Sarason and Mandler (1952; 1953) at Yale University in the early 1950s (cited in Spielberger, Gonzalez, & Fletcher, 1979) is an example of pioneering work on test anxiety, with most of the research being focused on academic performance

during tests and examinations at primary, secondary, and tertiary educational institutions. In a series of studies Sarason and Mandler demonstrated that test anxiety could lead to performance decrements in evaluative situations (Sarason & Mandler, 1952; 1953, cited in Spielberger, Gonzalez, & Fletcher, 1979).

Liebert and Morris (1967) introduced a two-component conceptualisation of anxiety which identified two major components of anxiety, worry and emotionality. Worry referred to the cognitive elements of the anxiety experience and included negative expectations and cognitive concerns about oneself, the situation at hand, and potential consequences. Emotionality referred to the individual's perception of the physiological-affective elements of the anxiety experience. This included awareness of the indications of autonomic arousal and the unpleasant feeling states of nervousness and tension. In a later development of the two-component anxiety concept, Wine (1971) attributed the debilitating effects of test anxiety on performance to attentional interference. She noted that high test-anxious students became pre-occupied with task-irrelevant worry responses during exams and did not devote enough time to the test-taking task. According to Hockey (1983) anxiety affects performance by producing changes in the selectivity and/or intensity of attention and as a consequence can affect the learning or acquisition of information as well as the retrieval of information such as in test or examination situations. Later researchers, Lyubomirsky and Nolen-Hoeksema (1995) argued that self-focusing or rumination can maintain or exacerbate dysphoria by enhancing the effects of a depressed mood on thinking and by interfering with good problem solving. A contemporary researcher, Soric' (1999) observed that situations of social evaluation (those situations in which either we, or our actions are evaluated, judged or observed by others) are by their nature usually very stressful. She attributed this to the fact that evaluations

are often used for the basis of selection and function as a filter for determining whether a student will advance or as a means of blocking those who do not meet the performance criteria. Soric''s research conducted on adolescents indicated that fear of negative evaluation was the main cause of stress in this period of life. A dynamic situation was identified where a student in an examination situation experiences test anxiety, gets poor marks and experiences the negative consequences of this which then functions as a confirmation of test anxiety in subsequent examination situations. The experience of stress then accumulates, generating more and more anxiety and bringing about a chronic loss of motivation. (Soric', 1999). Soric' (1999) reported significant gender differences in situations of social evaluation with females more likely to report psychological and physical symptoms. Wigfield and Eccles (1989, cited in Soric', 1999) observed that gender differences in anxiety scores may be due to boys' greater defensiveness about admitting anxiety. They suggest that boys and girls may become anxious for different reasons, or are anxious about different things.

As well as gender differences in social evaluation situations it has been suggested that language may be a significant factor where student pilots are concerned. The English language is the official language for all aviation communications and from research on training Korean military pilots transitioning to become civilian airline pilots, Cho (1998) indicated that ex-military pilots who speak English as a second language can experience anxiety and stress when communicating with foreign (English speaking) flight crew and ATC controllers.

2.2.4 The Interactional Model of Anxiety

Wine (1982) proposed that test anxiety should be conceptualised in terms of cognitive and attentional processes aroused in evaluational settings. An further interpretation of the interference model by Holroyd, Westbrook, Wolf, and Bodhorn (1978) proposed that test anxiety represented a problem of a broader behavioural scope than just the actual test situation and that the test-anxiety/academic performance relationship may also be influenced by study-related behaviour differences between high and low test-anxious individuals. Holroyds interpretation is congruent with Wittmaier (1972) who showed that high test-anxious students had significantly lower levels of study skill competence when compared to low test anxious students (Holroyd, Westbrook, Wolf, & Bodhorn, 1978).

Research by Culler and Holahan (1980) proposed a further interference model for test anxiety. According to this model anxiety produces task-irrelevant responses (concern about the outcome, thoughts of leaving, etc) during the test situation which interferes with the task-relevant responses necessary for good performance. Morris and Liebert (1970) cited in Culler and Holahan (1980) found a strong correlation between the cognitive component of anxiety (worry) and academic performance. Culler and Holahan's interference model assumed that test-anxiety is detrimental to performance during the actual test situation and that the anxiety will interfere with the student's ability to retrieve and use information.(Culler & Holahan, 1980) This view contrasts with that of Holroyd, Westbrook, Wolf, and Bodhorn (1978) who saw the problem of test-anxiety having a broader behavioural scope than the actual test situation.

Contemporary research has further enhanced the interference model of test-anxiety. The original observations made about test-

anxiety assumed a unidimensional relationship between test-anxiety and anxiety in general. Endler and Parker (1990) observed that a fundamental distinction needed to be made between state anxiety, which is a transitory and emotional condition, and trait anxiety, which is a stable personality characteristic regarding the potential for manifesting state anxiety, when measuring anxiety in general. Endler and Parker (1990) proposed an interactional model of anxiety, which emphasises the usefulness of distinguishing between state and trait anxiety, along with treating them both as multidimensional constructs. Sharing characteristics of the transactional model as described by Stokes and Kite (1994) the interactional model involved consideration of "person" factors and "situation" factors in predicting changes in state anxiety. The model proposed two components of state anxiety, cognitive-worry and autonomic-emotional. The dimensions of trait anxiety in the interactional model include;

(a) social evaluation (the test-anxiety situation), (b) physical danger, (c) ambiguous routines, and (d) daily routines.

The model suggests that state anxiety is a function of an interaction between a specific dimension of trait anxiety and a congruent threatening situation. The interaction model of anxiety thus acknowledges that people experience different levels of A-State in different situations by employing a situationally multidimensional conception of A-Trait.

The interactional model consists of a four-stage process. In the first stage individual variables such as trait anxiety, vulnerability, cognitive style, and heredity, interact with stress situations such as life experiences, crises, and traumas. The second stage induces a perception of threat or danger which leads to the third stage where this perception of threat causes an increase in state anxiety. The final stage involves reactions to the increases in state anxiety. These reactions can involve coping, biochemical reactions and physiological reactions which tend to reduce the state anxiety.

According to Endler and Parker (1990) the model emphasises the multi-directionality of the process with the different stages influencing each other in a feedback loop. The coping construct is an integral part of the model and can be conceptualised as both a consequence and an antecedent of state anxiety. This model is of particular interest because notwithstanding the generally accepted distinction of state-trait anxiety, the majority of research within the field of test anxiety considers test anxiety only as a state and largely ignores the trait anxiety construct.

2.2.5 Defining the Research Problem

Chapter One of this study referred to the various flight tests that student pilots undertake during the Massey University School of Aviation Flight Crew Major. Register, Beckham, May, and Gustafson (1991) found that up to 15% of High School students experience test anxiety in a stressor situation of a high school examination. It is suggested that both the interference model (Culler & Holahan, 1980) and the interaction model (Endler & Parker, 1990) can apply to flight tests in the same way as they are associated with academic tests and examinations. The flight test fits the description of a social evaluation situation as defined by Soric' (1999) in that the student pilot's actions are observed, evaluated, and judged by an independent observer (in this case a flight examiner). As in the case of a school examination the flight test itself can function as a filter for advancing the successful students and blocking the unsuccessful ones. A number of the student pilots who are candidates for a flight test will possibly find the experience stressful and in some cases, underachieving students may experience a chronic lack of motivation due to accumulating stress levels. As well as being subject to possibly stressful flight test situations, the student pilot experiences a social evaluation situation every time a dual training sortie is undertaken.

While the earthbound school or tertiary student enjoys relative anonymity in a classroom situation even during a test or examination, the aviation student is required to perform and achieve on every dual airborne training sortie. During the flight the student pilot will be expected to meet several performance criteria and the outcome of the flight will determine whether the student progresses. The student is therefore subject to evaluation on every training flight and may arguably experience similar stressors that are present during a flight test.

The previous sections of this study focused on the influence of anxiety on the effectiveness of flight training. A review of the flight training manuals commonly used by instructors and students indicated that the physiological effects of airborne instruction were often emphasised with little or no acknowledgement of the physiological effects. An analysis of the basic flying skills a student pilot needs to master, identified a series of cognitive and psychomotor abilities that are affected by stress and anxiety. While the importance of psychomotor skills diminishes as air transport aircraft become more highly automated, the student pilot still has to develop these skills during flight training. Underlying both flight training, and the operation of air transport aircraft, are cognitive skills which, it may be argued, become more challenged as the size and complexity of aircraft and their operation increases, notwithstanding the increase in automation. The literature reviewed clarified the constructs of stress, fear, and anxiety and their relationship with each other. The literature also indicated that stress and anxiety adversely affect the cognitive skills associated with aircraft operation with a consequent downgrading of pilot performance. The constructs of state and trait anxiety and the worry and emotionality components developed by Liebert and Morris (1967) was used as the basis for this research into test anxiety. (See figures 3 and 4) A significant portion of the non-aviation literature reviewed examined the relationship between

these constructs and human performance in evaluative situations. Most of this literature was concerned with the performance of secondary and tertiary students undergoing academic examinations. Central to this present study is the effect of anxiety on student performance when being evaluated in the aviation context.

The student pilot on a structured flight training course is under evaluation during a series of formal flight tests, which are scheduled throughout the course. It is suggested also that each dual training flight is similar to a formal flight test in that the student is evaluated and receives feedback and/or a grading on his or her performance during that flight. The outcome of the flight test or evaluated lesson has a direct effect on the student's wellbeing as it will determine progress onto the next phase or lesson, a retest or repeat of the lesson, or more tangibly, marks or grades that will contribute to final results. This study therefore focuses on practical tests and assessments conducted in the setting of a highly structured aviation course rather than the traditional educational settings and academic examinations referred to in the literature review.

The specific research questions generated by the study are:

(a) How does anxiety influence the student pilot's performance during flight training?

(b) Does gender and language affect the student pilot's disposition to trait and state anxiety?

(c) Do formally evaluated flight training exercises cause more anxiety in student pilots than non-evaluated flight exercises?

(d) Do flight tests cause changes in the worry and emotionality components of test anxiety in student pilots?

(e) Does the student pilot's predisposition to trait anxiety affect state anxiety levels during flight tests?

Chapter Three

METHODOLOGY

3.0 Subjects

The population for the study consisted of undergraduates from the Massey University School of Aviation's Palmerston North and Albany campuses who were enrolled in the Bachelor of Aviation Flight Crew Programme.

The Bachelor of Aviation programme caters for relatively small numbers of students with bi-annual intakes of between 10 and 35 students. Successive intakes of students were invited to take part in the study over a period of 5 years in order to build a moderate sample size.

The subjects were predominantly young male adults who, as a prerequisite to being accepted on the course, were required to meet the stringent CAA medical standards for the issue of a Class 1 Aviation Medical Certificate. All subjects were required to meet the standard university entrance qualifications and have English language competency to a minimum level of 550 TOEFL (Princeton Test of English as a Foreign Language) or 6.0 IELTS (International English Language Testing System). The flight training practicum component of the course involved course fees in excess of $60,000, making the Bachelor of Aviation Flight Crew major one of the more expensive courses offered by the University. The majority of the subjects aspired to become professional airline pilots after their training. Participation in the study was voluntary and the subjects were able to withdraw from the study at any time. During the study none of the students declined to participate and no students withdrew from the study.

3.1 Characteristics of Sample

3.1.1 Gender

Table 1. Gender

Total	Male	Female	Missing
220	175 (87.1%)	21 (10.1%)	24

3.1.2 Age

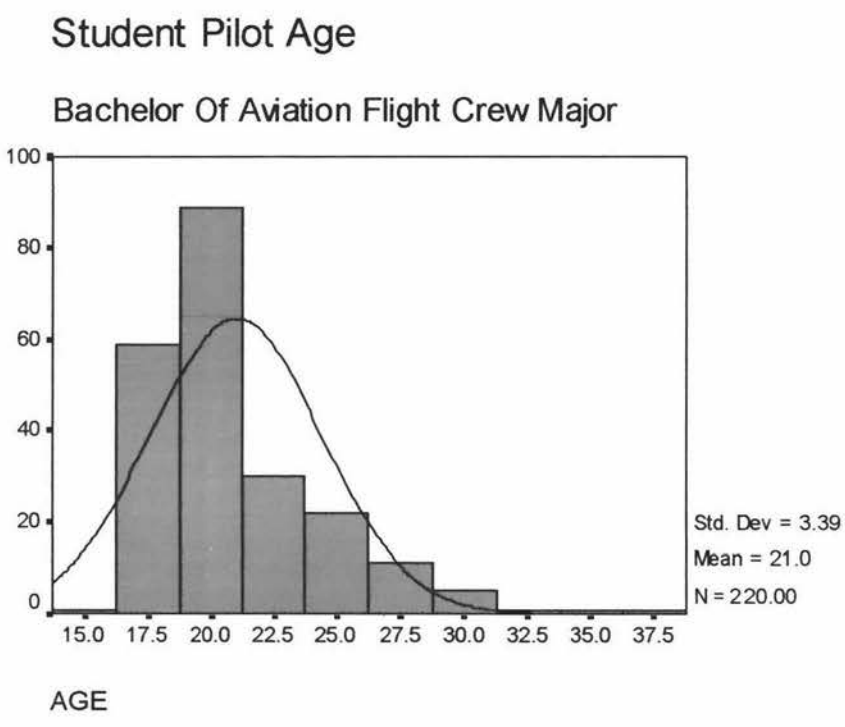

Figure 5

3.1.3 Language

The students originated from Australasia and from a variety of Asian and Polynesian countries. Learning difficulties experienced by Chinese and Indonesian Airline Pilot Trainees previously enrolled at the School of Aviation indicated that the lack of proficiency with the English language was a significant impediment to flight training. It was decided that for the purposes of the present study, students would be classified according to whether English was their first or second language. A large proportion of the B Av. Students enrolled on the course were not primarily English speakers.

Table 2. Language

Total	English first	English second
231	143 (61.9%)	88 (38.1%)

3.2 Test Instruments

De Montalk (1997) in a pilot study on anxiety in student pilots suggested that the State-Trait Anxiety Inventory Questionnaire developed by Spielberger, Gorsuch, and Lushene (1970) for measuring state-trait anxiety in high school and college students and also successfully applied to medical patients and prisoners, could be used for student pilots, with some minor modifications to update the language. The suitability of Spielberger's State-Trait Anxiety Inventory was reinforced by the observations of Kline (1995) who reported that Spielberger's trait scale correlated highly with two other anxiety scales, Cattell and Scheier's IPAT anxiety scale (Cattell & Scheier, 1963) and Taylor's Manifest Anxiety Scale (Taylor, 1953), between .75 and .85. He therefore concluded that the STAI trait test was valid. However, he had some reservations about the state anxiety scale concluding that the evidence for its validity was not unequivocal (Kline, 1995). Spielberger, Gorsuch, and Lushene (1970) had set out to demonstrate how state anxiety scores increased under stressful conditions. For ethical reasons, it was not possible to induce true stress into the test situation but students were asked to respond as if they were taking a stressful examination. Kline (1995) concluded that this experiment was unconvincing but as an overall assessment stated;

> As a quick and easy measure of state and trait anxiety, Spielberger's STAI would appear about as good as you can get.[p.478]

The anxiety measuring instruments consisted of a trait anxiety questionnaire developed from Spielberger's STAI questionnaire (Spielberger, Gorsuch, & Lushene, 1970) identified as the "A-

TRAIT FORM", and two state anxiety questionnaires, derived from Spielberger's STAI FORM X-1, to be administered pre and post a specific flight training event (Spielberger, Gorsuch, & Lushene, 1970). These were labelled A-State FORM 1 and A-State FORM 2 respectively. Three further research questionnaires were developed independently of the STAI. The first of these questionnaires, consisted of an eighteen-item worry inventory (WINV), in which student pilot's concerns associated with flight training or the prospect of flight training were recorded. The second instrument consisted of an Anxiety Situation Questionnaire (ASQ) in which the WINV categories were elaborated into categories with subcomponents explicating the students concerns. The final instrument was a biographical questionnaire from which data such as the respondent's name, age, gender, ethnicity, present instructors name, number of instructor changes throughout training, hours to first solo, and previous flying experience were determined.

3.2.1 The Measurement of Trait Anxiety

The A-TRAIT FORM was derived from STAI FORM X-2 by modifying the wording of some of the questions as indicated below. The changes were made where necessary to modernise and de-Americanise the language without loosing their original meanings. For example item #15 of the STAI FORM X 2 *"I feel blue"* was changed to *"I feel depressed"* as the original statement was meaningless to a large number of non-American respondents. The following table gives a comparison between the STAI FORM X-2 and the Massey A-TRAIT FORM:

STAI FORM X-2	A-TRAIT FORM
1. I feel calm	
2. I tire quickly	
3. I feel like crying	
4. I wish I could be as happy as others seem to be	**Other people seem to enjoy life more than me**
5. I am losing out on things because I can't make up my mind soon enough	**I lose out on things because can't make up my mind quickly**
6. I feel rested	
7. I am "calm, cool, and collected"	
8. I feel that difficulties are piling up so that I cannot overcome them	**I feel that difficulties pile up on me**
9. I worry too much over something that really doesn't matter	**I worry over insignificant things**
10. I am happy	
11. I am inclined to take things hard	
12. I lack self-confidence	
13. I feel secure	
14. I try to avoid a crisis or difficulty	
15. I feel blue	**I feel depressed**
16. I am content	
17. Some unimportant thought runs through my mind and bothers me	**Unimportant thoughts occupy my mind**
18. I take disappointments so keenly that I can't put them out of my mind	**I can't put disappointments out of my mind**
19. I am a steady person	
20. I get in a state of tension or turmoil as I think over my recent concerns and interests	**I get tense when I think of recent events**

Figure 6

The bold statements in the right hand column are the modified statements. In the blank spaces in the table the original questions were recorded verbatim. The original STAI FORM X-2 responses are graded on a four-point scale as follows: (1) Almost never. (2) Sometimes. (3) Often. (4) Almost always. This was changed to a five-point Likert-type scale for the A-TRAIT FORM responses to give a the students an opportunity for a neutral response if required, as follows: Almost never. (2) Infrequently. (3) On occasion. (4) Frequently (5) Almost always

In order to reduce the potential influence of an acquiescence set during responses (Spielberger, Gorsuch, & Lushene, 1970), both the STAI questionnaires were balanced as much as possible by having high ratings indicating both high and low anxiety. For a perfect balance it would be desirable to have equal numbers in each

questionnaire. A 10/10 balance was achieved in the A-STATE questionnaires with a balance of 13/7 in the A-TRAIT. This procedure was preserved when the STAI questionnaires were modified. Scores were later re-coded when appropriate so that a high rating indicated high anxiety. Internal reliability of the twenty-item scale was assessed using the Cronbach alpha technique. The scale produced a standardised item alpha of .8802, which is acceptable. (Burns, 2000).

3.2.2 The Measurement of State Anxiety

A-STATE FORMS 1 and 2 were developed from the STAI FORM X-1 modified as indicated by the table below. As in the case of the A-TRAIT FORM some of the questions were modified to avoid American colloquialisms. Questions 4 and 7 were modified to relate the questionnaire to a test situation. Because A-STATE FORM 1 was designed for administration before a test and A-STATE FORM 2, post test; the tense was altered when appropriate to reflect this.

STAI FORM X-1	A-STATE FORM 1	A-STATE FORM 2
1 . I feel calm		
2. I feel secure		
3. I am tense		
4. I am regretful	**I worry about doing this test**	**I am worried about the test outcome**
5. I feel at ease		
6. I feel upset		
7. I am presently worrying over possible misfortunes	**I worry about not doing well**	**I feel I could have done better**
8. I feel rested		
9. I feel anxious		
10. I feel comfortable		
11. I feel self-confident	**I feel confident**	**Same**
12. I feel nervous		
13. I am jittery		
14. I feel "high-strung"	**I feel uptight**	**Same**
15. I am relaxed		
16. I feel content		
17. I am worried		
18. I feel over-excited and "rattled"	**I feel over-excited**	**Same**
19. I feel joyful	**I feel happy**	**Same**
20. I feel pleasant		

Figure 7

The bold statements in the right hand column are the modified statements. The blank spaces in A-STATE FORM 1 and A-STATE FORM 2 indicate that the statements are unchanged. Internal reliability of the twenty-item scale was assessed using the Cronbach alpha technique producing a standardised item alpha of .9065, which is acceptable. (Burns, 2000)

The required responses to the A-STATE FORM 1 and 2 were:
(1) Very much so. (2) Considerably. (3) Moderately so.
(4) Somewhat. (5) Not at all.

3.2.3 Classification of Anxiety Inducing Factors in Flight Training

3.2.3.1 The WINV Questionnaire

The WINV questionnaire was developed from the work of an expert focus group. This group was comprised of senior flight instructors assigned to the B Av. programme and typically these instructors held either A or B category instructor qualifications and had at least five years instructional experience with a minimum of two years experience as flight instructors on the B Av. Programme. The group used a brainstorming technique to identify possible causes of anxiety in student pilots. Further causes of anxiety were identified from student training records. The records were maintained by the instructors and indicated problem areas affecting progress and performance together with an analysis of causes and possible remedies. From this information, specific anxiety-inducing factors were identified, and a general inventory of factors detrimental to the process of learning to fly was compiled. The stressors identified proved to be remarkably similar to those identified by 18 American flight instructors and used by Grandchamp (1971) as part of his research with student pilots.

For comparison both are reproduced below:

Grandchamp	**Massey**
Fear of:	**Concern about:**
Being tested or evaluated	Flight test stress Flight test performance The first solo flight
Injury	Perceived risks and dangers
Mechanical failure	In-flight emergencies Manoeuvres
The flight instructor	Instructor changes Instructor/student relationships
Inability to use radio	Using the aircraft radio Aviation terminology
Becoming lost	Cross country flying
Forgetting procedures	Busy airspace
Financial constraints	Cost
Fatigue	Domestic life Academic workload
Excessive heat Excessive noise Electric shock Height Poor airplane design Becoming ill in flight Violating air regulations Failure The unknown Appearing stupid or slow learning Adverse weather	The difficulties of learning to fly
	Holding an aviation medical

Figure 8

From the areas of concern identified by the Massey instructors, items were developed to measure the relative importance of those factors to the student's overall level of anxiety. The tables below show the worry factor questions that were derived from the concerns identified by the Massey instructors and the final worry inventory (WINV).

CONCERN ABOUT	FACTOR
The difficulties of learning to fly	I think flying is a high risk activity
The difficulties of learning to fly	I think that learning to fly is a difficult task
Using the aircraft radio	I think that using the aircraft radio is a difficult task
Instructor/student relationships	I do not get on well with my instructor
First solo flight	The idea of making my first solo flight worries me
Manoeuvres	Aircraft manoeuvres such as stalling and steep turn worry me
Aviation terminology	I find aviation terminology confusing
Cost	The financial cost of learning to fly worries me
Medical	The idea of losing my medical worries me
Flight test stress	The idea of having to do a flight test worries me
Instructor changes	The idea of having an instructor change worries me
Flight test performance	I worry about having my flying assessed by a flight examiner
Instructor/student relationships	I worry about having to fly with the CFI
Cross country flights	The idea of doing cross country flights worries me
In-flight emergencies	The possibility of an engine or systems failure worries me
Busy airspace	I worry about having to fly in busy airspace
Academic workload	The workload of my academic studies affects my flying
Domestic life	Everyday domestic pressures affects my flying

Figure 9

WINV

1) I think that learning to fly is a high risk activity
2) I think that learning to fly is a difficult task
3) I find that using an aircraft radio is a difficult task
4) I do not get on well with my instructor
5) The idea of making my first solo flight worries me
6) Aircraft manoeuvres such as stalling and steep turns worry me
7) I find aviation terminology confusing
8) The financial cost of learning to fly worries me
9) The idea of losing my medical worries me
10) The idea of having to do a flight test worries me
11) The idea of having an instructor change worries me
12) I worry about having my flying assessed by a flight testing officer
13) I worry about having to fly with the CFI
14) The idea of doing cross country flights solo worries me
15) The possibility of an engine or systems failure worries me
16) I worry about having to fly in busy airspace
17) The workload of my academic studies affects my flying
18) Everyday domestic pressures affects my flying

Figure 10

The WINV questionnaire consisted of the above eighteen statements about *"my concerns about learning to fly"* to which the student responded by indicating:

Strongly agree	=	*1*
Agree	=	*2*
Neither agree or disagree	=	*3*
Disagree	=	*4*
Strongly disagree	=	*5*

The student's responses were then recoded so that a high score indicated strong agreement with the statement. Internal reliability of the eighteen-item scale was assessed using the Cronbach alpha technique producing a standardised item alpha of .8188 which is satisfactory. (Burns, 2000)

3.2.3.2 The Anxiety Situation Questionnaire

The ASQ Form 2 was developed from the WINV to probe further the causes of anxiety, worry, or concern in the student pilots.
This was achieved by elaborating the WINV categories into a series of sub components so that a specific cause of the anxiety could be identified. The sub components were identified from feedback obtained from the student progress and flight test reports compiled by Massey instructors and flight examiners and *a priori* knowledge of student concerns and worries observed over the ten-year life of the School of Aviation.

The ASQ responses coded on a five-point scale as follows:
Unconcerned =1
Occasionally concerned = 2
Concerned = 3
Often concerned = 4
Very concerned = 5

The ASQ consisted of the following 17 statements and responses.
As with the previous questionnaires the internal reliability of each item was assessed using the Cronbach alpha technique.

Q1 *The difficulties of learning to fly worry me because:*

1)	I do not seem to have a natural aptitude for flying
2)	I do not seem to be progressing as well as others on my course
3)	I am not confident of attaining the high standards required to pass the flight tests
4)	I have a large financial commitment to the course
5)	I may not be able to find employment after the course

Figure 11 α = **.5270**

Q2 *The risks and dangers of learning to fly worry me because:*

1)	I may cause harm to myself or others as a result of a flying accident
2)	I might damage an aircraft as a result of an accident or mishandling
3)	I would suffer humiliation and embarrassment if I was responsible for an accident
4)	A training accident would be detrimental to my career

Figure 12 α = **.7489**

Q3 *Using the aircraft radio worries me because:*

1)	It distracts me from flying the aircraft
2)	I have difficulty in understanding what is being said
3)	I have difficulty remembering what to say
4)	I feel self-conscious about using the radio
5)	I feel embarrassed about making mistakes on the radio

Figure 13 α = **.7269**

Q4 *The things that concern me about the cost of learning to fly are:*

1)	I may not have enough money to finish the course
2)	I can only afford the minimum hours
3)	I may not be able to repay my loans
4)	Financial worries distract me from my flying and studies
5)	I feel that wealthier students have a greater advantage when doing this course

Figure 14. α= **.7810**

Q5 *I find it stressful when I have to fly with another instructor because*:

1)	Other instructors are more critical than my own
2)	I don't like revealing the weaknesses in my flying to other instructors
3)	I feel disadvantaged as the instructors favour their regular students
4)	I dislike change of any sort

Figure 15 α = **.6894**

Q6 *I find it difficult to give my best performance during a flight test because:*

1.	I feel inadequate when I have to demonstrate my skill to an experienced person
2.	I feel I may not be able to reach the high standards required
3.	My performance may compare unfavourably with others
4.	The flight-testing officer can influence my aviation career
5.	I worry about being assessed by someone other than my regular instructor

Figure 16 α = **.7524**

Q7 *My relationship with my instructor concerns me at times because:*

1.	My instructor seems to favour the higher achieving students on my course
2.	I feel that I let my instructor down when I can't meet the high standards that are set
3.	I feel embarrassed when I make errors when flying with my instructor
4.	My instructor can influence the successful outcome of my training and my future aviation career
5.	Our personalities seem to differ unfavourably

Figure 17 α = **.7165**

Q8 *I find training manoeuvres that involve extreme attitudes distressing because:*

1.	I feel I may loose control of the aircraft
2.	I may become airsick
3.	My instructor might see that I am afraid and nervous
4.	I have concerns about the structural integrity of the aircraft
5.	My fellow students might see how nervous I am

Figure 18 α = **.5880**

Q9 *I am concerned about my first solo flight because:*

1.	If I 'blow it" I might harm myself or the aircraft
2.	My Instructor might make me go solo before I feel confident
3.	I might take longer to go solo than others on my course
4.	I might not be able to reach the standard required
5.	I am not confident my instructor can judge when I am ready to go solo

Figure 19 α = **.7149**

Q10 *learning and using aviation terminology can be stressful because*:

1.	I might look foolish if I use the wrong terminology
2.	I may not understand what my instructor is saying at times
3.	I may not understand what the air traffic controllers are saying at times
4.	I would not like my fellow students to know that I did not understand the terminology completely

Figure 20 α = **.7511**

Q11 Flight tests are a stressful experience for me because:

1.	I may not be able to meet the required standard
2.	I will be faced with the additional cost of fees and training if I am unsuccessful the first time
3.	I will let my instructor down if I fail
4.	I worry what my fellow students will think if I fail
5.	Failure of a flight test may disadvantage my career prospects

Figure 21 α **= .7776**

Q12 *Operating in busy airspace concerns me because:*

1.	There is a possibility of a collision with another aircraft
2.	Any errors I make can have serious consequences
3.	I may not be able to handle some of the situations
4.	I might make embarrassing mistakes in the presence of other pilots

Figure 22 α **= .7499**

Q13 *I find the workload of my academic studies affects my flying because:*

1.	I have a large number of subjects that I have to learn
2.	I have to concentrate on my ground subjects to the detriment of my flying training
3.	My academic workload is higher than my flying workload
4.	The irregular hours rostered for flying disrupts my study plans

Figure 23 α **= .7499**

Q14 *My domestic life interferes with my flying training sometimes because:*

1.	I find it difficult adjusting to living away from home
2.	Domestic matters take up a lot of my time
3.	There is a lack of money for living expenses
4.	I need part time work in order to live and this can conflict with my studies

Figure 24 α = **.6036**

Q15 *Keeping a flying medical concerns me because:*

1.	Loosing my medical would mean the end of my flying career
2.	My feelings when I am due for a medical can be described as:
3.	I would lose a large financial investment if I lost my medical
4.	It is difficult to remain medically fit as one ages

Figure 25 α = **.8115**

Q 16 *I worry about the possibility of an in-flight emergency. I am particularly concerned because:*

1.	Aircraft are inherently unreliable
2.	The consequences of an in-flight emergency are more serious than with other forms of transport
3.	Injury or death may be the result
4.	I may not have the skill to handle the situation
5.	The emergency may be the result of my own incompetence

Figure 26 α = **.7671**

Q 17 *Cross-country flights can be stressful and I find that I am concerned about:*

1.	Becoming lost or disorientated
2.	Inadvertently entering controlled airspace without a clearance
3.	Encountering weather conditions that I cannot cope with
4.	Experiencing an engine failure of other emergency
5.	Looking foolish if I do not reach my destination

Figure 27 α = **.8177**

3.2.3.3 Identifying the Worry and Emotionality Components of State and Trait anxiety

Liebert and Morris (1967) distinguished between worry and emotionality as components of anxiety. Using Liebert and Morris' definition of worry as a cognitively focused component of anxiety, characterised by concern about one's performance, negative task-expectations and negative self-evaluations, and emotionality being the autonomic arousal aspect of anxiety, it was possible to identify these specific elements in the state and trait anxiety questionnaires (Liebert & Morris, 1967).

From the A-TRAIT FORM, the statements # 4, 5, 8, 9, 13, 14, 17, 18, and 20 were identified as fitting Liebert and Morris's definition of "worry" while the balance of the statements conformed to their concept of "emotionality". By a similar inspection, the "worry" components of A-STATE FORM 1 and 2 were identified as statements # 4, 7, 11, and 17, with the remaining statements being associated with emotionality.

The following tables show the worry components of the A-TRAIT and A-STATE forms:

Table 3. A-TRAIT

4.	Worry about other peoples perceived enjoyment of life
5.	Worry about not being able to make up one's mind quickly
8.	Worry about overwhelming difficulties
9.	Worry about insignificant things
12.	Worry about confidence level
13.	Worry about security
14.	Worry about being involved in difficulties or crisis
17.	Worry about trivial things
18.	Worry about past experiences
20.	Worry about recent events

Table 4. A-STATE FORM 1 and 2

4.	Worry about test participation (FORM 1), test outcome (FORM 2)
7.	Worry about test performance (FORM 1), underachieving (FORM 2)
11.	Confidence level
17.	Admission of feeling worried

A reliability analysis of the Trait and State worry components revealed a standardised α of .8150 and .8076 respectively while the emotionality components were .7907 and .8713 respectively

3.2.3.4 Developing an Interactional Aviation Anxiety Model.

An objective of the research was to develop an interactional anxiety model based on Endler's model that would measure the effect of both state and trait anxiety on the aviation students overall test anxiety (Endler & Parker, 1990). This model identified "person" factors and "situational" factors as predictors of change in state anxiety. Using the individual response statements from SSQ Form 2, classifications were made according to whether the statements were identified as "internal" (personal) or "situational". Items classified as "internal" were associated with trait anxiety while "situational" items were related to state anxiety. The internal factors were the questionnaire items concerning personal attitudes, fears, and worries, in other words internalised attitudes and feelings, of a stable and enduring nature, that is, trait anxiety. The situational factors were external or environmental factors identified by the

questionnaire that related to items external to the respondent and which produced transitory or state anxiety in response to perceived threats and dangers.

Using Q1 of the SSQ Form 2 as an example, the following classifications are made to illustrate how the internal or situational factors can be identified:

Q1 The difficulties of learning to fly worry me because:

1. I do not seem to have a natural aptitude for flying.

   This response is classified as internal and respondents scoring highly on this statement would indicate a high level of concern about their natural ability. Being an internal factor associated with self-confidence it would contribute towards trait anxiety and thus be of an enduring or stable nature

2. I do not seem to be progressing as well as others on my course.

   This response is typical of a situational or environmental response associated with state anxiety. The respondent is reacting to a perceived external situation. If the respondent considered that others on the course were progressing at a greater rate, this could cause an increase in state anxiety. Conversely, if others on the course were perceived as not doing so well as the respondent the corresponding state anxiety level may be lower. Situational or environmental threats may be seen as being beyond the respondent's control.

3. I am not confident of attaining the high standards required to pass the flight tests.

   (Internal) associated with trait anxiety

4. I have a large financial commitment to the course.

(Situational) associated with state anxiety

5. I might not be able to find employment after the course.

(Situational) associated with state anxiety

Items classified as internal are associated with trait anxiety and are likely to endure regardless of the circumstances while situational items effect state anxiety and can change frequently and rapidly as circumstances change.

It was found that the questionnaire items could further be classified into one of six groupings according to how they affected the internal or situational state of the respondent. For example in several of the questionnaire items, there was the reoccurring theme of "confidence" or consideration of the extent that the situation affects the respondent's self-confidence.

The other categories were:

- Control or the extent to which the candidate can influence the outcome of a situation
- Physical or the extent to which the respondents perceive they are exposed to physical threats such as death, injury, airsickness etc.
- Ego or the extent to which peer pressures and people relationships affect the respondent, as well as perceptions of how the respondent is viewed by others.
- Performance or how the respondent perceives he or she is coping with the task.
- Resource or the extent to which factors such as financial pressures affect the respondent.

Returning to the example of Q1, the statement can be coded as follows:

Table 5. Q1 Coding

Q1 The difficulties of learning to fly worry me because:

1. I do not seem to have a natural aptitude for flying
   INTERNAL. CONFIDENCE.
2. I do not seem to be progressing as well as others on my course
   SITUATIONAL. CONFIDENCE.
3. I am not confident of attaining the high standards required to pass the flight tests
   INTERNAL. CONFIDENCE.
4. I have a large financial commitment to the course
   SITUATIONAL. RESOURCE.
5. I may not be able to find employment after the course.
   SITUATIONAL. RESOURCE.

Ten scales were derived from the seventeen SSQ questions and tested for internal reliability.

Table 6. Internal reliability

INTERNAL. CONFIDENCE.	α = .7151
INTERNAL. PHYSICAL.	α = .7407
INTERNAL. EGO	α = .7950
INTERNAL. PERFORMANCE	α = .7596
SITUATIONAL. CONFIDENCE.	α = .6472
SITUATIONAL. PHYSICAL	α = .8080
SITUATIONAL. EGO.	α = .5147
SITUATIONAL. PERFORMANCE.	α = .8351
SITUATIONAL. CONTROL.	α = .6122
SITUATIONAL. RESOURCE.	α = .8600

Two further scales consisting of the sums of the internal factors scores and the situational scores respectively, gave a standardised α of .7845 and .8841.

3.3 Procedure

The study was completed in three stages. Stage one involved measuring the subject's trait anxiety level and identifying anxiety-causing factors that may affect the subject's performance during the course. Biographical data was also collected during this stage.

The second phase involved measuring state anxiety levels before and after nominated flight tests. Administered concurrently with the state anxiety questionnaire for the first flight test was an anxiety situation questionnaire (ASQ) designed to identify specific anxiety causing factors from the broader categories identified in the first stage. The final phase of the study involved measuring pre and post flight state anxiety scores during randomly selected pairs of dual training flights. The instructor would formally assess one of the training flights and allocate a grade, while the other flight would be conducted in the usual way with no formal assessment being made. The subject would be informed whether or not the flight would be assessed, immediately prior to the administration of anxiety questionnaire. The anxiety measuring instruments described in the preceding section were used to establish the subject's trait and state anxiety levels and to identify anxiety-causing factors. This data was then applied to the specific research questions generated by the study.

3.3.1 The A-TRAIT, WINV, and Biographical Data Questionnaires.

The A-TRAIT and WINV questionnaires and the biographical data questionnaire were administered by the student's flight instructor shortly after the beginning of the flight practicum programme. The

instructors were required to administer the questionnaires prior to the student achieving his or her first solo flight.
While not targeted to a specific flight lesson, the questionnaires were required to be completed as close as possible to the attainment of five hours of flight training.

With the mean time to first solo being established at 10.8 hours the five hour target meant that the students were well established in their training routine with the goal of the first solo flight firmly in sight. At the five-hour target it was considered that an instructor/student relationship would have been established and the student would have started to become comfortable with the sensation of flight and feel at home in the air.

The A-TRAIT questionnaire began with the following introduction:

INSTRUCTIONS:
This questionnaire includes a number of statements which may describe your feelings about how you feel about *life in general.*
Read each statement and indicate by marking the appropriate circle how you generally feel about things.
Do not spend too much time on any one statement but select the answer which seems best to describe your feelings.
There are no right or wrong answers.

Figure 28

3.3.2 The State Anxiety Questionnaires and ASQ.

A-STATE FORM 1, A-STATE FORM 2 and ASQ questionnaires were administered by a School of Aviation flight examiner. An A-STATE FORM 1 and ASQ was completed by the student immediately prior to departing for Flight Test 2 (FT 2) after being briefed by the examiner on the contents, form, and required competencies of the flight test. Successful completion of FT 2 would qualify the student for the issue of a private pilot licence, the privileges of which would entitle the holder to act as pilot in command of an aircraft carrying passengers. The FT 2 is normally

taken towards the end of the second semester when the student has almost completed his or her first year of the Bachelor of Aviation Programme. Typically, applicants for FT 2 would have gained around 80 hours flight experience including 25 hours pilot in command time. On completion of FT 2 and after being debriefed and informed of the test outcome the student was required to complete an A-STATE FORM 2 questionnaire. Similarly, A-STATE FORM 1 and A-STATE FORM 2 questionnaires were administered by the flight examiner pre and post FT 4 and FT 5. The A-STATE 1 questionnaire was introduced with the following instructions:

INSTRUCTIONS:
This questionnaire includes a number of statements which may describe your feelings about the *flight test you are about to undergo.*
Read each statement and indicate by marking the appropriate circle to indicate how you *feel at this moment about the test.*
Etc.

Figure 29

Similar instructions preceded the A-STATE 2 questionnaire.

INSTRUCTIONS:
This questionnaire includes a number of statements which may describe your feelings about how you feel about the *flight test you have just undertaken.*
Read each statement and indicate by marking the appropriate circle to indicate how you *feel at this moment now you have completed the test.*
Etc.

Figure 30

The ASQ instructions were as follows:

INSTRUCTIONS:
This questionnaire includes a number of statements which may describe your feelings about some of the problems and difficulties you may have encountered while learning to fly.
Read each statement and indicate *how you feel at this moment.*
Etc.

Figure 31

3.3.3 Random Administration of A-STATE Forms.

On two further occasions during the programme, the flight instructors were required to administer A-STATE questionnaires. This involved dual training flights rather than flight-tests, and were randomly selected by the student's instructor. On the first occasion, the student was given the A-STATE FORM 1 to complete after the pre-flight briefing and immediately before the flight. This form was designated (A) to distinguish it from subsequent tests. The A-STATE FORM 2 (B) was completed after the post-flight de brief.

On a second, randomly chosen training flight, the same student was given another A-STATE FORM 1 (C) to complete except on this occasion he or she was informed prior to completing the questionnaire that the instructor was going to formally assess the flight and allocate a grade. On completion of the flight and after being informed of the grade the student would complete the A-STATE FORM 2 (D).

Chapter Four

RESULTS

4.0 Data Analysis

The SPSS statistical package was used to examine data extracted from the questionnaires and the relationships between the observed variables.

Student performance, using dual hours to first solo and FT2 score as performance indicators, was evaluated by using descriptive statistics for calculating mean scores and standard deviations. The Pearson's correlation technique was used to examine correlations between Trait and State anxiety scores and hours to first solo and FT 2 scores. The Pearson Product Moment Correlation is an appropriate technique to determine the degree of relationship between two variables whose data have been collected on an interval scale (Hunt, 1984), and the Mann-Whitney U test was used to evaluate the effect of gender and language on trait and state anxiety scores. The Mann-Whitney U test is used when testing for differences between two independent groups when the measurement scale is ordinal and the paired sample t test is used when testing for significant differences between two samples which are related and are tested twice in a "before and after" situation with an intervention between the two occasions and when the data is parametric (Burns, 2000). A paired sample *t* test was used for evaluating the effect of a scored assessment on state anxiety scores recorded during a routine dual training flight.

4.1 The Relationship between Student Pilot Trait and State Anxiety and Student Performance

The first research question examined possible relationships between the student pilot's trait and state anxiety levels and their performance on the course as indicated by the amount of dual instruction received before they were authorised to make their first solo flights and the score they achieved on their FT 2.

4.1.1 Descriptive Statistics

In order to measure and compare student performance the following descriptive statistics were computed to determine mean dual hours to first solo and mean FT 2 score for the sample. The smaller sample size for the FT 2 score reflected the smaller number of students who had progressed to that point in their training.

Table 7. Hours to first solo – FT2 score

Dual hours to first solo	$\bar{X}$ = 10.83	SD = 3.67	N = 165
FT2 total score	$\bar{X}$ = 36.6	SD = 4.41	N = 116

Anxiety scores, both trait, and state for FT2 were then computed with the following results:

Table 8. Anxiety scores

Trait Anxiety	$\bar{X}$ = 44.17	SD = 11.1	N = 202
State pre-test	$\bar{X}$ = 57.16	SD = 11.62	N = 86
State post-test	$\bar{X}$ = 48.17	SD = 15.6	N = 87

4.1.2 The relationship between Performance and Anxiety

Pearson's correlation was computed to determine the relationship between trait anxiety score and hours to first solo and FT 2 score. No relationship was found between trait anxiety score and hours to first solo.

Table 9. Anxiety score – Hours to first solo

r = .088	df = 156	p =.27

Question 5 of the Worry Inventory (WINV) required the student to indicate to what extent they were worried about the prospect of making their first solo flight. As the WINV was completed prior to the student's first solo flight it was thought that a high score on this question may indicate that the prospect of first solo might constitute a stressor that could cause anxiety in the student and adversely affect his or her performance. When an attempt was made to correlate WINV Q.5 with hours to first solo, no discernible relationship was established.

Table 10. WINV – Hours to first solo

$r = .000$	$df = 158$	$p = 1.000$

Pearson's correlation technique was used to identify possible correlations between ASQ responses and hours to first solo. The ASQ contains the statement;

"I am concerned about making my first solo flight because":

The subject was required to respond, by indicating degree of concern on a five-point Liekert type scale, to a series of five statements covering possible student pilot concerns about making the first solo flight. Low correlations were found between the concern scale and hours to first solo indicating a weak relationship (See table 11).

Table 11. Student's concerns – Hours to first solo

$r = .245$	$df = 165$	$p = 0.01$

Standardised $\alpha = .7174$

Student – instructor relationships was another area explored by the ASQ statement;

" My relationship with my instructor concerns me at times because".

The subject was again given a set of five statements where degrees of concern about the subject of student, instructor relationships could be indicated on a five-point Liekert type scale. Low correlations were found between the instructor concern scale and hours to first solo (See table 12)..

Table 12. Instructor relationships – Hours to first solo

r = .364	df = 165	p = 0.01

Standardised α = .7180

A further ASQ response, which also indicated a weak relationship, was found when concern about learning and using aviation terminology was correlated with hours to first solo.

Table 13. Terminology – Hours to first solo

r = .243	df = 165	p = 0.01

Standardised α = .7549

The relationship between trait anxiety and pre-test and post-test state anxiety and FT 2 scores was then computed using Pearson's correlation. No relationship was found between trait anxiety or pre-test or post – test state anxiety and the FT 2 score.

Table 14. Anxiety – FT2 score

Trait Anxiety	r = - . 018	df = 110	p = 0. 852
State Pre - Test	r = . 006	df = 74	p = 0. 961
State Post - Test	r = - . 121	df = 75	p = 0. 294

4.1.3 The relationship between Gender and Anxiety

The Mann-Whitney U test was applied to determine if there was a statistically significant difference between male and female student's trait anxiety scores and pre and post FT 2 state anxiety scores. The test showed that there was no significant differences between male and female trait and state anxiety scores.

Table 15. Male and Female anxiety differences

Trait Anxiety	**U = 1752.0**	**P = .379**
State (pre-test)	**U = 243.5**	**P = .146**
State (post-test)	**U = 332.5**	**P = .485**

4.1.4 The relationship between Language and Anxiety

The Mann-Whitney U test was then applied to determine if there was a difference between English speaking students and students who used English as a second language, and anxiety. A significant difference was found between the language variable and trait anxiety. This indicated that students whose primary language was not English had significantly higher trait anxiety than their counterparts who used English as their first language. However there was no significant difference between the language variable and pre or post FT2 state anxiety.

Table 16. Language differences

Trait Anxiety	**U = 3347.5**	**P = . 001**
State (pre-test)	**U = 818.5**	**P = . 416**
State (post-test)	**U = 915.0**	**P = . 891**

4.2 The Relationship between Student Pilot pre and post-test State Anxiety and Evaluated and Non-Evaluated Dual Training Flights.

The second question was directed at routine dual training flights rather than formal flight tests and attempted to determine whether evaluated dual training flights cause more anxiety in student pilots than non-evaluated dual training flights. A paired sample *t* test (N = 48) was conducted to evaluate whether pre and post-state anxiety scores were significantly different between non-evaluated dual flights and dual flights with the intervention of a scored evaluation process administered by the flight instructor. The mean scores between pre-flight state anxiety tests (A and C) differed markedly with the pre-flight anxiety score being significantly higher on the assessed flight.

Table 17. Pre-flight anxiety – Assessed flights

$t = -3.060$	$df = 47$	$p = <0.005$

The mean post-flight state anxiety scores (B and D) also differed significantly with the mean post-test score being significantly higher on the assessed flight.

Table 18. Post-flight anxiety – Assessed flights

$t = -3.335$	$df = 47$	$p = <0.005$

The calculated effect size was .47, a medium value.

4.3 Changes in the worry and emotionality components of test anxiety as a result of undergoing a flight test.

The third research question attempted to identify changes in the worry and emotionality components of anxiety in student pilots as they underwent a flight test. Pearson's correlation technique was

used to examine the relationship between the worry and emotionality components of the state anxiety questionnaires and the total pre and post test state anxiety scores associated with FT2. A significant positive correlation was found between the worry components of A-State Form 1 and the total pre-FT2 state anxiety score indicating a marked relationship between pre-test worry levels and pre-test state anxiety levels. Similarly, a significant positive correlation was found between the post–test worry component and the post–test state anxiety level.

Table 19. Post-test worry – Post-test state anxiety

Pre-test state (w)	***r* = 0.78**	***df* = 86**	***p* = < .001**
Post-test state (w)	***r* = 0.74**	***df* = 87**	***p* = < .001**

When the emotionality components were compared a significant positive correlation was found between the pre-test emotionality component and the total pre-FT2 state anxiety score indicating a very strong relationship between pre-test emotionality and total pre-test state anxiety levels. Again, post-test emotionality scores correlated highly with the total post-test state anxiety score

Table 20. Post-test emotionality – Post-test state anxiety

Pre-test state (e)	***r* = 0.95**	***df* = 87**	***p* = < .001**
Post-test state (e)	***r* = 0.91**	***df* = 87**	***p* = < .001**

Pearson's correlation technique was then used to determine if there was a correlation between the worry and emotionality components of the trait anxiety questionnaire and the pre and post-test state anxiety scores for FT2.

There was no statistically significant relationship between the worry component of trait anxiety and the pre-test state anxiety score. There was however a low correlation between the worry component of the trait anxiety and the post-test state anxiety score indicating a weak relationship

Table 21. Worry –Post-test state anxiety

Pre-test trait (w)	$r = 0.17$	$df = 79$	$p = < 0.117$
Post-test trait (w)	$r = 0.29$	$df = 80$	$p = < .001$

Low correlations between the emotionality component of trait anxiety and the pre and post-test state anxiety scores also indicated weak relationships.

Table 22. Emotionality – Pre and post – test state anxiety

Pre-test trait (e)	$r = 0.31$	$df = 79$	$p = < .001$
Post-test trait (e)	$r = 0.22$	$df = 80$	$p = < .005$

A paired sample *t* test was conducted to evaluate whether worry and emotionality scores differed in a statistically significant way as a result of undergoing FT2. Significant differences were found between pre and post test worry scores and pre and post-test emotionality scores with the post-test mean scores being significantly less than the pre-test mean scores.

Table 23. Worry and emotionality – FT2

Pre-test and Post-test (w)	$t = 2.535$	$df = 86$	$p = < . 013$
Pre-test and Post-test (e)	$t = 6.575$	$df = 86$	$p = < . 001$

4.4 The relationship between a student's predisposition to trait anxiety and the state anxiety experienced during flight training.

The final research question was directed at determining if a student pilot's trait anxiety level had any effect on the state anxiety experienced by the student during a flight test. Pearson's correlation technique was used to establish the relationship between the trait anxiety and state anxiety experienced by a student pilot before and after a flight test. A high correlation was found between the total "person" factors (TINT) identified by the SSQ and the total

"situational" factors (SSIT) indicating a marked relationship between trait and state anxiety related factors

Table 24. Person factors – Situational factors

$r = .804$	$df = 124$	$p = < 0.01$

A paired samples *t* test (N = 86) was conducted to evaluate whether state anxiety scores differed after FT2 was carried out.
The mean scores between pre and post-tests differed significantly with the pre-test score being significantly higher than the post-test score.

Table 25. State anxiety scores – FT2

$t = 5.109$	$df = 85$	$p = < 0.01$

Using Pearson's correlation technique low correlations were found between TINT and total pre and post-test anxiety (TFT2A and FT2B) indicating a weak relationship between trait anxiety related factors and the state anxiety pre and post-test scores

Table 26. Trait anxiety scores – FT2

Pre-test	$r = 0.314$	$df = 70$	$p = < 0.01$
Post-test	$r = 0.254$	$df = 70$	$p = < 0.05$

A similarly weak relationship was observed between state anxiety related factors (SSIT) and the state anxiety pre and post-test scores

Table 27. SSIT – FT2

Pre-test	$r = 0.361$	$df = 84$	$p = < 0.01$
Post-test	$r = 0.258$	$df = 84$	$p = < 0.05$

Chapter Five

Discussion

5.0 Introduction

This chapter discusses the findings of the study and their implications and application to flight training and makes recommendations for future research in the area. The study set out to examine the effects of anxiety on human performance in the context of aviation students undergoing a pilot training programme as part of a university aviation degree. Recognising through the literature a considerable awareness of the effects of anxiety on learning, tests, examinations, and assessments in the context of general education at school and college level, the study attempts to determine the applicability of these effects to the aviation environment, an area in which considerably less research appears to have been undertaken.

5.0 The Relationship between Trait and State Anxiety and Student Performance.

Two benchmarks were chosen as indicators of the student pilot's performance, hours of dual instruction to first solo and FT 2 (PPL) marks. Hours to first solo is a traditional method of measuring a students aptitude in the initial stages of training and of his or her ability to a foreign and challenging environment. The next major event in the student pilots' career is the attainment of the Private Pilot Licence. In the Bachelor of Aviation programme the PPL is obtained by achieving a pass in FT 2 which is the second of a series of practicum events leading to the flight crew major. Because the CAA sets stringent standards for a pass grade in the PPL, practical

test scores obtained in FT 2 were considered to be an indication of pilot performance at that level.

The correlation between trait anxiety and hours to first solo failed to reach significance at the .05 level, thus the null hypothesis of no relationship between student pilot trait anxiety levels and the number of hours taken to first solo cannot be rejected. This finding supports Grandchamp (1971) who found in his study on student pilots' attitudes toward fear concepts in flight training, that attempts to correlate fear concepts with success or lack of success in learning to fly were inconclusive and statistically insignificant. Grandchamp used the same indicators of performance, hours to first solo and attainment of PPL in his study. During the pre-solo phase of training there is often competition among students to see who solos first. The dual hours to solo, taken by the earliest solo students, becomes a benchmark against which other students compare their own performance. While the events leading up to first solo flight are potentially stressful, therefore anxiety provoking, flight instructors are trained to minimise any adverse effects associated with the occasion. Campbell (1985) recommends:

> " It is advisable not to tell the student that you plan to send him on his 'first solo' flight until a few minutes before you do so. This is to avoid apprehension or a tendency for him to try too hard, which may detract from his performance". [p.14.2]

Responses from the WINV (completed at five hours dual instruction) and the ASQ (completed immediately before FT 2) however revealed that the students did have some concerns about how long they might take to solo compared with others on the course, not reaching the required standard, and their instructor's ability to determine when they were ready for solo flight. The other ASQ responses that indicated significant relationships (albeit weak), were

centred on instructor / student relationships. Again, there is some concurrence between this study and Grandchamp's findings.

Grandchamp (1971) concluded that there was a statistically significant high level of fear of the flight instructor and that the flight instructor was one of the most feared elements of the whole flight training process ahead of such constructs as fear of injury, fear of mechanical failure, and fear of weather. According to Grandchamp (1971) this fear of the flight instructor reduced dramatically after the first solo flight implying that the student pilots were only fearful when there was a need to be fearful such as on those occasions when they were most dependent on him or her. The weak relationship between student/instructor relationships and hours to first solo determined by the present study would suggest that the student/instructor relationship is important particularly at the start of the flight training and although this relationship has not been fully established by the study the influence of the instructor on the student's anxiety level cannot be discounted.

When hours to first solo was used as a performance indicator for examining the relationship between anxiety and performance, no relationship was established. Similarly no relationship was established between anxiety and FT 2 (PPL) scores. It was expected that student pilots with high anxiety scores would score lower marks in the test than those students with lower levels of anxiety. The expectation was that high anxiety levels in test situations would interfere with the student's ability to retrieve and use information as proposed by the interference model for test anxiety. (Culler & Holahan, 1980). The fact that this did not seem to occur may lend support to the interactional model of anxiety proposed by Endler and Parker (1990) which recognised amongst other factors that coping strategies could reduce state anxiety and consequently the "interference" effects. Another factor may be the nature of the flight test itself. In a situation associated with test anxiety the student is

normally undergoing some form of written examination or evaluation where they are confronted with an unknown task (at least until they are allowed to read the exam paper), which will probably involve recalling and processing learned material under strict time constraints and with little or no opportunity to communicate with the examiner. In contrast, during a flight test, the student will be undergoing a familiar and well-rehearsed routine. There will be very few surprises and it will be possible to communicate with the flight examiner to question and clarify points of the test if necessary. According to McClelland, Patel, Stier, and Brown (1987) the presence of test anxiety under these conditions may lead to "power arousal" which is associated with challenge or threat stressors and may be characterised by an increase in adrenalin production, which may in turn enhance test performance. The overall lack of a relationship between trait and state anxiety and FT 2 performance being possibly attributable to both coping and arousal effects.

5.2 The Relationship between Student Pilots' Gender , Language, and Anxiety

While no relationship was discovered between gender, and trait and state anxiety scores, it was found that students for whom English was the second language (ESL), experienced significantly higher levels of trait anxiety than their English speaking colleagues. No relationship was discovered between language and state anxiety. In contrast O'Hare and Roscoe (1990, cited in Cho, 1998) stated that pilots who speak English as a second language can experience anxiety and stress when communicating with foreign flight crew and foreign ATC controllers. Biggs (1999) observed that "international students" (defined as non-Anglo-Celtic students) attending university, often experienced cultural problems which were typically of three kinds; social-culture adjustment, language, and learning/teaching problems due to 'culture'. According to Biggs (1999) many international students (ISs) have language problems

which need addressing despite language prerequisites for their courses.

The reason for the higher levels of trait anxiety exhibited by the ESL students is not clear. Trait anxiety is thought to be a stable and enduring characteristic while state anxiety is situational therefore it would be expected that language difficulties would be reflected in heightened state anxiety levels rather than heightened trait anxiety. The test instruments used in this research developed from the STAI Manual of Spielberger, Gorsuch, and Lushene (1970) may have cultural limitations. Kline (1993) notes that the norms for the STAI Inventory are high school and college students, psychiatric and medical patients, and prisoners. Although the inventory was developed in the USA for a diversified group, the fact that it was developed from a Western culture cannot be overlooked. No indication was found in the literature to confirm its cross-cultural suitability.

5.3 The Relationship between Student Pilot Pre and Post - Test State Anxiety levels and Evaluated and Non-Evaluated Dual Training Flights.

A significant increase in state anxiety levels was observed, both pre and post-test as the result of the intervention of a formal in-flight assessment. While there was no evidence that the increased anxiety affected the student's performance or the outcome of the flight, further research may be warranted. Should a continuous assessment regime be introduced into the BAv flight-training syllabus, such questions as the long-term effects of evaluated flights on state anxiety and any possible arousal or interference effects would need to be assessed. Biggs (1999) suggested that continuous assessment had the advantage of taking the heat off a final summative assessment but cautioned that students might be

motivated to conceal weaknesses during learning if assessment marks were to count towards a final grade.

The lack of evidence of a relationship between test anxiety and performance may be consistent with the findings of Hunsley (1985) who stated:

> " Whereas some studies have reported a significant relation between test anxiety and course grades (e.g., Culler & Holahan, 1980), others have found no relation (e.g., Paulman & Kennelly, 1984). Research therefore does not strongly support the perception of many students and educators that test anxiety has a profound effect on academic performance". [p.678]

5.4 Changes in the Worry and Emotionality Components of Test Anxiety when undergoing a Flight Test.

An inspection of the trait and state anxiety questionnaires was made to identify the worry and emotionality components of anxiety with a particular emphasis on the identification of the "worry" elements. Wine (1971) cites Morris and Liebert (1969) as suggesting that "it is worry, not 'anxiety,' which affects performance on intellectual-cognitive tasks and which interacts with the relevant variables of the test situation. According to Wine, worry divides the student's attention between self and task to the detriment of performance. Emotionality on the other hand affects autonomic activity, which is less likely to require high levels of attention. In the flight test situation there is an emphasis on attentionally demanding cognitive activity and therefore the identification of the "worry" components of trait and state anxiety was thought to be important. By identifying "worry" components and bringing them to the attention of the flight instructors, future strategies may be developed to reduce student pilot anxiety both in the test situation and during dual training flights.

The research results indicated marked relationships between pre and post-test worry levels and the corresponding state anxiety levels in the student pilots undergoing FT 2. Similarly, a very strong

relationship was observed between pre and post-test emotionality scores with the corresponding state anxiety levels. No relationship however was established between the worry components of trait anxiety and pre-test state anxiety although there was a low correlation between trait (w) and post-test state anxiety indicating a weak relationship. The strong relationship between worry and total state anxiety is not unexpected given that worry implies a preoccupation with performance and concern about the consequences of the test. The lack of a relationship between the worry components of trait anxiety and state anxiety and the weak relationship between the emotionality components of the same, and total state anxiety may possibly be explained by Spielberger, Gorsuch, and Lushene (1970) who stated that even though a person may possess a high level of trait anxiety this does not necessarily translate into a high level of state anxiety unless the person interprets the situation as being threatening or dangerous.

The paired sample *t* test results, indicating significant differences between pre and post-test emotionality and worry scores is consistent with the findings of Spiegler, Morris, and Liebert (1968) who suggested that scores on the worry component tend to be fairly constant across time; while emotionality scores reach a peak immediately before an examination, falling off rapidly immediately after the examination.

5.5 The Relationship between Trait Anxiety and State Anxiety levels during Flight Tests

The final research question attempted to determine if a student pilot's predisposition to trait anxiety affected state anxiety levels during a flight test.

The low correlation between the "person" factors (TINT) and pre and post-test anxiety (FT2A and FT2B), indicate a weak relationship between trait anxiety and state anxiety associated with the flight test. It is interesting to compare these results with the results of a study made by Soric' (1999) on anxiety and coping in the context of a school examination. Soric' (1999) determined that social evaluation trait anxiety, that is anxiety arising from those situations in which we or our actions are evaluated, judged, or observed by others, was highly related to pre-test and post-test state anxiety. Soric' (1999) attributed this finding to the fact that both measurements were conducted in an examination situation which, largely, contained elements of social evaluation, that is, elements congruent with the measured dimension of trait anxiety. Soric' (1999) cites the Endler and Parker (1990) interactional model of anxiety, proposing that the dimension of social evaluation (trait anxiety) in interaction with the congruent situation of social evaluation, conditions changes in experienced state anxiety. While the relationship between trait anxiety and pre and post-test state anxiety in the present study is much weaker than in Soric's it is suggested that the results still conform to Endler's interactional model. Possibly, the weaker relationship may be attributable to the nature of the test itself and the circumstances in which it was administered.

Soric's research was aimed at adolescent high school children who, according to the researcher, point out the fear of negative evaluation as being the main cause of stress in this period of their lives. The student pilots on the other hand were of a more mature age group, being young adults with a mean age of 21 years. It is suggested that the student pilots, having the experiences of adolescence and school examinations behind them, may be less sensitive to the effects of social evaluation.

Earlier in the study it was suggested that the student pilot might perceive the flight test as being a less threatening experience than a formal written examination because of the practical nature of the flight test, focusing as it does, on a series of well-rehearsed events, manoeuvres, and procedures that the student pilot has covered many times with his or her flight instructor, prior to the test. Significantly, the School of Aviation student pilots are required to obtain a pass in an "Improving Human Performance" paper before qualifying for the PPL issue. By the time the student pilot undergoes FT2, instruction would have been received in a wide range of human factor topics including anxiety and aviation, and coping strategies such as visualisation techniques for reducing anxiety. It is suggested that the results of this part of the study may indicate at least some success in the application of *a priori* knowledge of coping techniques, which is an important part of Endler's interactional model of anxiety.

5.6 Limitations of the Study

The small size of the Bachelor of Aviation programme compared to other university programmes resulted in small yearly intakes of students and consequently it took time to achieve a satisfactory sample size for the research. While it was possible to assess student performance in terms of hours to first solo and FT2 results, the two or more years required for the student pilots to complete the programme meant that it was not possible to assess the results of the more advanced flight tests or to examine the long term effect of anxiety levels within a reasonable time frame.

5.7 Conclusions and Recommendations

In reviewing the standard aviation texts, it was found that there was an emphasis on the physiological considerations associated with learning to fly rather than the psychological factors inherent in the

process. While the Bachelor of Aviation programme provides in depth instruction in aviation human factors including, amongst other topics, learning strategies, human error, anxiety and self concept, and stress it is important that the theory as taught in the Improving Human Performance lectures is applied and reinforced in the flight training environment. To achieve this every flight instructor employed by the school needs to be made aware of these concepts. As a majority of the instructors are from a general aviation background and may not be aware of the scope and content of this paper, it is recommended that the relevant areas be covered comprehensively as part of the orientation training of a new instructor. As a further recommendation consideration should be given to similar training or refresher training for all aspiring flight examiners employed by the School of Aviation. Although designed primarily for use with normal adolescents and adults as well as with various patient populations, Spielberger's State-Trait Anxiety Inventory, as modified, seems suitable for measuring these constructs within an aviation environment (Spielberger, Gorsuch, & Lushene,1970) Test anxiety and the associated construct of social evaluation trait anxiety as reported in the literature seems to apply to the flight test situation as well as the more traditional written examination. As a result of the study it is suggested, with caution, that the Anxiety Situation Questionnaire (ASQ) from which "worry" and "emotionality," and the "person" and "environmental" factors can be identified, is a suitable instrument to be used or developed for the application of the interactional model of anxiety in the context of flight testing.

One of the questions raised by the study was the establishment of suitable performance indicators against which the student pilot's progress can be measured. In this study, the benchmarks of hours to first solo and FT2 scores, while appearing at first to be appropriate measures, yielded inconclusive results. Again, it is tentatively suggested that this is in conformance with the fourth

stage of Endler's interactional model resulting from coping strategies feeding back to cause an overall reduction in state anxiety (Endler & Parker, 1990). Of significance to the Bachelor of Aviation Programme is the increased trait anxiety experienced by students for whom English is a second language. While this did not have a measurable effect on performance during the study, the relatively large proportion of ESL students enrolling in the programme, and its high profile in the Asian aviation market indicate that at least in the early parts of the programme lecturers, instructors, and examiners need to be aware of possible raised anxiety levels.

From the ASQ responses there was a statistically significant, weak relationship between the student pilot's concerns about instructor relationships and hours to first solo. This finding was of interest because of its apparent agreement with previous research that established a relationship between the student's attitude towards the flight instructor and the construct of fear. While beyond the scope of the present study the whole area of student pilot/flight instructor relationships in respect to anxiety seems to offer scope for further research.

5.8 Areas for Future Research

While the present study was confined to a single university's Bachelor of Aviation programme, the limitations previously mentioned of restricted sample size would be overcome if the research was expanded to similar institutions offering highly structured professional pilot training courses. This would include military training establishments. A parallel study conducted on general aviation professional pilot training schools would provide a useful comparison. Further research into the interaction model of anxiety particularly in the context of flight training and flight-testing is warranted.

The perception of the flight instructor/flight examiner as a threat and the role of the instructor/examiner as a calming or disturbing influence in the third and fourth stages of the model would be a useful area of research. Similarly, research on the flight instructor's perception and awareness of student pilot anxiety throughout the training programme would be useful in designing strategies for reducing anxiety during flight training and assessment.

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APPENDIX A:

Overview of Massey University Bachelor of Aviation Flight Crew Major.

(Source: Massey University School of Aviation Handbook Annex B, 2000)

BACHELOR OF AVIATION (Flight Crew)

The Massey University Bachelor of Aviation (Flight Crew) is a 400 point degree of which the first 300 points arise from a compulsory 24 paper, 24 month course which closely integrates academic studies with related practicum events.

The Bachelor of Aviation is an applied professional degree designed for students who intend making a career in Aviation as a professional air transport pilot. To this end the academic and flight training components are explicitly focussed on those competencies most relevant to airline operations. Emphasis is placed on multi-crew resource management from an early stage and Aviation Human Factors is a particular strength of the Massey University Programme.

This detailed and specific connection of practicum events to specific lectures and modules is one of the unique qualities of the Massey Bachelor of Aviation. In order to achieve this close integration of flight training and academic study Massey University owns and operates a fleet of training aircraft and a staff of permanent fulltime Flight Instructors; many of whom hold tertiary academic qualifications.

Syllabus

The practicum syllabus contains some 227 "events". The term event is generic and covers such activities as :

Mass briefs
Single engine flight simulator
Twin engine flight simulator

Single engine aircraft :
Dual flying
Solo flying (PIC)

Twin engine aircraft :
Dual flying
Solo flying (PIC)

These events total 166 hours in single engine aircraft and 54 hours in twin engine aircraft. Instrument flying is done in both types and on completion of the course, the student will hold a multi engine instrument rating. On completion of the 24-month programme, the student will hold a **CPL, Multi-Engine Instrument Rating, and ATPL** (frozen).

Lesson No	Type of Lesson	Description	Class	Simulator 1	Simulator 2	Single A/C Ground	Single A/C Dual	Single A/C PIC
1	MB1	Preparation for flight/Documentation	1.0					
2	CPT1	Preflight, Checks				1.0		
3	MB3	Taxying	1.0					
4	CPT2	Taxying				1.0		
5	GF1	Air Experience					0.7	
6	GF2	Training area famil					0.7	
7	MB2	Effects of Controls	1.0					
8	SIM1	Effects of Controls			0.5			
9	MB4	Straight and Level	1.0					
10	SIM2	Straight and Level			0.5			
11	MB5	Climbing	1.0					
12	MB6	Descending	1.0					
13	SIM3	Climbing and descending			0.5			
14	MB7	Turning	1.0					
15	SIM4	Turning			0.5			
16	GF3.1	EoC,S&L					0.80	
17	GF3.2	C&D,Turning					0.80	
18	MB8	Stalling	1.0					
19	SIM5	Basic Stalling			1.0			
20	SIM6	Advanced Stalling			1.0			
21	GF4	Stalling					1.1	
22	MB9	Take-off and Initial Climb	1.0					

23	MB10	Approach and Landing	1.0					
24	MB11	Circuits 1	1.0					
25	SIM7	Circuit procedures			1.0			
26	GF5	Circuits					1.0	
27	GF6	Circuits - Xwind & flapless					1.0	
28	GF7	Circuits - Glide and EFATO					1.0	
29	GF8	Circuits - Check					1.0	
30	T1PC	Circuits - First solo						0.2
31	GF9	Circuits - Glide, Check,					0.8	
32	GF10	Circuits						0.5
33	GF11	Circuits					0.5	
34	GF12	Circuits						1.0
35	GF13	Circuits						1.0
36	GF14	Circuits						1.0
37	MB12	Departure and Rejoin	1.0					
38	MB17	Forced Landing without power	1.0					
39	GF15	PFLWOP					1.3	
40	MB21	Advanced Turning	1.0					
41	SIM8	Steep Turns			0.5			
42	GF16	PFLWOP, Steep turns					1.3	
43	GF17	PFLWOP, Steep turns						1.2
44	GF18	PFLWOP, Steep turns, Stalling					1.2	
45	GF19	Stalling						1.2
46	GFX	As Required					1.2	
47	GFX	As Required						1.0
48	GF20	Revision for FE1					1.2	

49	GF21	Revision for FE1						1.2
50	T1FE	Single Engine Handling 1					1.2	
51	MB16	Basic Instrument Handling	1.0					
52	SIM9	IF - S&L, C&D, Turning		1.0				
53	IF1	IF - S&L, C&D, Turning					1.2	
			15.0	**1.0**	**5.5**	**2.0**	**18.0**	**8.3**
54	GF22	Crosswind Circuits					1.0	
55	MB13	Compass Turn	1.0					
56	MB20	Limited Panel IF, U/A,s	1.0					
57	SIM10	U/A's, Stalls, Steep Turns, Limited Panel		1.0				
58	IF2	S&L, C&D, Turning, U/A's, Limited Panel					1.2	
59	MB30	Navigating by NDB	1.0					
60	SIM11	NDB Tracking and Intercepting		1.0				
61	MB31	Navigating by VOR	1.0					
62	MB32	NDB / VOR Approaches	1.0					
63	SIM12	VOR Tracking and Intercepting		1.0				
64	MB28	Night Flying	1.0					
65	NF1	Intro to night flying					1.0	
66	MB15	Max performance Take-off and Landing	1.0					
67	GF23	Circuits, Max Perf					1.0	
68	MB33	Holding Patterns	1.0					

69	SIM13	VOR-HOLD-VOR/DME 07		1.0				
70	IF3	VOR-HOLD-VOR/DME 07					1.2	
71	NF2	Night flying emergencies					1.0	
72	MB22	Low Flying	1.0					
73	GF24	Low Flying					1.2	
74	NF3	Circuits						1.0
75	MB24	Single Pilot Visual Navigation	1.0					
76	NAV1	Map reading					1.5	
77	MB23	Precautionary Landing	1.0					
78	T2PC	Precautionary Landing (GF25)					1.0	
79	NF4	Circuits						1.0
80	MB27	Survival	1.0					
81	NAV2	V Nav					2.5	
82	MB19	Circuits 2	1.0					
83	GF26	Consolidation						1.2
84	NF5	Circuits						1.0
85	NAV3	V Nav						1.5
86	MB18	Spinning and Visual U/A's	1.0					
87	AERO1	Spinning / Aerobatic intro					0.8	
88	MB25	Lost and diversion	1.0					
89	NAV4	V Nav					2.0	
90	GF27	Consolidation						1.2
91	NAV5	V Nav						3.0
92	AERO2	Loops					0.8	
93	GF28	Consolidation						1.2
94	NAV6	V Nav					2.0	

95	NAV7	V Nav						3.0
96	GF29	Consolidation						1.2
97	GFX	As Required					1.1	
98	GFX	As Required						1.3
99	MB26	Mountain Flying	1.0					
100	T2FE	V Nav					2.0	
			16.0	**4.0**	**0.0**	**0.0**	**21.3**	**16.6**
101	GF30	Review					1.0	
102	MB14	Emergencies	1.0					
103	GF31	Consolidation						1.2
104	AERO3	Barrel rolls					0.8	
105	GF32	Circuit Consolidation					1.0	
106	SIM14	Revision		1.0				
107	GF33	Consolidation						1.2
108	GF34	Maximum Rate Turns					1.2	
109	GF35	Maximum Rate Turns						1.2
110	GF36	Revision for FT 2					1.0	
111	GF37	Revision for FT 2						1.2
112	GF38	Revision for FT 2					1.2	
113	GF39	Revision for FT 2						1.2
114	GF40	Revision for FT 2					1.2	
115	T3PC	FT 2						1.5